THIRTY-SIXTH ANNUAL REPORT

OF

Department of Geology and Natural Resources

INDIANA

EDWARD BARRETT
State Geologist

1911

INDIANAPOLIS:
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THE STATE OF INDIANA,
EXECUTIVE DEPARTMENT,
April 15, 1912.

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statement.

OFFICE OF AUDITOR OF STATE,
INDIANAPOLIS, April 16, 1912.

The within report has been examined and found correct.

W. H. O'BRIEN,
Auditor of State.

APRIL 17, 1912.

Returned by the Auditor of State, with above certificate, and transmitted to Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

MARK THISTLETHWAITE,
Secretary to the Governor.

Filed in the office of the Secretary of State of the State of Indiana.

L. G. ELLINGHAM,
Secretary of State.

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ED D. DONNELL,
Clerk Printing Board.

State of Indiana,
Department of Geology and Natural Resources.

INDIANAPOLIS, IND., April 15, 1912.

Thos. R. Marshall, Governor of Indiana:

MY DEAR SIR—I transmit herewith for your inspection and approval, the manuscript of the Thirty-sixth Annual Report of the Department of Geology and Natural Resources of Indiana, the same being for the calendar year 1911.

Respectfully submitted,

EDWARD BARRETT,
State Geologist.

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INTRODUCTION.

By Edward Barrett.

The work of the department for the year 1911 was conducted along six lines dealing with the geological features and natural resources of the State, enumerated as follows:

1. Glaciation in Its Relation to the Soils of the State.
2. Soil Survey of a Portion of Central and Western Indiana.
3. Water Powers of Rivers of Northern Half of the State.
4. The Pleistocene Age and Its Vertebrata.
5. The Oil and Gas Fields.
6. Hypsometry of Indiana.

A synopsis of each of the above subjects is here given, both as to the manner and areal extent of the investigations. In the body of this volume each field assistant gives an elaborate discussion of his investigations of the work assigned him. The bulk of the investigations made by the State Geologist and his field assistants during the year 1911 is so intimately related to the question of glaciation that it is deemed best to discuss at some length the Ice-Sheet Theories. In order to avoid repetition, early last spring the State Geologist notified the field assistants to avoid a detailed discussion of glaciation in their reports, he expecting to cover the subject in sufficient detail to embrace all its relations.

Prof. O. P. Hay submitted his paper on The Pleistocene Age and Its Vertebrata on April 1st, and in it he necessarily discusses the Ice Age in relation to its Vertebrate Fauna; this discussion encroaches but little on the paper by the State Geologist who deals mostly with the Soil phase of Glaciation. The Iceberg and Ice-Sheet Theories are discussed at some length, the writer indicating which theory in his judgment is most deserving of acceptance. There is no phase of geology so important to the student, the farmer, or the geologist in acquiring a thorough knowledge of soils as the question of glaciation.

Soil Survey.—This survey is of paramount importance to the farmer, the gardener, and the landowner. Since it is important to these classes of people, it touches the welfare of the whole people, inasmuch as the welfare of the whole people depends upon the products of the soil.

The first soil survey ever made in Indiana was by the U. S. Bureau of Soils, of which Milton Whitney is chief, and the work was done by geologists, chemists and soil men of the above department. Below are some of the counties, with the year of survey: Posey, 1902; Madison, 1903; Marshall, Spencer and Warrick, 1904; Tippecanoe, 1905; and Marion in 1907. Other counties were surveyed by this Bureau later. The work done by the U. S. Bureau was on its own initiative, and not in co-operation with the State. The first soil work done by the State of Indiana was in 1907, mostly in the unglaciated portion of the State.

Knowing the importance of the soil survey, the present Geologist, on taking charge of the department, January 1, 1911, organized a large soil force, working in harmony with the methods of the U. S. Bureau. Four areas were selected for soil work and placed in charge of competent field men. The work in the counties of Hancock, Shelby and Johnson was done by Prof. Allen D. Hole, of the Chair of Geology at Earlham College, Richmond, Indiana. Prof. Hole was formerly with the U. S. Geological Survey, and the State Surveys of Iowa and Illinois, and brought to his work a rich, ripe and painstaking experience that few States are fortunate enough to receive.

The area comprising Owen and Morgan counties was in charge of J. B. Edmondson, a graduate of Purdue University, Lafayette, Indiana, and fresh from the agricultural laboratories of that institution. Mr. Edmondson went carefully over the area assigned him and supplemented his work with talks to farmers about their soils.

Charles W. Shannon, a graduate of Indiana University, and probably the most experienced soil man in Indiana, had charge of Clay, Vigo, Sullivan and Knox counties, and the people of these counties have the advantage of a report from his hands.

The soils of an area consisting of St. Joseph and Laporte counties were surveyed by E. J. Quinn, a graduate student of Notre Dame University, South Bend, Indiana, and for a time instructor in chemistry in that institution. The department had no more conscientious and industrious field man than Mr. Quinn. He also did the soil work of Bartholomew County, which it seemed for a time would have to go over until next year.

The State Geologist is pleased to announce that he has arranged for co-operative soil work for the year 1912, between the Department of Geology and the U. S. Bureau of Soils, and that the soil work of the State will have the benefit of the scrutiny and criticism of that Bureau.

Water Powers.—All of the important rivers of the northern half of the State, including the Mississinewa, Eel, Pigeon, Elkhart, St. Joseph, Tippecanoe, Sugar Creek and the Wabash from Markle to Terre Haute were surveyed. The work was in charge of Mr. W. M. Tucker, of Indiana University, assisted by Mr. J. C. Clark, of Purdue University. Many new power sites were located and estimated, and a number of old sites were surveyed and new estimates made, corrected to new conditions. The work appears in detail in the report of Mr. Tucker.

The Pleistocene Age and Its Vertebrata.—This important scientific paper is the result of years, perhaps a lifetime, of research by Prof. O. P. Hay, of the National Museum, Washington, D. C. There is no one in this country more capable of preparing a paper on this subject than Prof. Hay. In addition to his long experience as college instructor in geology and zoölogy, he has had years of research work in the National Museum at Washington. Besides the above resources for preparation, he visited many museums of Natural History, such as Philadelphia, New York and Chicago in preparing his report, examined skeletons, and made measurements and photographs.

The Oil and Gas Fields.—There was no survey of these fields made as a special assignment. The Chief Supervisor of Gas, Mr. William E. Morse, has been in the field continually, and conditions and new developments are noted in his report. Great good has been accomplished by his work of checking the waste of gas, and every precaution has been made to conserve the gas, without discouraging the legitimate development of the oil industry. The tendency of gas and oil investments is to attempt the development of these resources by deeper drillings in new areas, rather than in the old fields.

Hypsometry of Indiana.—Practically no topographic work has been done by the State of Indiana. Small areas in Spencer, Warrick, Monroe, Clay, Lake and Allen counties have been surveyed by the U. S. Geological Survey, but these have never been followed up by any State work. In view of this, the present Geologist prepared for this volume exhaustive tables of altitudes from profiles furnished him by the railroads operating in Indiana. A more extended discussion of hypsometry, or topographic work, appears in another part of this report.

Museum and Department Library.—The most of the material in the museum needs rearrangement, classification and cataloging. No inventory of the museum and library collections was ever made and none ever furnished to the writer.

In the Department of Relics no systematic arrangement has ever been made. At the present date, however, a rearrangement of this material is being made into chronological and historical periods, and it is the purpose to supplement this work with like work in the Department of Minerals. Many of the files of the State Reports, from the various States, are incomplete, and an attempt is now being made to fill out these files by securing copies from State Geologists.

Glass, Moulding and Sawing Sands.—Many inquiries were received during the year as to the possibilities of the State in regard to the above varieties of sands. With these inquiries in view, the writer visited a number of places having sand deposits and a number of analyses were made. The investigations, however, could not be completed in time for this report. The work will be continued during the coming season and the results will be incorporated in the Annual Report for 1912.

Correspondence.—Much of the State Geologist's time was occupied during the past year in answering hundreds of letters of inquiry from citizens and corporations touching the natural resources of the State. Many samples of minerals have been sent to the Department for examination and analysis, and all such have been attended with promptness and exactness.

Glaciation and Soils.

By Edward Barrett.

In the following discussion of the drift age, or Ice-sheet, it is not the purpose of the writer to try to prove or disprove any of the many theories extant as to how the thick mantle of material that covers the northern third of North America, and the northern third of the United States, and the northern three-fourths of Indiana came to be where it is. But, rather, it is the writer's purpose to admit the fact that there was an Ice-sheet at one time in remote ages that covered the above areas, and left the rich heritage of mantle drift where we now find it. Indeed, the main purpose of this article is to discuss the marvelous era known as the Ice age in its relation to our soils, so that we may more readily understand the discussions of soil types in different parts of the State as described by the several field men who worked on the Soil Survey. The words *drift* and *glaciation* are used frequently by the field men in descriptions of types, and questions like the following will naturally arise in the minds of average readers. What is Drift? What is Glaciation? Whence came this mantle of soil? How came it to be here? What power, or force, made it and brought it here?

Primarily, the purpose of the Soil Survey is to assist the farmer in a better understanding of his soils, and a knowledge of the above questions will help him.

It will not be out of place to discuss briefly the two theories of glaciation that are most generally accepted as explaining the work of the Ice age and Ice-sheet.

The first of these is known as the *iceberg* theory. To the mind of the writer, this is the simpler of the two, since it introduces no new phenomena, nor does it involve any crustal movements outside of the ordinary, i. e., the elevation and subsidence of the crust of the earth—admitted phenomena ever since the earth left its molten stage. In fact, the iceberg theory is simply that the northern part of North America by crustal subsidence was submerged by the waters of the northern ocean and that icebergs broken off from mountains of ice in northern regions were floated south by ocean currents, just as they may be seen today in the north Atlantic, particularly south of Greenland. These icebergs were as great beasts of burden, carrying the materials torn from cliff and crag and ledge, cut from sides of shore and bluff, or picked up from the bottom by these huge moving masses, sand, gravel, dirt, and huge boulders of which our soil and subsoil are made, and after melting dumping their loads in southern latitudes on the bottom of the sea.

Following the dropping or deposition of glacial debris by the icebergs there was elevation of the northern part of North America

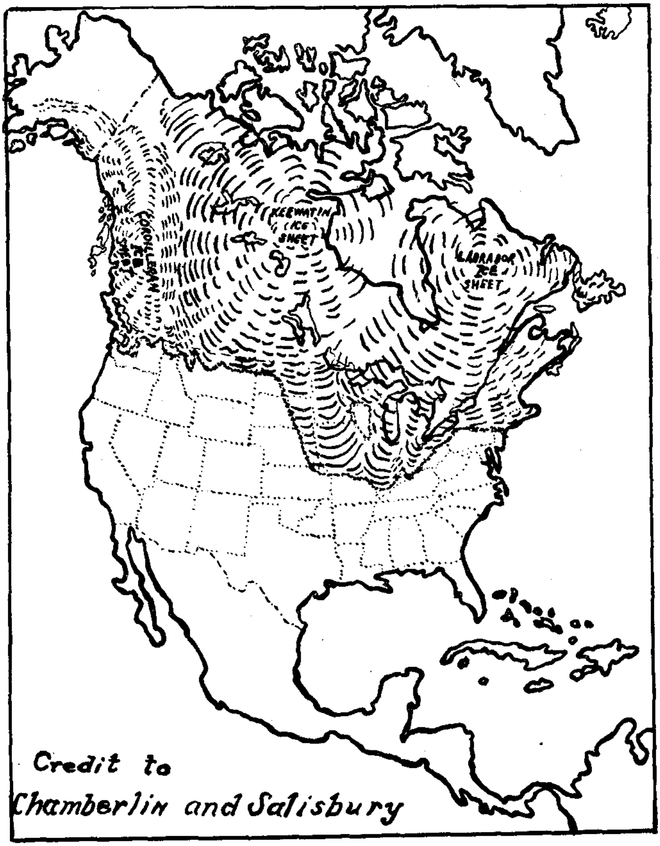
Glaciated Boulder found about one mile north of Warwick, St. Joseph County, Township 38 North, Range 1 East, on Railroad to St. Joseph, Mich.

almost, if not quite, to its present altitude. Thus the "dry land" was formed. The theory is simple and probable and involving only conditions that existed, preeminently those of elevation and subsidence, in the early stages of the geological history, and conditions too that are being observed today, though of course in a lesser degree.

The Ice-sheet theory, the one that is accepted by the scientific world almost unanimously, presupposes higher elevation in northern North America and vast accumulations of snow and ice. Such accumulations would be the result of high altitude and latitude.

Scientists recognize at least three great centers of accumulation and radiation known as the Labradorean, the Keewatin, and the Cordilleran. (For location of these centers see map after Chamberlin and Salisbury, below.)

"From these centers, ice-sheets spread, covering some 4,000,000 square miles. The centers from which the movements radiated are



Sketch-map showing the North American area covered by ice at the stage of maximum glaciation.

determined with certainty by glacial striæ, and by the direction of transportation of drift.

"From the Labradorean center, the extension was notably greatest to the southwest, and in this direction the limit is some 1,600 miles from the center of dispersion, in latitude about 37° 30′, the most southerly point of the great lowland glaciation of the period. The extension of the Keewatin ice-sheet to the southward was scarcely less. It found its limit in Kansas and Missouri, about 1,500 miles from its center, while to the west and southwest it reached 800 to 1,000 miles toward the Rocky Mountains. One of the most marvelous features of the ice dispersion was the great extension of the Keewatin sheet from a low flat center westward and southwestward over what is now a semi-arid plain, rising in the direction in which the ice moved, while mountain glaciers on the west, where now known, pushed westward but little beyond the foothills.

"The Cordilleran Ice-sheet is less simply defined. Much of it occupied a plateau hemmed in by mountains, and plateau glaciation was complicated by extensive mountain glaciation of alpine type. In some sense, the whole Cordilleran Ice-sheet was the product of a confluence of mountain glaciers deploying on the intervening plateau; but there appears to have been plateau glaciation not solely dependent on contributions of ice from the mountains. The southerly lobes of the complex body of ice crossed the boundary of Canada into the United States. Though hampered by its environment, the Cordilleran ice-sheet seems to have conformed to the habit of the Labradorean and Keewatin sheets in expanding chiefly to windward. The plains of Alaska seem to have been largely free from glaciation even when the waters of the Ohio and the Missouri, 2,000 miles farther south, were being turned from their courses by the ice-sheets. The localization of the glaciation is one of its most significant features.

"South of the more or less continuous Cordilleran glaciation of Canada, local glaciers were widely distributed in the western mountains, even down to New Mexico, Arizona, and southern California. They were larger at the north and smaller at the south. Of glaciation in the mountains of Mexico little is known.

"Greenland was glaciated somewhat more extensively than now, but its glaciers appear never to have extended to the continent, as was formerly conjectured. Newfoundland seems to have had its own ice-sheet, and the same was probably true of Nova Scotia, and perhaps of the peninsula between the Bay of Fundy and the lower St. Lawrence."

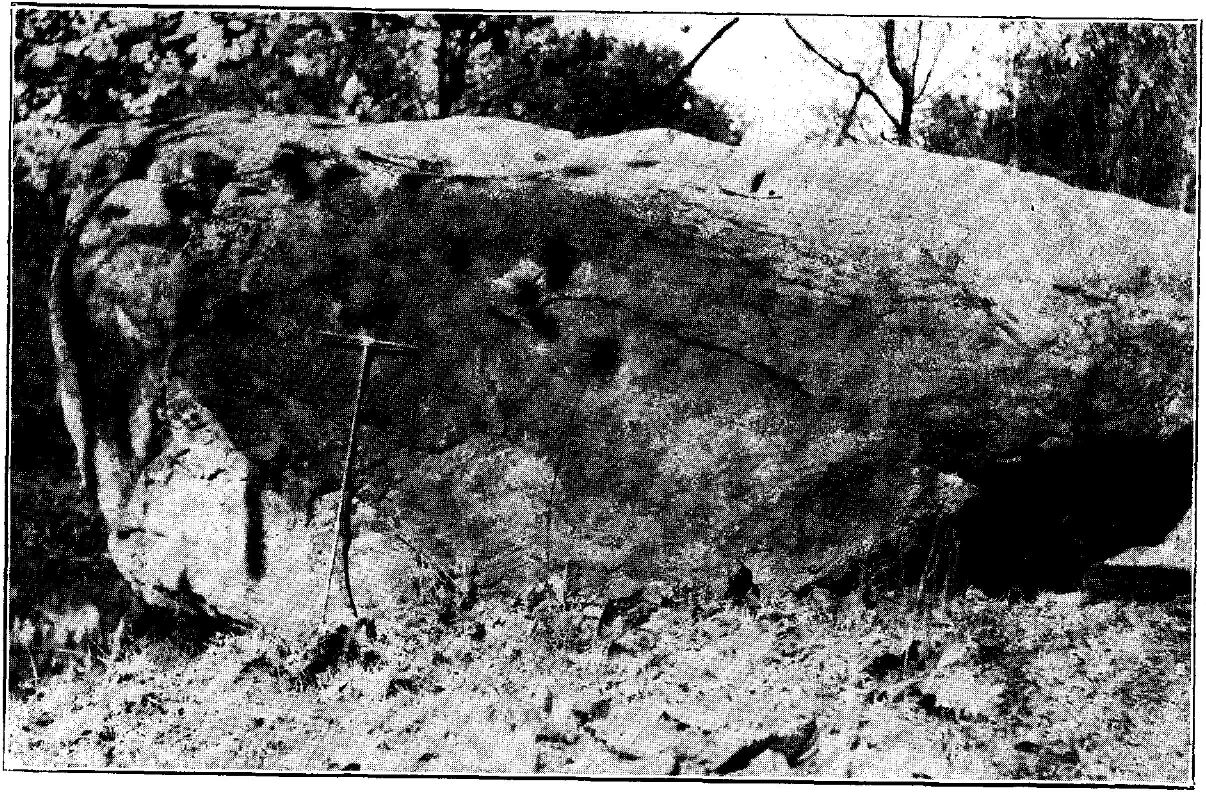
The center of radiation that we in Indiana are most interested in is the Labradorean, for this Ice-sheet in two of its stages, the Illinois and the Wisconsin, carried to Indiana the two vast accumulations of drift that have influenced so profoundly the surface and soil of the northern three-fourths of the State, and reduced to their last analysis, have influenced our civilization to a marked degree.

The older of these two ice-sheets is the Illinois, the southern limits of which are marked by a line running through the following counties: western Clark, eastern Washington and Jackson, extreme southwestern Bartholomew, northern Brown and Monroe, extreme southeastern Owen, eastern Greene, western Martin, northwestern Dubois, central Pike, southeastern Gibson and central Posey to the Wabash River.

South of this approximate line lies the unglaciated portion of the State, comprising in whole or part, twenty counties. The soils of this region, known as residual, are derived from the disintegration of the underlying rock by action of heat and cold, freeze and thaw, wind and rain, acids from the vegetation above, and carbonic acid from the air carried down by rain. If all the soil and subsoil and related material covering the unglaciated portion of the State were lifted or removed, the underlying rock would present the appearance of a loose, broken, disintegrating mass, with no evidence of an abrading force having passed over it. The soil and subsoil make but a thin mantle, rarely ever more than a few feet thick, except along streams where erosion, floods, and slope wash have brought more or less drift from the adjacent glaciated area. Residual soils are necessarily deficient in many of the principal elements of mineral plant food because as a rule they are derived from one or two kinds of rock, either limestone or sandstone, or both, and the underlying rock of the unglaciated area abounds in these varieties.

The area of the drift material of the Illinois ice-sheet in Indiana lies between the above described line and a line beginning at the southeast corner of Franklin County, northwest into southern Fayette, turning southwest across the northwest corner of Franklin, and southwest across Decatur to the southeast corner of Bartholomew, northwest across this county into southern Johnson and across its southwest corner, into Morgan, thence northwest to southeastern Putnam, northwest into Parke and southwest across its southeastern corner, and striking the middle of the northern boundary of Vigo, thence southwest across its northwest corner to the Indiana-Illinois State line. The last described line marks the southern limit of the Wisconsin, or latest, ice-sheet and drift.

The soil and subsoil of the area between these two lines is made up of the Illinois drift, which disappears under the Wisconsin drift. The soils of this region have many rock elements not found in the residual soils, to the south. The Illinois drift is quite thin in certain areas, and erosion has played such a prominent part in removing the drift that in many places residual soils prevail.



Glacial Boulder found in Madison Township, Morgan County.

From the line that marks the southern limit, in Indiana, of the Wisconsin ice sheet, northward to the Indiana-Michigan line, glaciation has profoundly influenced the topography and soils of the State, and added many mineral foods to the soils. The combined thickness of the two great drift mantles over this portion of the State varies from 40 or 50 to 250 feet, the average being near 150 feet.

Thus far in this discussion we have not mentioned the many advances and retreats the ice-sheets may have made, due to variations in the climatic conditions of the periods, nor have we noticed the possible inter-glacial periods. Our sole purpose is to bring prominently before the reader the two great glacial periods that have benefited our soils so marvelously in bringing a rich heritage of mineral plant food from regions far to the north where the rocks differ so widely in chemical elements from our own. Bearing on this point, we quote the following from Circular 79 of the Ohio Agricultural Experiment Station and apply it to Indiana:

"Thus we see that the larger part of the surface of Indiana has been overrun by the continental Ice-sheets which crept southward from the polar regions in prehistoric times, grinding into gravel and powder the rocks over which they passed and spreading the material thus formed in the sheet of drift clay which covers the northern three-fourths of the State, and from which the soils of that region have been formed.

"The outcome of this soil history is that throughout the drift covered area of Indiana the soil is stored with the essential mineral elements of fertility in quantities sufficient to maintain crop production at the maximum limit, which the various species of plants are capable of attaining, for a very long time, were they in such form that they could make use of them.

"The soil a great storage battery: A little reflection, however, will show that if all the plant food in the soil were immediately available it would have been leached out and carried to the sea ages before man came to inhabit the earth, except in those regions where the annual rainfall is less than the yearly evaporation; but as it is, this plant food is stored in such forms that it is only given up little by little, as each suceeding annual growth of vegetation has need of it, and to prevent the possibility of waste, on most soils, and under natural conditions, the quantity thus yielded annually is less than the crops cultivated by man are capable of utilizing, under the favorable conditions for growth which cultivation provides.

"Forms in which plant food is stored: Some of these forms of food storage may be illustrated by the following examples: Orthoclase feldspar is a constituent of granite, and is one of the chief sources of clays; it is therefore a mineral of great abundance. This feldspar contains nearly 14 per cent. of potassium, or three times as much as wood ashes, but this potassium is held in such firm combination that feldspar has never yet been made a source of the potash used in human industry, multiple as are the uses of this substance and urgent as is the demand for a cheaper source of it.

"Another illustration: Phosphorus is universally distributed through the soil, usually in combination with lime or iron; but when we attempt to use either of these combinations as a fertilizer without some treatment calculated to break up the combination and liberate the phosphorus we get practically no result. Immense beds of phosphate of lime are found in several southern States, from which a large part of the phosphorus of manufactured fertilizers is drawn; but so necessary is treatment of this material, either with suitable chemicals or by incorporating it with fermenting manure or other organic matter, that without such treatment it is practically worthless as a fertilizer.

"Again: Swamp muck or peat is rich in nitrogen, the air-dry material containing sometimes as much as two per cent. or more of this element. But this substance is the result of the growth of plants which live where their roots are constantly submerged, and it has acquired such resistance to the ordinary agents of decay that until this resistance is overcome by proper treatment the nitrogen of peat is held in almost as firm a grip as the potassium of feldspar or the phosphorus of the southern rocks.

"Total quantity of plant food not an index to productiveness: From these examples it is evident that the total quantity of a given chemical element found in a soil is not a trustworthy index to the fertility of that soil. For instance, the East farm of the Ohio Experiment Station, on which some of its soil studies are located, is found to contain 1,100 pounds of phosphorus per acre in the upper foot of soil, or enough of this element for 117 forty-bushel crops of wheat, yet when phosphorus is omitted from the fertilizer this land produces only a little more than twelve bushels of wheat per acre, even when available nitrogen and potassium are furnished in great abundance.

"This land also shows in the surface foot a total of 56,000 pounds of potassium per acre, or as much of this element as would be carried in nearly 1,500 forty-bushel crops of wheat; yet the addition of a few pounds of a readily soluble salt of potassium to a fertilizer carrying nitrogen and phosphorus has caused a further increase in the fourteen-year average yield of wheat of nearly three bushels per acre over the yield produced by the nitrogen and phosphorus without the potassium.

"Again: This land contains as much nitrogen to the acre as would be found in more than 100 forty-bushel crops of wheat, and yet the addition of twenty-five pounds of nitrogen per acre, carried in dried blood and nitrate of soda, to a liberal dressing of phosphorus and potassium, has increased the yield by a fourteen-year average of six bushels per acre. But twenty-five pounds is only about one part in 140,000 of the weight of an acre of soil, taken to the depth of one foot, or seven ten-thousandths of one per cent.—a quantity so small as to be far within the limits of error of ordinary chemical analysis.

"Attempts to determine available plant food: After discovering that the total quantities of plant food were not a reliable guide to the fertilization of the soil, chemists attempted to discover some method by which the disposition of the soil to give up its stores might be ascertained, and many methods of analysis have been devised in the attempt to imitate the action of the plant roots in unlocking these stores; but here again disappointment has been the reward of the investigator. It is true that some of these methods are, in some respects, a nearer approach to a solution of the problem than the total analysis; but when the chemist faces the fact that an acre of clover will abstract from the soil approximately ten times as much lime and only half as much phosphorus as would a corn crop grown on the same land and under the same conditions, he faces a problem which chemistry is not yet able to solve."

It is not a far stretch of the imagination to think that Indiana and parts of surrounding States also were once covered by a portion of the great continental Ice-sheets referred to above. Probably 25,000 of our State's 35,000 square miles were thus covered. Today, an Ice-sheet 500,000 square miles in extent covers Greenland. This is twenty times as large an area as was covered by the ice-sheets in Indiana. Again, the Greenland Ice-sheet doubtless has movement from a center, as great masses of ice are continually breaking off about the coast, and dropping into the Atlantic Ocean; these masses float to the south as huge icebergs and often carry on their sides and bottoms loads of debris gathered from the surface of Greenland.

If all the drift covering the glaciated portion of Indiana could be lifted or removed, the surface of the underlying rock would present an appearance in marked contrast to the underlying rock in the unglaciated region. The surface would be found to be planed and smoothed; striated and grooved; and the disintegrating mass of rock, noted below the residual soil in the unglaciated area, would be entirely absent. The reason for this is apparent—the thick mantle of drift prevented action by the disintegrating agents, after the ice-sheet passed over.

Bearing on the subject of glacial deposits and soils, Lyon and Fippin say:

"Purely glacial deposits differ in chemical and physical properties from soils derived from the same formations by other means. There is a large element of mechanical grinding without any large amount of chemical change or solution. The particles have not been subjected to long-continued leaching, which characterizes residual or marine soils. Such material is chiefly rock-flour, that is, pulverized rock. The readily soluble minerals and elements are therefore present in proportionately larger amounts than in soil formed by other means. While a residual soil from limestone may be very poor in lime carbonate, a glacial soil formed from limerock is often rich in lime, sometimes containing 50 per cent. of that constituent, as has been found in some Dakota soils. As appears from the tables of analyses, such soils are generally rich in all of the basic elements.

CHEMICAL COMPOSITION OF GLACIAL SOILS. HYDROCHLORIC ACID ANALYSES.

	I.	II.	III.	IV.	V.	VI.
	Silt Loam, Wooster, Ohio.	Clay Loam, Strongsville, Ohio.	Loam, Columbus, Ohio.	Clay Loam, Germantown, Ohio.	Loam Subsoil, Prairie, Western Minn.	Loam Subsoil, Prairie, Southeastern Minn.
1. Insoluble	87.85	83.80	83.87	89.20	73.95	74.05
2. Silica (SiO_2)	....	....	....	....	6.85	8.46
3. Alumina (Al_2O_3)	3.46	4.11	4 26	3.69	4.63	3.27
4. Ferric iron (Fe_2O_3)	3.30	4.72	3.63	2.26	3.05	5.44
5. Ferrous iron (FeO)	....	....	....	....	....	....
6. Sulfur trioxide (SO_3)	0.04	0.03	0.10	0.03	0.04	0 12
7. Phosphoric acid (P_2O_5)	0.11	0 09	0.15	0.12	0 26	0 16
8. Lime (CaO)	0.25	0.18	0.69	0.13	0.70	0.51
9. Carbon dioxide (CO_2)	....	....	....	....	0.36	0.09
10. Magnesia (MgO)	0.39	0.45	0.62	0.37	0 36	0.22
11. Soda (Na_2O)	0.34	0.29	0.78	0.23	0.42	0.16
12. Potash (K_2O)	0.25	0.22	0.56	0.21	0.40	0.22
13. Water	....	....	....	....	....	....
14. Organic matter	....	....	....	....	....	....
15. Volatile Matter	4.09	5.92	5.64	3.86	9.12	7.29

"The physical properties of glacial soils are also distinctive. Excepting subsequent modifications due to water, such deposits show little or no stratification or sorting. They are heterogenous in material and arrangement. Much of such material is termed boulder clay, from the mixture of coarse and fine particles. It is also to be noted that such soils contain, relatively, a larger proportion of silt particles, and a smaller amount of clay, than soil formed by purely chemical process from the same rock.

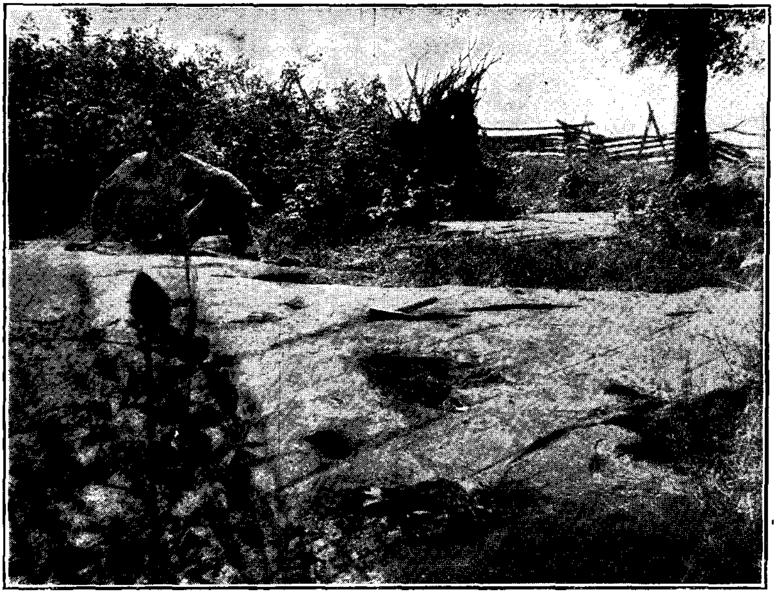
"Associated with the results of pure ice-action is much modified glacial till, due to the influence of great volumes of water. Naturally, the melting of the ice results in immense volumes of water, which drain away over, under, or along the ice margin. Temporary streams of large size and great violence existed and there were also ponds and lakes, some of the latter of very great extent. This water further assisted in moving the ice debris. Such deposits are called modified drift, or aqueo-glacial deposits."

S. W. Fletcher, of the Michigan Agricultural College aptly puts the matter as follows:

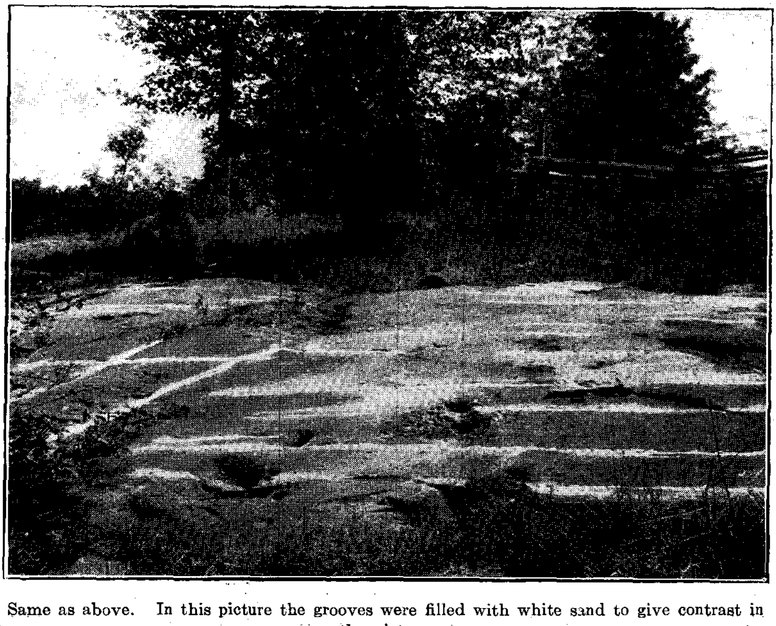
"As would be expected, the distribution of drift soils is very erratic. An acre may contain several wholly distinct kinds. There is a field of one acre near Lansing, Mich., in which about one-half of the soil is a stiff clay, one-fourth is gravelly loam, and the balance, which was formerly a swamp, is muck. Who would try to advise the owner how to treat this field as regards tillage, fertilizing, and draining?

"The value of drift soils for cropping is very variable, depending upon the material of which they are composed, and the way in which they are laid down. As a rule, however, they are fertile because they are composed of materials that have been brought together from several sources, and there is therefore greater likelihood that the essential plant foods will be present in abundance. They are apt to contain more sand or gravel and less clay than sedentary soils; hence they are usually of good texture and easily worked. But a drift clay or muck is not more valuable or manageable than a sedentary clay or muck. Those containing a fair percentage of clay are more valuable than those that consist chiefly of gravel."

The soil survey now in progress in the glaciated area of Indiana, the writer believes, is the most important survey ever undertaken by the Department of Geology. Every other mineral resources in the State has been surveyed and resurveyed. The stone, the coal, gas, oil, surface and under clays all have been written



Glacial Striae on Mansfield Sandstone on farm of James Campbell near Bowling Green. There are several grooves deeply cut and many slight markings are visible.



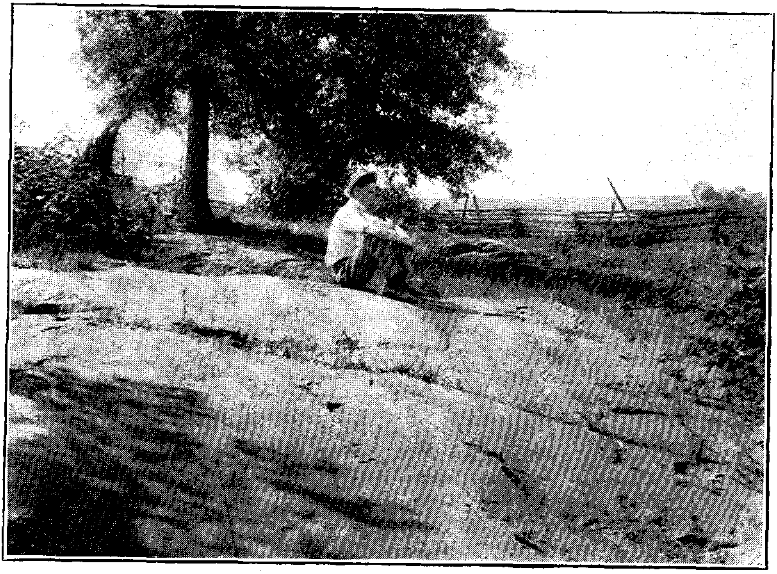
Same as above. In this picture the grooves were filled with white sand to give contrast in the picture.

about over and over again. The entire gamut of geological formations from the lowest Ordovician up *to* the Glacial have been described and redescribed. But the topmost formation, the soil, the one on which we live and move and have our being; the one which is a composite of all geological formations; the one which came to us mostly from regions far to the north and without money or price; this soil, the richest heritage of a beneficient Creator, is at last getting the attention it so richly deserves at the hands of our National and State governments. I say the survey is important because the soil constitutes the one great inexhaustible natural resource of the State. "From it spring not only the food and raiment of the people, but nearly 50 per cent. of the materials used in manufacture, and more than 60 per cent. of the commodities exchanged in commerce." Important because it touches every one of our State's 22,500,000 acres. Important because the cultivation of the soil engages more of the brain and brawn of the State than any other occupation or dozen occupations. For these reasons, and many others that could be given the department is devoting the bulk of its energy and means to this survey. Next year we shall devote two-thirds of the appropriation of the department to soil work. This year the field work, under my direction, has been done in a belt of counties through the State just south of the National Road and southwest as far as Knox County. The equipment and work of the soil men may be described briefly as follows: Each man is assigned an area consisting of one or more counties, and supplied with apparatus for the work. The equipment consists of an extension soil auger, size one and a half inches, a hammer, microscope, barometer, level, acids and blue litmus paper for making tests, maps, and a carrying bag. After locating in a township the field man goes out a foot from day to day over as much area as he can cover over hills, valleys and plains. A soil examination consists in boring to a depth of three feet with the auger and bringing up the soil and subsoil; the upper six to ten inches as a rule are regarded as the soil and all below this as the subsoil. However, the thickness of the soil may vary, sometimes less than this and sometimes more, dependent on the location, as uplands and bottom lands. Where there is similarity of texture and color the work consists of numerous examinations; where there are variations, samples are taken up and put in bags, the exact geographical location being noted on a card deposited in the bag with the soil, and also noted in the field book. The geological features of the area are studied, particularly the underlying formation, so that in case of residual soil (soil made by disintegration cf underlying rock) its character and influence on the surrounding soils may be noted. However, only a very small portion of the areas surveyed this year have residual soils—a small part of southwestern Bartholomew and southeastern Owen counties. There are no residual or unglaciated soils in the northern three-fourths of the State. The practiced eye and touch of the field man soon learns him to distinguish the slightest variation in composition, texture, color, and organic matter in the soils he examines. The topography of an area has much to do with its soils, certain types being found at different levels or altitudes. The questions of natural drainage and necessity of artificial drainage are studied and worked out by the soil man. If the soil is so situated as to have excessive or deficient drainage, the highest efficiency of the soil cannot be expected until these conditions are alleviated. Areas of sour soils are noted and the degree of the acidity determined by the litmus reaction test. Areas of wornout or exhausted soils are marked out and the proper treatment of such soils determined, if possible.

After an area is surveyed in this manner, the soil samples collected are sent in to the department and two analyses made. First, a mechanical analysis with a system of screens is made. Five separations based on the size of the particles of a sample are made. The separations thus made are grouped as fine gravel, coarse sand, medium sand, fine sand, and very fine sand. The silt and clay separations are made with sedimentation bottles, or the centrifugal machine. The mechanical analysis of a soil is very important, for by it the texture is determined, and the moisture and aeration are dependent upon the texture. The second analysis is chemical. By this the chemical constituents of the soil are determined. The purpose of this analysis is to reveal, if possible, the plant food present or lacking in the soil. This does not mean, however, that this analysis shows the available plant food as most people think and believe. The chemical analysis may or may not show the available plant food in a soil. Most likely not, I dare say. The analysis may show the amount or per cent. of nitrogen, phosphorus, potash, or lime, four essential plant foods in a soil, but it cannot show whether these are in a condition to feed the plant; it is barely possible that it will take the addition of a fertilizer, or some form of organic matter to put the above plant foods in a condition to be absorbed by the plant. To illustrate this point further, permit me to quote from Prof. Fletcher of Michigan:

"The analyses of representative soils show that all of them contain almost unbelievable quantities of the plant foods that we buy and apply so grudgingly. An average farm soil usually contains about 4,000 pounds of nitrogen, 6,000 pounds of phosphoric acid, and 20,000 pounds of potash per acre in the upper eight inches of soil. 'Wornout' soils, which scarcely produce enough to pay for cropping them, often contain nearly as much plant food as this, while some rich soils have over 6,000 pounds of nitrogen, 10,000 pounds of phosphoric acid, and 50,000 pounds of potash per acre in the first eight inches. Besides all this large amount of plant food in the surface soil, the soil below the first eight inches usually contains nearly as much, and a part of this can be used by the roots of most farm crops. These figures are astounding to those who have believed that a soil gradually ceases to be productive because the plant food in its becomes exhausted. The chemists give us indisputable proof that even a soil that has become so 'poor' that it hardly pays to crop it, is likely to have stored within it tons upon tons of plant food; that it is in no way exhausted, as we have been taught to believe. Yet the fact remains that this same soil will not produce large crops. What, then, is the trouble? Much of the tons of plant food that the chemist finds in ordinary farm soils, is 'locked up', or unavailable, from two causes. In the first place it may not be in the right form for plants to use, it may be in a compound that it distasteful to the plants; or it may be in a form that is not soluble in soil water, so that it cannot be absorbed by the roots. Plants accept food only when it is in a certain form. The chemist, however, cannot tell how much of the total amount of nitrogen, potash and phosphoric acid that he finds in soil is in such shape that plants can use it. He cannot determine with any degree of certainty what proportion of the 4,000 pounds of nitrogen, 6,000 pounds of phosphoric acid and 20,000 pounds of potash that are in an acre of average farm soil is in the right form for crops to use. There is no way of finding out this very important point except to grow plants upon the soil."

Numerous letters come to the department requesting chemical analyses of soils under the erroneous impression that such analysis will show the available plant food in soil samples sent in. My instructions to the field men were to get the above erroneous idea out of the minds of people whenever possible, and substitute the idea of a mechanical analysis, coupled with proper drainage, aeration, moisture, organic matter, and tillage.



Showing polished surface oi Sandstone polished by glacier. Near Bowling Green, Clay County.

Glacial boulders of large size in field — miles northwest of Bowling Green. This is the southern limit of boulders of size in this area.

Erosion caused largely by the removal of forests and improper tillage is devastating large areas of Indiana soils, particularly in the southern part of the State. When farmers learn to cultivate slopes or hillsides by contour or terracing, or not at all, much erosion and devastation will be prevented.

Mapping is another essential feature of the work of the soil survey. Two sets of maps are made and used by the field men—one a base map, showing sections, townships, ranges, drainage and roads. This is for field use. The other is for locating areas of soil types after the examinations and analyses are all made; a print of this map accompanies the published report of the area.

The purpose of the Indiana Soil Survey is to assist farmers in increasing the productivity of the soil. To help them make two blades of grass grow where one has grown before, by suggesting better methods of drainage, aeration, adaptation, rotation and tillage. Our purpose is identical with that of the United States Deparment of Agriculture, from which we quote the following:

"The work of the soil survey is based upon the principle that there are differences among soils which so affect plants that not all soils are equally suited to the production of all crops. This work, therefore, comprises a study of both the character of these soil differences and the effects which they produce in the growing of farm crops.

"In the field work of the soil survey the soils are studied to determine their texture, or the relative amounts of coarse or fine particles of which they consist; their structure, or the relationship of these particles one to the other; their organic matter content, both quantity and distribution; their internal natural drainage, and their topographical relief. These factors operating together determine the character of the home which plants are to find in the soil. All masses or areas of soil which are found to be closely similar in all of these respects are said to belong to the same soil type. Under similar climatic surroundings the type is capable of producing similar kinds of crops, and under the same conditions of farm management and of farm efficiency they may be expected to produce practically equivalent amounts of crops. It has also been found that several soil types in a given region may differ only in their texture, being identical or similar in all other respects. Such a group is called a series. Again, several series have been found to be derived from the same classes of material by similar processes and to exist in a region having similar climatic features in the broadest sense. Such a region constitutes a soil province.

"The soil survey recognizes at present thirteen great soil provinces, fifty-eight soil series, and 461 soil types. Of these types some 130 are more or less local in character, while the remainder are of widespread occurrence within their respective provinces.

"It is necessary that the discovery, introduction, and culture of crops adapted to various types shall follow such lines that the greatest food values as well as the highest commercial values shall be rendered by each soil. It is also a necessity that upon widely extended types such crops shall be grown as are subject to wide demand in the markets of the world. Otherwise the farmers engaged in crop production must face a destructive competition or else portions of the soil type must be neglected or but feebly utilized.

The soil-survey work thus possesses a dual aspect: (1) It must deal with those problems of crop and soil adaptation which concern the present individuals and generation; and (2) it must accumulate a fund of information in regard to soils which will assist in solving the broad problems of the nation's soil resources and the utilization of these resources, not only for the support of a growing population, but also, for maintaining a favorable balance of trade for the nation,

"From these reports on soil surveys the individual farmer may learn the relationship of the soils upon his own farm, not only to the other soils in the immediate neighborhood, but to soils of the same character in widely separated regions. He may thus observe and study understandingly the methods and results obtained under the most favorable conditions by successful farmers upon these soils. His horizon of observation is enlarged, and he may more surely apply the experience and the observation of others to his own particular needs and conditions. He is able to consider his own farm, not as an isolated property, but in its due relationship to other farms located upon the same soils and in a region of similar climatic surroundings. The single report thus serves the purpose of the individual whose problem is one of a fixed and occupied region.

At the present time, as at all times in the history of the country, there is a large class of persons who for various reasons desire to secure new farms in more or less distant localities for the pursuit of general agriculture, or for the production of special crops. Inquiries from such persons always cover certain climatic and soil features, and each desires to secure information which will enable him to compare conditions personally known to himself with those of new localities under consideration. Inquiries of this nature are constantly received at the department, and wherever possible the information is supplied by the reports and maps covering the areas concerned. No advice to do this or that is communicated; only the information upon which a judgment may be based. The use of soil-survey reports for this purpose is by no means confined to reports upon regions which are sparsely settled or newly opened for agricultural occupation. The constant changes in farm values in all parts of the United States are calling the attention of individual farmers to particular localities in the older States, where possible advantages may be gained from the sale of high-priced lands and the purchase of others which, for the time are offered at a lower figure.

"During the past decade the funds accumulated by large investment companies have increasingly sought a farm-land outlet. The soil-survey reports are regularly requested by many such companies. Some only desire the reports in particular circumscribed regions. Others desire these reports as an unprejudiced basis upon which a judgment of land uses and of farm development in widespread and remote regions may be based. Obviously, the common interest of the entire community is served by these reports of soil facts, just as the individual interests of the persons concerned are safeguarded at the same time.

"The use of the soil-survey maps and reports by educational institutions has greatly increased within a few years, accompanying a renewed activity in the study of soils and in the teaching of soil subjects. Not only are the maps and reports used by those institutions directly for the study of soils, but they are also used in studies of crop production, of farm economics, and of the distribution of agricultural products. Nonagricultural colleges and universities are also using these reports in connection with courses in commercial geography.

"The time has come in the agricultural development of the United States when accurate and detailed knowledge of the soil—its character, varieties, capabilities, and adaptations—is of great importance; and as the years go by such knowledge will become more and more important, until ultimately our greatly increased population will need and will be able to utilize fully the diverse capabilities of these 461 different types of soil."

From what has been said above it is clear that the largest asset of Indiana is her soils. The care, the handling, and the productivity of these should be her largest concern. The history of agriculture in this country is but the history of European countries repeated. First, the exploitation of and depletion of virgin, fertile soils; then a national effort to correct the mistakes, and restore the lost productivity. It is easy in the memory of middle-aged citizens of Indiana that when a virgin field became exhausted, a "deadening" was cleared up for new ground. To make and clear a "deadening" in the forest was the crop rotation of fifty years ago. It was a part of the farmer's yearly programme to "deaden" a piece of timber for "new ground." Now the word "deaden" is not in the vocabulary of the Hoosier farm boy, and a field of "new ground" is beyond the ken of his knowledge. Indiana is but one of the many States in which this flagrant waste of forest and soil went on. The Atlantic seaboard first; then the western slope of the Appalachians down to the Mississippi; then the Great Plains west of the Mississippi to the Rockies. But now the giant forests that formerly covered the land from the Atlantic to the Mississippi seem to have moved farther and farther away from the old farmstead—indeed, they now present the appearance of a disappearing view—a hazy cloud on the horizon. People stand in wonderment at the marvelous development of the past century, but do not stop to think that it was made possible at the sacrifice of the virgin fields, farmed to death by the advancing host in its westward course. Fifty to seventy-five years ago the cry went up "Go west, young man." People seemed to care little for the exhaustion of the older lands of the East, so long as fertile land remained unoccupied in the West. The former high-priced lands of the East became low-priced. But now the last virgin field of the West has been plowed. The exploitation of her fertility has been circumvented. But a new era is dawning. Science, which is simply applied common sense, has taken the reins and is pointing the way to a restoration of the lost fertility of Indiana soils, and as a result the tide of emigration that had ever flowed westward is now ebbing toward the East. The higher priced lands of the West are being sold and the capital invested in lower priced lands of Indiana and the East, the investors confident that science will yet point the way to a margin of profit in the tillage of the once depleted farms.

SOIL SURVEY

OF

HANCOCK, SHELBY AND JOHNSON COUNTIES

BY

ALLEN DAVID HOLE

1912

Soil Survey of Hancock, Shelby, and Johnson Counties.

BY ALLEN DAVID HOLE.*

HANCOCK COUNTY.

LOCATION.

Hancock County is located a little east of the central part of the State, and is bounded on the north by Hamilton and Madison counties; on the east by Henry and Rush counties; on the south by Shelby County; and on the west by Marion County. It includes 307 square miles, lying in townships 15, 16, and 17, N., ranges 5, 6, 7, and 8, E., of the U. S. Land Survey.

HISTORY.

The earliest settlements within the county were made in the southeastern part, on Blue River, in 1818, and in Center Township, not far from the same time. In 1823 the whole of the present county was included in the new county of Madison, organized in that year; but five years later, in 1828, it was given an independent organization, and named in honor of John Hancock, one of the

[* The author has supplemented the knowledge gained from his own investigations in these counties by consulting various authorities on special subjects more or less closely related to the work undertaken. For example, the data in regard to farms, as to acreage, yield of different crops, etc., has been taken largely from the reports of the Census of 1910; some geological data from the reports of the Indiana Department of Geology, and from publications of the U. S. Geological Survey; and the historical summaries from various editions of county histories. For assistance with the work in the field acknowledgments are due to Messrs. B. W. Kelly, Mark Baldwin, and Willard Roberts; and for a careful study of the trees growing on the different soil types, to Mr. J. F. Thompson, the results of whose observations are incorporated in this report. The chemical analyses were all made by Prof. W. M. Blanchard of DePauw University under instructions given by State Geologist, Edward Barrett. In the mechanical analyses (made by the author), the sizes of particles determined are approximately as follows:

Clay, up to 0.01 mm. in diameter; silt, 0.01 mm. to 0.05 mm.;

Fine sand, 0.05 mm. to 0.15 mm.; medium sand, 0.15 mm. to 0.375 mm.; coarse sand, 0.375 mm. to 2.0 mm.

The methods used in the mechanical analysis were (1) agitation for 6 to 7 hours in a shaker, (2) a separation of the finer particles by the sedimentation process, and (3) a separation of the coarser particles by means of sieves. — A. D. H.]

signers of the Declaration of Independence. In the same year, 1828, Greenfield, the present county seat, was laid out, and the county was divided into nine civil townships in most of which permanent settlements had already been made. Throughout the county from this time on settlements increased in number, and the work of changing the forest wilderness into well-kept farms went steadily on. With but little exception the land was everywhere to be cleared, and over large areas to be be drained before agriculture could be carried on successfully; and as must nearly always be the case in a newly settled country, markets for farm products were distant and the roads leading thither were for a considerable portion of the year almost impassable. Added to all these difficulties was the prevalence of malarial diseases, often in severe forms, a necessary result of the conditions under which the pioneers had to undertake their task. That all these difficulties have been met and largely overcome, the following items summarizing briefly the present conditions show:

(1) About 90 per cent. of the entire area of the county has been cleared and is now being used as farming land.

(2) Open ditches and tile drainage have reclaimed nearly all of the marshes and swamps which once covered such a large part of the county, and with this change has also passed away the prevalence of malarial diseases.

(3) Reasonably good roads are found practically everywhere; this means that either crushed stone or gravel, usually the latter, has been used as road metal so generally that there is scarcely a square mile in the county which cannot now be reached by continuous travel over reasonably good roads.

(4) Five railroads and four electric lines cross the county; two of each passing from east to west the entire length of the county; the others crossing the northeast, the northwest, and the southwest corners, respectively.

(5) There is no considerable area in any part of the county unsettled. The majority of the 20,000 inhabitants live on farms, which are as a rule well improved.

GEOGRAPHY AND GEOLOGY.

Almost the entire surface of the county is level to gently rolling, the streams having in general low gradients and correspondingly sluggish currents. Near the streams the surface is usually somewhat hilly, the relief being in places as much as 40 to 60 feet, as for example (1) in the northwest corner of the county along small tributaries of Fall Creek; (2) along the lower part of the valley of Sugar Creek; and (3) in the southeast corner, near Blue River. The inter-stream areas rarely have relief exceeding 10 feet, while in places, notably in the west-central part of the county, there are numerous areas with practically level surfaces, the sites of former ponds and marshes which have been silted up or drained.

The natural drainage of the county is, in general, to the south and southwest, chiefly through tributaries of Blue River. Blue River itself crosses the southeastern corner of the county; Brandywine Creek drains a considerable area in the east-central and south-central parts, joining Blue River in Shelby County, some 12 or 13 miles south of the county line; Sugar Creek gathers the waters from a broad, irregular belt extending from the northeast corner of the county along the northern side well toward the northwest corner, thence southwestward, crossing the south line near the southwest corner; Buck Creek, a tributary which joins Sugar Creek six miles south of the southern boundary of the county, drains a large share of the western side; while tributaries of Fall Creek and White River receive the drainage from the remainder of the western and northwestern parts.

The valleys in which these streams flow owe their general direction to the slope of the surface of the material left by the continental ice-sheets when they finally withdrew from the region; many of the minor irregularities of the course of these valleys are also due to irregularities of the surface of the drift, as for example, the tortuous course of Sugar Creek from the northern and northeastern to the southwestern part of the county. Some of the characteristics of the valleys are clearly due, however, to conditions existing as the ice withdrew, which caused the drainage in certain places to be strikingly different from that which exists in the same places now. A notable example of this is the presence of relatively large valleys drained by disproportionately small, in some cases insignificant, streams. The best illustration of abandoned channels of this kind to be found in the county, is in the north-central part, extending in a general north-south direction about a mile east of the village of Eden. A part of this channel is referred to by Dr. R. T. Brown in the Fifteenth Report of the Department of Geology and Natural Resources of Indiana, where he notes the depression southward from Eden, but apparently without seeing the relation existing between the channel he describes and the equally striking portion extending northward to the Madison County line. This northern portion begins at the county line somewhat east of the center of Sec. 9, T. 17 N., R. 7 E., as a flat-bottomed valley one-fourth of a mile wide and from 10 to 15 feet deep, extends west of south to the eastern part of Section 20, east of Eden, where it crosses Sugar Creek and continues its southwestward course to the north part of Section 29; from here its direction is southward until it joins the valley of Brandywine Creek in the middle of Sec. 16, T. 16 N., R. 7 E. The total length of this channel within the county is about 7½ miles; in parts of its course, the drainage is by open ditch or small stream, sometimes northward, sometimes southward; in parts there is no surface stream at all. Throughout most of its course the soil in the bottom is black, usually a clay loam to loam, with a considerable amount of organic matter. The hills on either side are usually of light colored clay loam with varying amounts of gravel and boulders, but sometimes containing stratified sand and gravel. At certain points the hills bounding the valley almost disappear, leaving the boundaries of the channel somewhat indefinite; this is especially the case on the east side at about the center of Sec. 29, T. 17 N., R. 7 E., where two kame-like hills alone mark clearly the limit of the valley; but in most places the valley boundaries are definite, being limited by distinct morainal hills.

This channel of 7½ miles is evidently only a part of a general north-south system of drainage which prevailed at a certain stage in the withdrawal of the ice-sheet. Southward the valley of the Brandywine itself seems to be a part of the same glacial channel, while northward, as observed by Leverett and by members of the U. S. Soil Survey, the channel extending from above Anderson to Pendleton and on across Fall Creek and Lick Creek to the southern boundary of Madison County, is to be accounted for only by the work of waters flowing under conditions entirely different from those of the present day. Leverett, on his map of the Maumee-Miami glacial lobe, marks the Anderson-Pendleton channel as subglacial, and calls attention to the close association of a similar north-south channel at Muncie with an esker. In view of the fact that the general slope of the surface of the drift is to the westward in northern Hancock and southern Madison counties, as shown by the westward course of Fall Creek, Lick Creek and Sugar Creek, each of which now cuts directly across this glacial channel, it would seem probable that for at least a part of the time in which the waters were forming the north-south valley the channel may have marked the eastern boundary of a lobe of ice as the glacier retreated, and even after the withdrawal of the ice for a time may have afforded an outlet for waters due to ice melting and precipitation until the present east-west streams established themselves by virtue of their higher gradients.

The geological formations present in Hancock County include only those of the Pleistocene and Recent epochs, so far as exposures at the surface are concerned. Bed rock of Palæozoic age lies everywhere buried beneath a covering of glacial debris to a depth of from 100 to over 200 feet. Borings for natural gas have shown, for instance, a thickness of drift at Greenfield of 205 feet; at points about two miles northwest of Shirley, 125 to 130 feet. This drift is made up for the most part of unassorted material such as boulders, pebbles, gravel, sand, silt and finer particles mixed together in varying amounts and proportions. At the surface the boulders are occasionally sufficiently large and numerous to be especially noticeable, or even to interfere with the cultivation of the ground; as, for example, about six miles northward from Greenfield in Secs. 30, 31, and 36, T. 17 N., R. 7. E., where they form a distinct belt extending for nearly two miles in a northeast-southwest direction. Fig. 1 is from a photograph of a 12-foot granite boulder lying in Section 30 near the northern end of this belt. Some of the drift has, however, been assorted by the action of water so that in numerous places beds of sand and gravel are found nearly free from clay, silt and boulders. In general these stratified deposits are more abundant near the surface in the vicinity of the streams; but they are also found in the areas between the streams, as in Sec. 32, T. 17 N., R. 8 E., 1½ miles southwest of the village of Wilkinson, where gravel for use as road material is being taken out. In drilling or digging for wells, strata of sand and gravel are occasionally encountered, so that the drift is to be regarded as a great deposit, largely unassorted, to be classed as ground moraine, yet including many lenses and sheets of stratified deposits at different levels which are parts of outwash plains, valley trains, silted-up ponds, etc. In age, the unmodified drift, so far as ascertained by exposures at the surface, is referred to the Late Wisconsin stage.

The most important of the Recent deposits in the county include (1) alluvial deposits along streams such as flood plains, (2) alluvial fans in some places at the base of the steeper slopes, (3) lacustrine flats or silted-up ponds, and (4) accumulations of organic matter, some of it to be classed as peat, though most of it containing too much finely divided mineral matter to deserve the name. These different forms of Recent deposits correspond to a considerable degree to some of the different soils to be described farther on; for example, the flood plains are in most cases to be classed as Wabash loam, and the silted-up ponds as Carrington black clay loam. Further description of these forms will, therefore, be given when the various soil types are described.

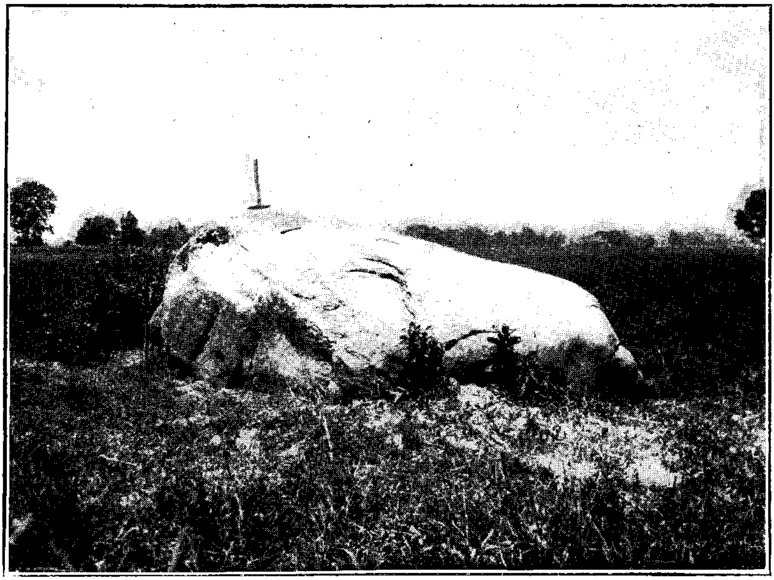


FIG. 1. Granitic Boulder in Section 30, Township 17 N., Range 7 E.; about six miles northward from Greenfield. (Photo by B. W. Kelly.)

ECONOMIC GEOLOGY.

Gravel.—In the Thirtieth Annual Report of the Indiana Department of Geology, Mr. A. E. Taylor (1905) summarizes the location of gravel deposits in substance as follows:

(1) The principal deposits are found along the larger streams and in certain areas of partially assorted drift, principally in the northeastern part of the county.

(2) Areas in which little or no gravel is found include (a) a strip about four miles wide along the western end of the county, and (b) certain areas in the north-central, east-central and southern parts.

Since that report was written some new deposits have been opened up, but it is still true that the main deposits are to be found along the larger streams and in sheets of outwash materials associated with moraines. A few of these deposits are above the level of ground water and so can be easily reached by excavations from which the gravel can be shoveled directly into the wagons which are to haul it away. By far the largest proportion of gravel in the county, however, lies below the water level, sometimes in streams, sometimes in flood plains or terraces, sometimes in the nearly level inter-stream areas. In such cases the gravel is brought to the surface by means of steam power applied either to an endless chain to which small buckets are attached, or to a cable carrying a single large excavating bucket. Fig. 2 shows the latter method of bringing up gravel from below the surface of the water. Data as to the amount of gravel used each year are not available; but the total must be large, since in addition to a very considerable amount used in concrete construction, plastering, etc., hundreds of cubic yards are applied every year to the repair of the numerous gravel roads already completed, and in the extension of the work to reduce still further the small percentage not yet improved in this way.

Water Supply.—An abundance of water may be secured at most places in the county by sinking a well to a depth not to exceed 30 to 40 feet. The exceptions to this are those points where there is exposed at the surface a thick layer of unassorted drift composed largely of rock particles of the fineness of clay, which obstructs the ready flow of the water. Even in such places as these some water is usually found, but not in sufficient quantity to afford a continuous supply. In general, however, such strata of nearly impervious drift are not thick enough to make the sinking of a satisfactory well too expensive or difficult.

The minimum depth of wells varies according to location, being least near streams and in the level areas which were formerly covered by water for almost the whole year. In such places the surface of the ground water may be within four or five feet of the surface throughout the year. This depth, although small, is nevertheless in the marshy areas a reduction of ground water level since the settlement of the county by almost its own amount, due to the opening of ditches and the increased evaporation because of the removal of so large a proportion of the forests. Wells sunk only to the level of ground water, while still numerous, are now being replaced by tubular wells which pass through the layers of sand and

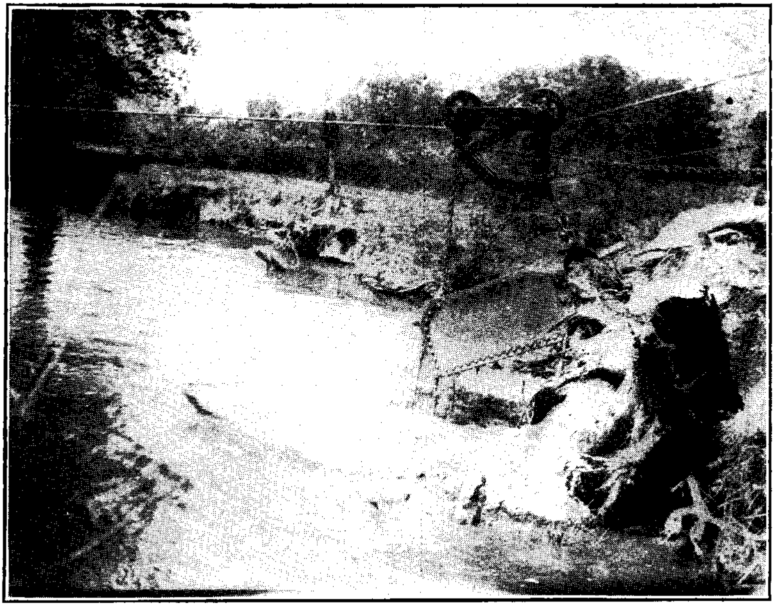


FIG. 2. Cable and single bucket for dipping gravel. Sugar Creek, in Hancock County. (Photo by J. F. Thompson.)

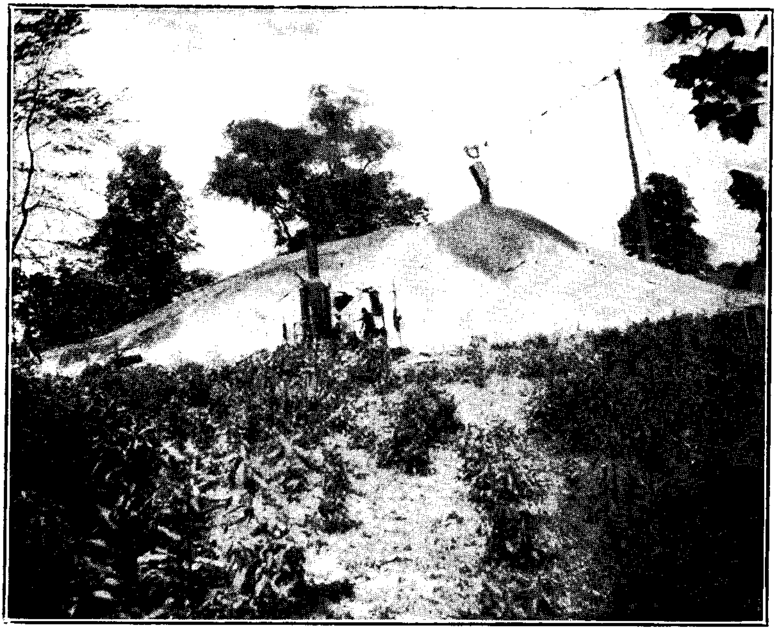


FIG. 3. Bucket shown in Fig. 2, in process of dumping a load. Sugar Creek, Hancock County. (Photo by B. W. Kelly.)

gravel near the surface, and after penetrating more or less impervious layers of glacial till, draw their supply of water from strata of sand and gravel lying 75 to 100 feet or more below the surface. The additional first cost of such wells is more than justified by the added security to health thus obtained, and by the certainty of an ample supply of water even in seasons of greatest drought.

Artesian, or flowing wells occur at a number of points in the county: (1) in the northern and northeastern parts near Shirley and at various points from three to six miles to the north and north-

FIG. 4. Flowing well in Section 13, Township 17 N., Range 7 E. Northern part of Hancock County. (Photo by B. W. Kelly.)

west; (2) in the central and west-central parts, as at Greenfield and near Philadelphia; and (3) at several points from three to six miles southward and southeastward from Greenfield. Most of these flowing wells are abandoned natural gas wells in which the casing has been allowed to remain because of the abundant flow of excellent water which is thus brought up from the surface of the underlying bed rock 100 to 200 feet below. The exact number and location of flowing wells which have been produced in this way in the operations of natural gas companies is difficult to ascertain, because in many cases the wells have been destroyed by the drawing of the casings when the yield of gas became too small to pay for the expense of cleaning out, repairs, etc. Fig. 4 is from a photograph of a well located in Sec. 13, T. 17 N., R. 7 E., near Sugar Creek. Investigations in this county alone are not sufficient to determine the source from which the water supplying these wells comes. It is, however, known from well-borings that the general slope of the surface of bed rock is here in a southerly direction; it is also reported that in certain cases in the northern part of the county the flow of one well seems to be affected by the opening of another well as much as two or three miles away along a north-south line. These two facts would indicate that the head causing the overflow lies somewhere to the northward. Furthermore, the abundant flow from so large a number of wells in which the pipe conveying the water ends at the surface of bed rock, would indicate that there is a continuous stratum of sand and gravel lying on bed rock and extending in a somewhat winding, irregular course across the county from the northeastern, through the central to the southeastern part. Flowing wells in the parts of Madison and Shelby counties adjacent to the areas in Hancock county where flowing wells occur, indicate that the portion of this water-bearing stratum underlying Hancock County is but a part of a continuous deposit of sand and gravel extending in a north-south direction across this part of the State; and, if so, the water which permeates this stratum is to be considered as an underground stream flowing on the surface of bed rock, whose position has been determined by drainage conditions which existed possibly in part before the first ice sheet which covered this part of the State appeared; existed certainly at least in part subsequent to the withdrawal of that earliest member of the series of glaciers that once covered this county.

CLIMATE.

The general characteristics of the climate of the county are shown in the following tables, data for which has been supplied by Mr. V. H. Church, Section Director of the U. S. Weather Bureau at Indianapolis:

Table I. Mean Temperature and Average Precipitation at Greenfield.

Month.	Mean Temperature. Degrees F.	Average Precipitation. Inches.
January	29.9	2.97
February	29.7	2.68
March	43.2	4.80
April	50.8	3.08
May	61.6	4.22
June	70.6	3.52
July	73.8	3.46
August	73.2	2.78
September	68.2	3.18
October	53.9	3.40
November	42.5	2.56
December	32.1	2.59
Annual	52.5	39.24

Table II. Maximum and Minimum Temperatures.

Highest temperature recorded from 1904 to date......100° in July, 1911.
Lowest temperature recorded from 1904 to date.....-17° January 7, 1912.

NOTE.—The lowest previous record was —16° in February, 1905.

Table III. Average Dates of Killing Frosts at Greenfield.

Last in spring...April 21.
First in autumn..October 16.

It will be observed from the above tables that the precipitation is well distributed throughout the year, so that crops do not ordinarily suffer. Occasionally, however, unusual conditions result in a reduction of the amount of rainfall which cuts down the yield in certain crops for the season; but such losses can to a considerable degree be prevented by a more careful management of the soils, in drainage, and in methods of cultivation adapted to the special conditions present at a given time. (See suggestions at the close of the report for this county.)

The maximum and minimum temperatures given are ordinarily of short duration, as may readily be inferred from the table of mean temperatures given. Temperatures of zero and below often occur when the ground is well covered with snow, which thus acts as a protection to winter wheat and to low fruit plants such as the strawberry plant. In general, however, the fact that zero weather and below is likely to occur each winter is taken into account in determining what varieties of fruit trees, plants, etc., shall be depended upon, and only those are chosen for extensive planting as have proved themselves capable of withstanding the lowest temperatures named.

AGRICULTURE.

Of the 196,480 acres in the county, 94.8 per cent., or 186,190 acres is in farms varying in size from less than three acres to 500 or more. As ascertained by the census of 1910, there are 2,154 farms in the county, of which about one-third include 50 to 100 acres each. In the 10 years from 1900 to 1910 the farming lands in the county increased nearly 100 per cent. in value, being listed in the latter year at a total valuation of $16,598,947, or an average of nearly $90 per acre; while the total valuation of farm property including buildings, implements, domestic animals, etc., adds over $5,000,000 to this amount, making an average of land and farm property together of about $120 per acre.

The following tables taken from the report of the census of 1910, show in condensed form the principal crops raised, the acreage, and the yield per acre; and the number and valuation of the principal kinds of domestic animals and poultry:

Table IV. Principal Crops.

	Acres.	Bushels.	Tons.
Corn	61,637	2,950,148	......
Oats	15,190	347,295	......
Wheat	27,853	343,144	......
Timothy hay	10,283	....	13,334
Clover alone	3,295	....	3,549
Timothy and clover mixed	3,273	....	4,073
Clover seed	.....	837	......

Table V. Domestic Animals and Poultry on Farms.

	Number.	Value.
Cattle	13,380	$404,592 00
Horses	9,406	996,940 00
Mules	530	68,575 00
Swine	43,707	282,089 00
Sheep	10,911	46,448 00
Poultry	147,540	87,357 00

It will be seen from Table IV that the average yield for corn is a little less than 50 bushels per acre; for oats not quite 23 bushels; for wheat between 12 and 13 bushels; and for hay about $1\frac{1}{4}$ tons per acre. It is to be noted, however, that on many farms the average yield is much higher than this; from reports received from farmers in response to questions sent out by the State Geologist, and from interviews with farmers while the field work was in progress it is known that yields of 80 bushels per acre for corn, and 20 bushels for wheat are not uncommon under favorable conditions.

It is recognized, however, that the county as a whole does not produce wheat as profitably as corn, and even in the case of the latter crop the yield is not yet up to the average that may be expected when the possibilities of the soil are fully realized. Definite suggestions as to the best methods to be pursued to increase the yield per acre are given at the close of this report.

Of the crops not yet much grown which promise excellent results, alfalfa should probably receive most attention. It is not, however, so much in the introduction of new crops as in more careful work in the case of crops already being grown, that the greatest increase of wealth may be expected.

As a whole the soil of the county is best adapted to heavy farming; nevertheless truck farming is engaged in successfully in some places, and might be profitably extended to the more sandy soils near the streams; even the level to slightly rolling inter-stream areas may, with careful treatment, be made to yield profitable crops of small fruits and vegetables as is being done in some sections to an increasing degree.

Dairying is not as a rule carried on except in a small way in connection with general farming. The total number of dairy cows in 1910 was reported as 6,301; of these but few were in large herds. In most cases where an attempt is made to maintain a herd, the milk or the cream is shipped to neighboring cities; the same method of disposing of the product is used by many who wish merely to have a convenient means of turning into cash the surplus milk for a part of the year. The use of centrifugal separators has very generally replaced the various gravity systems of separating the milk from the cream, wherever the amount of milk to be handled is large enough to justify it.

The chief obstacles to successful agriculture in this county may be enumerated as follows; a part of these obstacles have been largely removed, but much yet remains to be done before the possibilities of production from the soils of the county are realized:

1. The forest growth. This originally covered almost the whole county, consisting principally of oak, ash, walnut, beech, sugar maple, elm, and hickory. In a few places the original growth of timber has remained untouched by the lumberman's axe, as for example in a part of Sec. 23, T. 15 N., R. 5 E. (Fig 5); but about 88 per cent. of the farm land is now free from forests. Some further work in removing forests may possibly be done to advantage; but on the other hand some work in reforestation should be undertaken, especially in some of the more hilly belts.

2. Marshes and swamps. Areas over which water stood for a considerable portion of the year are found in the inter-stream areas near Buck Creek, Brandywine Creek, Sugar Creek, and their tributaries. Of these marshes but few now remain. The opening of large ditches, the deepening and straightening of many small stream channels, and the use of a large amount of tile in underdrains, have resulted in providing adequate means for the rapid removal of water, so that in but few places does it accumulate to the disadvantage of farming operations as it did generally a genera-

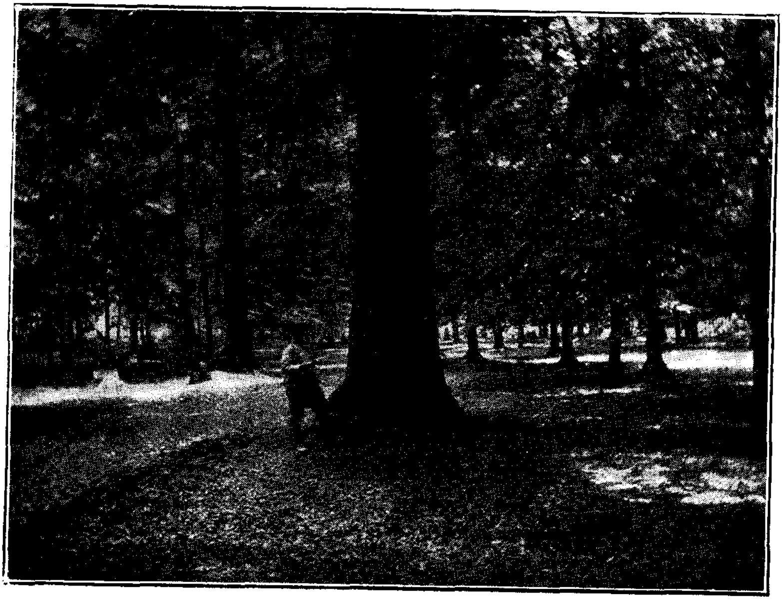


FIG. 5. Oak tree in forest in the southwestern part of Hancock County. (Photo by B. W. Kelly.)

tion ago. This does not mean, however, that the work of drainage is complete; it merely means that a prime difficulty, that of getting rid of water on and very near the surface, has been overcome.

3. Lack of sufficient air in the soil. This difficulty is closely associated with the presence of conditions which permit water to stand. Much of the soil is a clay loam which contains a sufficiently large percentage of very fine mineral particles to cause the soil to form into very compact layers or masses, and especially when well moistened to become more or less impervious to air. The work of

earth worms and other forms of animal life, the growth and decay of the roots of plants, and the alternate freezing and thawing in winter, all contribute something to the process of opening up the ground so that the air may have access to some depth. But all of these processes together are not sufficient to accomplish what is needed. The most effective means for most of the soil in the county is an extension of the system of tile drainage until all clayey soils are traversed by lines of tile not less than four inches in diameter, at an average depth of about 30 inches and not more than three to five rods apart. No other method is known which for soils of this kind will result beneficially in so many ways at the same time as in such a system of tile drainage if properly put in. For, in addition to supplying the especial lack here referred to, that of giving a sufficient amount of air to the needed depth in the soil, two other desirable results are accomplished, viz.: (1) The removal of the excess of moisture if any should occur; and (2) the gradual transformation of the soil and subsoil from a stratum compact and almost impervious to air into a layer filled with fine pores which can hold a large amount of moisture ready to be given up to the roots of plants in time of drought.

4. Other difficulties such as ignorance as to the proper management of soils under certain special conditions. Some of these will be referred to under the descriptions of different soil types, and others will be mentioned in the suggestions at the close of the report of the work done in the county.

Origin of the Soils.

The soils of this county are chiefly derived from the disintegration of rock materials left by the glacial sheets which came into Indiana from the north and northeast. As shown by the kinds of rock present in the soil in the form of boulders, pebbles, etc., part of this material came from the outcrop of granites, gneisses, diorites, and other crystalline rocks beyond the Great Lakes; and part came from the limestones, sandstones, and shales outcropping much nearer, that is, within the state; some, indeed, perhaps from points only a few miles away. In addition to this large amount of weathered glacial debris there is also included a small amount of fine mineral matter brought by the winds, and another probably larger amount of decaying vegetable matter which has been mixed with the mineral particles at the surface, giving the black color to the soil as found in streaks and patches in all parts of the county.

Soil Types.

The soil types found in the county with the approximate area covered by each is given in the following table:

Table VI. Soil Types.

Name.	Acres.
Miami clay loam	182,610
Wabash loam	6,250
Carrington black clay loam	5,400
Sioux loam	1,870
Wabash sandy loam	275
Meadow	50
Muck	25

The boundaries between the different types as shown on the accompanying map, are in some places drawn arbitrarily, as for example where the Carrington black clay loam joins the Wabash loam. In such cases the Wabash loam forming the flood plain of a small stream gives place gradually in the up-stream direction to the Carrington black clay loam as the area is reached which was covered with standing water for a considerable part of the year before the better drainage conditions were established. So, too, the boundary between other types is not always clearly marked; for instance, the Miami clay loam sometimes continues as the subsoil for considerable distances beneath the edges of the Carrington black clay loam, forming thus an irregular belt around the latter in which the surface soil is black, but having a yellowish mottled subsoil with some pebbles instead of the silty, drab colored subsoil to be found at the center of the area. In certain places, as in sections a few miles west and southwest of Greenfield, large areas of land with black surface soil have almost everywhere a subsoil practically the same as that of the Miami clay loam; these areas have, in general, been classed as Miami clay loam since the time available for detailed examination was too limited to make any accurate subdivisions of the type.

Miami Clay Loam.

This type includes about 93 per cent. of the total area of the county, and occupies the greater part of the inter-stream areas. Typically it is a light-colored soil formed from the weathering of unassorted glacial till. When deposited by the ice sheets it contained a large percentage of finely ground limestone mingled with much smaller quantities of finely ground shale, true clay, sand grains, fragments of crystalline rocks, etc. At the surface the finely divided limestone has been leached out to a depth of from two to three feet, the other rock fragments have been much disintegrated, and decaying organic matter has been incorporated to some extent, so that the upper three feet shows in general the following section:

Light buff to light gray soil with few pebbles, 8 to 10 inches.

Yellowish to grayish-brown subsoil, sometimes mottled, usually quite compact, containing up to 4 or 5 per cent. of pebbles and rock fragments of small size, from 8 or 10 inches to a depth of three feet.

Below the depth of three feet, the material is in some cases a continuation of the unassorted glacial till practically to bed rock; but more often where tests have been made by well borings it gives place to sheets of stratified sand and gravel which alternate with strata of unassorted material.

In topography this type is nearly level to gently rolling, and can in nearly all cases be thoroughly drained. Since it occupies the higher points and ridges on which the water does not stand, and since the work of draining the marshes and other low-lying areas has been difficult and expensive, the Miami clay loam is as yet but poorly supplied with the necessary lines of underdraining, necessary not so much for the purpose of draining as for the purpose of aerating the somewhat heavy soil.

The original forest growth on this type of soil included white oak, beech, and walnut; sugar maple where sand is rather more abundant; and elm, hickory and ash in less well drained areas. The principal farm crops now raised are corn, wheat, and timothy and clover hay.

As shown by the mechanical analysis given below, this type has a high percentage of silt, making it thus less difficult to work than would be the case if the clay content were higher. The proportion of finer particles is, however, large enough to make care necessary in the preparation of the soil for crops as well as in the cultivation afterward, in order to avoid the formation of clods which, once formed, often cause trouble for an entire season. The plant food content is in general abundant, but only a small amount is available at any one time, so that the practice of using fertilizers is increasing, with results which seem to justify the expenditure of a considerable amount of time and money in this way. It is to be remembered, however, that the chief advantage from the use of a fertilizer is not always, if indeed ever, because of the actual plant food added to the soil; sometimes it is because the fertilizer destroys compounds in the soil which prevent the healthy growth of crops; sometimes, because the elements of the fertilizer help to set free elements already in the soil. A careful study of the analysis of soils and fertilizers, with equally careful attention to the results gained under different conditions will eventually lead to safe conclusions in regard to the use of the various commercial fertilizers offered for sale.

In general, the Miami clay loam does not produce as much corn per acre as the Carrington black clay loam or the Wabash loam. There are cases, however, of careful farming in which the yield has been made through a series of years to average higher on the light-colored than on the dark-colored soils; so that it seems probable that the possibilities of improvement and permanent fertility are greater for the Miami clay loam than for any other soil type in the county.

Table VII. Mechanical Analysis of Miami Clay Loam. (Average.)

	Coarse Sand. %	Medium Sand. %	Fine Sand. %	Silt. %	Clay. %	Total. %
Soil	8.16	10.15	21.49	46.80	13.20	99.80
Subsoil	5.44	10.83	18.79	40.65	24.25	99.96

Table VIII. Chemical Analysis of Miami Clay Loam.

	Soil, 0" to 10".	Subsoil, 10" to 3' 0".
Reaction to litmus	Neutral	Neutral
Moisture in air-dried soil	1.17%	1.11%
Total nitrogen	0.128%	0.049%
Analysis of soil dried at 105° C.—		
Volatile and organic	3.85%	2.50%
Insoluble in HCl (Sp. g. 1.115)	88.90%	89.60%
Soluble silica (SiO_2)	0.21%	0.22%
Ferric oxide (Fe_2O_3)	2.53%	2.63%
Aluminum oxide (Al_2O_3)	2.72%	3.78%
Phosphor. acid anhydride (P_2O_5)	0.64%	0.28%
Sulphuric acid anhydride (SO_3)	Trace	Trace
Calcium oxide (CaO)	0.29%	0.28%
Magnesium oxide (MgO)	0.41%	0.47%
Potassium oxide (K_2O)	0.15%	0.16%
Sodium oxide (Na_2O)	0.16%	0.16%
Total	99.86%	100.08%

Wabash Loam.

This type occupies only a little more than 3 per cent. of the total area of the county, being found as a narrow strip along the larger streams. It consists of a brown loamy to sandy soil 10 to 15 inches deep, followed by a sandy subsoil to a depth of three feet or more. In places there is some gravel to be found in the soil, with usually a larger percentage in the subsoil; in small areas the gravel may be abundant. The original forest trees on this type of soil include as principal kinds beech, sycamore, elm, and soft maple. Some parts mapped as Wabash loam are still subject to overflow at times of high water, and are consequently not used for cultivated crops. Most of the type is, however, adapted especially to corn, of which excellent crops are raised; tomatoes and other vegetables are successfully grown on limited areas.

The surface of the Wabash loam is nearly level. Occasionally there are slight depressions at the base of the valley slopes, the sites of former bayous now nearly silted up; some such areas are yet undrained and owing to their small elevation above the stream cannot now be freed from the excess of water. The total area of such undrained portions is, however, very small, and with the deepening of the stream channels which is going on in most places these areas can finally be brought under cultivation.

Table IX. Mechanical Analysis of Wabash Loam.

	Coarse Sand. %	Medium Sand. %	Fine Sand. %	Silt. %	Clay. %	Total. %
Soil	6.51	15.02	30.34	39.17	9.90	100.94
Subsoil	5.47	15.18	29.32	39.55	10.22	99.74

Carrington Black Clay Loam.

The total area occupied by this type is less than three per cent. of the whole area of the county, but is distributed in many small, irregularly shaped patches chiefly in the western half of the county as shown on the accompanying map. Typically the soil of this type is 10 to 12 inches deep, black in color, loose under cultivation, and underlain by a drab to dark gray silty clay which is usually very compact and tenacious. In some of the areas mapped as Carrington black clay loam on the accompanying map there is a variation in the soil by an increase in organic content approaching the composition of muck, and in the subsoil by the presence of an abundance of sand. In general the areas belonging to this type are the sites of former marshes or ponds which have been filled up in part by silting up, in part by the accumulation of organic matter which has been incorporated with the soil. The original growth in these areas included elm, ash, some oak and hickory and, characteristically, button bush. When well drained the crop most profitably grown now is corn, the yield being often from 80 to 100 bushels per acre. It is found, however, that with successive crops of corn without alternation with other crops, the yield diminishes, so that some plan of rotation is necessary to keep the yield up to even a fair average for other types of soil which are naturally less well adapted to corn production.

Before the drainage is complete soils of this type are likely to be sour; this can be corrected by the addition of mineral fertilizers, but best by an adequate system of ditches and under-ground drainage.

Table X. Chemical Analysis of Carrington Black Clay Loam.

	Soil, 0" to 8".
Reaction to litmus	Neutral
Moisture in air-dried soil	3.79%
Total nitrogen	0.306%
Analysis of soil dried at 105° C.—	
Volatile and organic	11.76%
Insoluble in HCl (Sp. g 1.115)	75.78%
Soluble silica (SiO_2)	0.13%
Ferric oxide (Fe_2O_3)	3.34%
Aluminum oxide (Al_2O_3)	5.75%
Phosphor. acid anhydride (P_2O_5)	0.51%
Sulphuric acid anhydride (SO_3)	0.10%
Calcium oxide (CaO)	1.50%
Magnesium oxide (MgO)	0.87%
Potassium oxide (K_2O)	0.33%
Sodium oxide (Na_2O)	0.42%
Total	100.49%

Sioux Loam.

This type occupies less than one per cent. of the total area of the county, and is found chiefly in the southeastern part along Blue River, and in the south central part along Brandywine Creek. In both localities it consists of a light brown or yellowish brown loam 10 to 12 inches thick with some pebbles scattered on the surface, underlain in places at a depth of from two to four feet by stratified sand and gravel sufficiently free from silt and clay to be used as road material. From both the soil and the subsoil above the gravel the calcareous material is practically all removed, the pebbles that remain being with but few exceptions fragments of crystalline rocks, chert, quartz, quartzite, and others which are not easily affected by the processes of weathering. The surface of this type is slightly rolling, lies in general higher than the Wabash loam, and often between the latter and the Miami clay loam forming the slopes bounding the valleys. It thus constitutes terraces or second bottoms along streams. The drainage is usually good both on account of the surface configuration, and because of the underlying gravel which permits the water which may accumulate on the surface to settle away rapidly through the soil. Crops of all kinds generally do well on this type, the chief difficulty being that in dry seasons sufficient moisture is lacking. On account of the ease with which water passes through the soil it cannot long hold soluble fertilizers.

Wabash Sandy Loam.

One small area in the southeastern part of the county has been mapped as Wabash sandy loam. It lies chiefly in Sec. 35, T. 15 N., R. 8 E., within a valley which is now drained by an insignificant stream, but through which a very considerable amount of water no doubt passed at about the time of the withdrawal of the latest ice sheet. To the sediment deposited at that time has been added the wash from the adjacent hills, a kind of colluvial deposit which while not typically of the Wabash series nevertheless seems to be at least quite similar to what has been described under that name. The soil has a depth of from 10 to 18 inches, contains more fine to medium sand than is usually the case with the Wabash loam, is well drained, and for the most part works loose and mellow. The boundary between this type and the Carrington black clay loam farther up the valley is drawn arbitrarily; the change from the one type to the other is gradual and extends over a considerable distance, the color changing almost imperceptibly to a darker brown, then gray, and finally black, while the texture likewise shades off from the sandy loam through loam to typical clay loam.

Meadow.

Following the usage of the U. S. Bureau of Soils, the term "meadow" is here applied to small areas which are at present too poorly drained to be cultivated satisfactorily, and yet do not have the peaty, marshy character of the areas classified as muck. The composition of this soil cannot be stated accurately, but for the most part mineral ingredients seem to constitute a far larger percentage of the whole than organic matter. These areas are at present used only as pasture ground, but may in time become valuable for general farm crops.

Muck.

In many places small areas of a few acres each are found in which the soil is but little different from true peat. Only two of these areas are of sufficient size to be mapped, but the soil type is of interest to a considerable number of farmers because small patches of it occur in many places, and because soil of this kind has proven somewhat difficult to bring under profitable cultivation. The first difficulty is, of course, with the excess of water; and no method that can be applied will be successful until some system of drainage has reduced the water level to at least a foot, preferably much more than a foot, below the surface. The next difficulty usually becomes more evident in the second year of cultivation than in the first; that is, the looseness or lack of coherence, the "chaffiness" of the soil. The presence of a large percentage of partially decayed vegetable matter, or to state it on the other side, the absence of a sufficiently large percentage of finely divided mineral matter, causes the soil to dry out easily, so that corn, for example, after a short time of vigorous growth suddenly turns yellowish and either remains dwarfed or dies. Usually there is a considerable amount of organic acids present at a short distance below the surface, but if the drainage is good this does not last long in amount sufficient to damage the growing crops. The following methods of further treatment have been found to yield good results:

1. Most satisfactory results have come from a liberal application of stable manure. Several instances are recorded in the county in which one application was sufficient to bring about good crop-growing conditions.

2. Excellent results were secured in a few instances by mixing a considerable quantity of clayey soil with the muck. Where the muck consisted of but a thin layer, this was accomplished by very deep plowing, thus turning up to the surface a quantity of very finely divided mineral particles such as may usually be found below peat or muck. In another case lines of tile ditches were run through the muck area, and the clay thrown up in the work was scattered as widely as could conveniently be done.

3. Log heaps and brush piles burned on peaty soils have in some cases remedied the trouble. This will not suffice in all cases, however, since some such soils will at such a time take fire; and where fires have burned over considerable areas the possibility of profitable corn production has been postponed for an indefinite period.

4. The use of commercial fertilizers strong in potash has been reported as successful in one case. There is, however, some doubt as to the general efficacy of this method, since results reported do not in all cases agree.

SUGGESTIONS.

As a result of the work done in this county, the following suggestions are offered as pointing the way to what should be done as rapidly and as thoroughly as possible to increase the productiveness of the soil:

I. First in urgency is the need of more systematic and more extensive systems of drainage. This applies to practically all soils in the county except to parts of the Sioux loam; in only a few isolated instances are the farms in the county adequately supplied with proper drainage systems. It is not possible in the space properly allotted to this report to make clear the reasons for thus emphasizing a work which in some parts of the county has, it is true, been well begun. The following summary of the benefits of thorough drainage will, however, suggest the importance of the subject; the summary is taken in substance from Bulletin 254 of the Agricultural Experiment Station of the College of Agriculture of Cornell University:

1. Drainage removes the excess of water from the surface and from the pores of the soil.

2. Drainage is directly operative to change an unfavorable physical condition into a desirable one; such as to change a puddled, impervious soil into a granular, more open one.

3. Drainage increases the amount of moisture available to crops. Well drained soil, instead of allowing so large a proportion of the rainfall to drain away as is commonly believed, absorbs and retains a larger proportion than would be otherwise possible, and so makes it available in times of dry weather.

4. Drainage promotes the aeration of the soil; that is, the entrance into the soil of the external air, supplying the oxygen needed for the proper growth of living organisms in the soil.

5. Drainage permits the soil to maintain a higher average temperature than is possible in a wet soil, and thus by making a warmer soil lengthens the growing season for plants.

6. Drainage increases the available food supply by increasing the chemical activity in the soil.

7. Drainage enables a plant to make a better use of the food and moisture supply in the soil.

8. Drainage greatly reduces the injury to winter crops resulting from the freezing of large amounts of water in the soil.

9. Drainage reduces or prevents the erosion or washing of soils on a slope.

10. Drainage increases the yield of crops. It is known that the returns from cultivated land can be increased from 10 per cent. to 100 per cent. without any corresponding increase in other expenses.

Further particulars as to the best methods of putting in systems of drainage, with estimates as to cost, etc., can be secured from the above named bulletin which may be procured by addressing the Director of the Experiment Station at Ithaca, N. Y., or from Bulletin 199 of the Agricultural Experiment Station of the University of Wisconsin, to be procured by addressing the Director of the Agricultural Experiment Station of the University of Wisconsin, at Madison, Wis.

II. What commercial fertilizers can be used to advantage, what methods of culture are best, what rotation of crops to use, whether the sale or the feeding of grain is more profitable, and similar questions, cannot be answered in a general report such as this of necessity must be. But with the information in this report as a basis, further detailed suggestions as to what is probably best to be done in each separate case can be obtained by addressing the Director of the Indiana Agricultural Experiment Station at Purdue University, Lafayette, Indiana, giving as fully as possible all the particulars in regard to the kind of soil, kinds of crops raised, and the results obtained thus far.

SHELBY COUNTY.*

LOCATION.

Shelby County is located southeast of the central part of the State and is bounded as follows: on the north by Hancock County; east by Rush and Decatur counties; south by Decatur and Bartholomew counties; and west by Johnson and Marion counties. It includes 408 square miles, lying in townships 11, 12, 13 and 14, north, ranges 5, 6, 7 and 8, east, of the U. S. Land Survey.

[* The geological formations and the soils of Shelby County are in part very similar to those of Hancock County. In so far as the characteristics of the two counties are practically identical, the discussion for Hancock County will not be repeated; such parts of the latter report, however, as should be read in order to insure a full understanding of the conditions in Shelby County, will be indicated in the appropriate connection in each case.—A. D. H.]

HISTORY.

The area now included in Shelby County was once a part of the territory occupied by the Delaware Indians. Two years after Indiana was admitted as a State, a treaty was made with the Indians by the Government according to the provisions of which they sold their land, but retained the right of occupation for two years more, or until 1820. Some settlements were, however, made before the Indians withdrew, the first being on Blue River not far from the present site of Marion in the autumn of 1818. The county was organized under an act of the Legislature, in 1821, and was named Shelby County in honor of Isaac Shelby, an officer in the Revolutionary War and War of 1812, and at one time Governor of Kentucky.

Following the organization of the county, settlements were made in increasing number, and the work of removing the forests, draining the marshes, and making roads went steadily on. In the year 1850 Shelbyville, the county seat, was incorporated, and within the next ten years a dozen villages were laid out in different parts of the county. At present about 90 per cent. of the farm land has been put in condition for cultivation, and the roads which reach every section of the county are for the most part gravelled and kept in good repair. Four railroads and two electric lines cross the county, affording thus convenient means of travel, and giving also transportation facilities for produce within reasonable distance of even the most remote sections.

GEOGRAPHY AND GENERAL GEOLOGY.

In general the surface is level to gently rolling, with its average slope to the west of south. In certain parts of the county the natural drainage was so poorly developed that many ponds and marshes existed when the first settlers came into the county. This was particularly the case in the strip of low-lying land extending southward from Shelbyville, still referred to occasionally as "The Slough." The removal of so large a percentage of the forests, and the systematic efforts at drainage have now so far reduced the water level that nearly all of these former marshes can be cultivated. Two poorly drained areas of small extent are shown on the accompanying map; one, two miles southeast of Waldron; the other one-half to three-fourths of a mile west of Boggstown; in a number of other places similar areas, too small to be mapped, are found.

With the exception of a few small areas in the southeastern part from which the water flows into tributaries of White River, the entire county is drained by Flat Rock Creek, Big Blue River and their tributaries. Big Blue River traverses almost the entire length of the county, entering at the north end three and one-half miles from the east side, and leaving on the west side a little more than two miles from the southern boundary. Within the county it receives as tributaries Little Blue River, which enters from the east at Shelbyville; and Brandywine Creek which joins it from the north nearly five miles farther to the west. Sugar Creek with its tributaries Little Sugar Creek and Buck Creek, drains the northwestern part of the county and joins Blue River a few miles beyond the county line in the southeastern part of Johnson County. The inter-stream areas are in general flat to gently rolling. Rather notable exceptions to this are found in the very prominent drift hills in the southwestern part of the county near Mt. Auburn, and to the east and northeast of Marietta. Near the valleys the topography is often very hilly. This is particularly the case of the slopes adjacent to Flat Rock Creek, for here the underlying rock is near the surface and contributes somewhat to the formation of more pronounced irregularities of surface.

The underlying rock in this county has been determined to be Silurian and Devonian in age; outcrops are found in numerous valleys in the southeastern part near Waldron and St. Paul, and in the bed of Blue River at Shelbyville. The hills, ridges, and inter-stream areas are, however, even here practically all covered with soil which is made up largely of material derived from the weathering of glacial debris. Occasionally there are areas in this part of the county where the increased number of chert fragments and the scarcity of glacial pebbles suggest a close approach to a residual soil; but even at such places there are no considerable areas in which the usual clear signs of the glacial origin of the soil are lacking. Over much of the county the drift covers the bed rock to depths varying up to 100 feet or more, consisting of alternating layers of glacial till, sand, gravel, etc., some of which is assorted and was deposited as sediment from currents of flowing water, and some a heterogeneous mixture of finely ground rock, clay, silt, sand, pebbles and boulders, with the addition in places of fragments of tree trunks, roots, leaves, grasses and other organic matter. In general, the inter-stream areas may be said to consist more commonly of unassorted drift, that is, of glacial debris in the form of morainal masses; while near the streams the material near the surface is more largely assorted, some no doubt having been laid down by the waters which flowed from the disappearing ice-sheet, but some deposited by waters of a much more recent time.

As has been noted by various observers, a part of the county evidently received a considerable coating of loess, which has now become mixed to a greater or less extent with other material, forming a soil high in its percentage of silt, and where the loess was especially large in amount, producing a soil lighter and more porous than is usually to be found in glacial soils outside loessial areas. At a few isolated points both soil and subsoil were found to be practically alike, made up of almost typical loess such as is found for instance on the bluffs at Muscatine, Iowa, at Kansas City, Mo., or at Omaha, Neb.; all such places found were, however, too small to be mapped.

Usually the soil to a depth of from 10 to 15 inches is very silty, free from clods or pebbles, and light buff in color, while the subsoil is much more like the subsoil of the moraines, that is, made up of clay or finely ground rock along with some silt, sands, and occasional pebbles of various kinds and sizes. Over considerable areas, moreover, even in the southern part of the county, the surface material was not found to be noticeably silty or loess-like. A few cases in the west central part of the county are shown on the accompanying map of soils classed as Knox silt loam; these are more pronounced in type both as to soil and subsoil than the majority of the areas which show a pronounced loessial character at the surface. With the exception of these areas of silt loam, it may be said, roughly, that the valley of Big Blue River divides the county into two divisions on the basis of the abundance of the silt or loess contained in the upper layers of the soil; the division to the east and south of the river showing a higher percentage of loess than that to the north and west.

Reference has been made in the report on Hancock County (page 35) to certain valleys which evidently were formed by streams of water flowing under conditions very different from those which exist today. Shelby County likewise affords examples of valleys of this kind, but on a much more extensive scale. The principal places in which it is evident that former drainage conditions were strikingly different from those of the present, are as follows:

1. As is indicated on the accompanying map by the areas marked Sioux loam, waters at one time passed, in the north central part of the county, either from the valley of Brandywine Creek

to that of Big Blue River, or in the contrary direction; or, possibly, the waters may have passed, some of the time one way, some of the time the other.

2. At Shelbyville, waters no doubt once flowed southward from the Blue River valley along "The Slough," later to join with the waters of Lewis Creek and Flat Rock Creek, or possibly in part to return again into the Blue River valley between the high gravelly hills northeast of Marietta. A fuller description of "The Slough" will be given in discussing the Sioux loam type of soil; but it may be said here that for three miles south of Shelbyville this valley, three-fourths of a mile to a mile wide, is at present drained only by underground movement of the water, by lines of tile drains, or by insignificant surface streamlets. Present drainage conditions could never account for the formation of such a depression.

3. Two and one-half to three and one-half miles northward from Marietta, waters from the valley of Blue River at one time spread westward, flowed thence in a southwesterly direction, and dividing a mile and a half or more northwest of Marietta, separated into two streams one of which returned to Blue River, while the other passed over into the valley of Sugar Creek. This inference, based on the topographic and areal relations involved, is confirmed by a record made some 20 years or more ago when the water from Blue River at flood was seen to flow westward at the southern side of the gap indicated about two and one-half miles north of Marietta, disappearing in this case, however, before reaching Blue River again by sinking away into the somewhat gravelly loam which is found in the old stream channel.

Economic Geology.

The principal economic products found in the geological formations of the county are (1) gravel, (2) limestone, and (3) an abundant supply of water.

Gravel.—As in Hancock County, the deposits of gravel near enough to the surface to be taken out economically are found in or near the larger valleys; considerable deposits in the inter-stream areas are, however, not wanting, especially in the prominent hills in the southwestern part of the county. The location of the principal gravel pits in use in 1905 is given by Mr. E. J. Cable in the Thirtieth Annual Report of the Department of Geology of the State. As shown by him, there are certain parts of the county not supplied with sufficient gravel of quality suitable for road making, and as a consequence a long haul is necessary in such sections. Other deposits have, however, become available since that time, as for example, the stratum lying a few feet below the surface in the old valley southward from Shelbyville. At a point about one-fourth of a mile northeast of Fenn's Station, in the north half of Sec. 30, T. 12 N., R. 7. E., gravel is being taken out by means of an endless chain to which small buckets are attached, some such method being necessary because the ground water level is here not more than five or six feet below the surface of the valley bottom. The section so far as exposed by the work here is as follows:

Fig. 6. Gravel dipped by means of buckets attached to an endless chain. Near Fountaintown, Shelby County. (Photo by B. W. Kelly.)

1. Loamy soil with pebbles mostly of cherts, granites, diorites, and other crystalline rocks, and much deecayed gneisses, three feet.
2. Stratified sand and gravel, containing a large percentage of limestone pebbles and very subordinate amounts of little weathered crystalline rock fragments, 22 feet.
3. Compact till (unassorted glacial material), to an undetermined depth.

A majority of the roads in the county are gravelled and kept in good repair; a very considerable percentage of the road mileage is, however, little improved beyond grading and the construction of such bridges and culverts as are most needed.

Stone.—Limestone for building and for burning into lime is quarried at a number of points in the southeastern part of the county, notably near St. Paul. Some of the strata, as pointed out by State Geologist Collett in the Eleventh Annual Report of the Department of Geology and Natural History of the State, are suitable for road material, but so far but little use has been made of them for this purpose.

Underground Water.—The underground water supply over the greater part of the county is contained in beds of sand and gravel, and is reached by wells varying in depth from five or six to 100 feet or more. While in many places a permanent supply of water may be obtained from shallow wells, considerations in regard to health have prompted the sinking of an increasing number of tubular wells to a depth sufficient to secure a supply which is free from the injurious compounds so generally found at certain times of the year, at least, in surface waters.

As noted in the report for Hancock County, the belt within which flowing wells occur extends into the northern part of this county, those at Morristown being the examples best known. What the limits of this low-lying water-bearing stratum may be has not been determined.

Climate.

The climatic conditions are but slightly different from those in Hancock County. The following tables give the data from observations made at Shelbyville, and are furnished for this report by Mr. V. H. Church, Section Director of the U. S. Weather Bureau at Indianapolis:

Table XI. Mean Temperature and Average Precipitation at Shelbyville.

Month.	Mean Temperature. Degrees F.	Average Precipitation. Inches.
January	30.8	3.04
February	29.7	2.90
March	43.8	3.17
April	51.4	3.76
May	63.0	4.75
June	71.4	4.25
July	74.3	4.79
August	73.6	3.18
September	68.1	3.44
October	55.3	4.12
November	41.8	2.75
December	31.2	3.01
Annual	52.9	43.16

Table XII. Maximum and Minimum Temperatures.

Highest temperature recorded from 1905 to date, 103° in July and also in August, 1911.

Lowest temperature recorded from 1905 to date, –18° on January 7, 13, and 16, 1912.

NOTE—The lowest previous record was 17° below zero, Feb. 1905.

Table XIII. Average Dates of Killing Frosts at Shelbyville.

Last in spring	April 21
First in autumn	October 15

It will be observed by comparing the data for the three counties here considered that the chief difference in the climatic conditions is that the precipitation is greatest in Shelby County, the increased amount being well distributed throughout the year.

AGRICULTURE.

Of the 260,480 acres in the county, 96.7 per cent. or 251,903 acres, is in farms varying in size from less than three to over 500 acres. As ascertained by the census of 1910, there are 2,702 farms in the county, of which over one-half (58 per cent.) include 50 to 175 acres each. The farming land in the county increased a little more than 100 per cent. in value in the 10 years from 1900 to 1910, being listed in the latter year at a total valuation of $24,890,457, or an average of nearly $100 per acre; while the total valuation of farm property including buildings, implements, domestic animals, etc., adds about $6,500,000 to this amount, making an average valuation of land and farm property together of nearly $125 per acre.

The following tables taken from the report of the census of 1910, show in condensed form the principal crops raised, the acreage, and the yield per acre; and the number and valuation of the principal kinds of domestic animals and poultry:

Table XIV. Principal Crops.

	Acres.	Bushels.	Tons.
Corn	85,829	4,092,210	
Oats	4,949	106,075	
Wheat	58,354	755,387	
Timothy hay	7,983		10,537
Clover alone	9,109		10,937
Timothy and clover mixed	3,981		5,495
Clover seed		7,057	
Potatoes	666	65,824	

Table XV. Domestic Animals and Poultry on Farms.

	Number.	Value.
Cattle	15,759	$462,408
Horses	12,795	1,258,540
Mules	860	105,990
Swine	49,631	306,080
Sheep	10,751	46,468
Poultry	180,468	111,438

The general conditions in regard to farm crops is much the same as in Hancock County, and practically all that has been said under the heading of Agriculture in the report for that county applies also to Shelby County. The principal differences to be noted are (1) that the soil in the inter-stream areas in Shelby County has, especially in the southern part, a somewhat higher average content of silt, which has the effect of making the soil in general somewhat more loose and easily worked; and (2) that there is in Shelby County a very much larger proportion of the acreage which is underlain at a depth of a few feet by sufficient sand and gravel to insure excellent drainage except at times of unusual precipitation. The treatment of these somewhat gravelly, well drained soils should, of course, be very different from that given to the heavier, more compact types; tile drains need not be laid so close together as in the more clayey soils, and fertilizers of different composition are usually to be chosen.

The presence of considerably larger areas of well drained, looser, warmer soils has made profitable the introduction of truck farming to a much larger extent than in Hancock County. At present, tomatoes and sugar corn are the crops most largely grown, the entire yield being in most cases disposed of to canning factories.

Origin of the Soils.

As in the case of the soils of Hancock County, the soils of this county owe their origin chiefly to the work of the great ice sheets which once covered this part of the State, and to the agencies and processes that accompanied them. In Shelby County the chief differences to be noted are as follows:

1. So far as the surface layers are concerned, there is much more assorted drift than in Hancock County; that is, more sand and gravel at and near the surface, much of it in stratified beds, covered now more or less completely by a layer of soil which is due to processes of weathering and the effects of the growth of

plants since these deposits were made. The presence of stratified drift in larger amounts than in Hancock County implies the former presence of a correspondingly greater abundance of water, which is to be accounted for by the fact that the county, lying as it does farther down the inclined surface over which the ice moved, has been obliged to accommodate in its various drainage channels not only the water formed from precipitation and the melting of ice within its own borders, but also the water coming from the greater area of the higher slopes above. This has resulted in the presence of a larger proportion of gravelly and sandy soils.

2. The presence of a larger proportion of silt in the upper layers of the soil, especially in the southern part of the county. This is due primarily to the greater amount of loess deposited here chiefly by the agency of the wind at some time after the withdrawal of the ice.

Soil Types.

The following table gives the names of the soil types found in the county, with the approximate area covered by each:

Table XVI. Soil Types.

Name.	Acres.
Miami clay loam	207,755
Sioux loam	26,690
Wabash loam	22,760
Carrington black clay loam	2,000
Coloma sandy loam	455
Knox silt loam	385
Wabash fine sandy loam	280
Miami gravelly loam	80
Meadow	50
Wabash sandy loam	35
Muck	20

The boundaries between the different types as shown on the accompanying map is in some cases drawn arbitrarily, as for example in places where Carrington black clay loam joins Sioux loam, especially in the areas southwest of Boggstown and northeast of Fairland. Much detailed work, including many more borings than the time allotted for the field work permitted, would be necessary in order to establish the boundaries with complete accuracy; in general, however, the lines mark approximately the place where the character of the soil changes.

In some cases, as for example in the Sioux loam, the characteristics of the soil vary somewhat from place to place within the boundaries indicated for the type; this grouping of somewhat different soil types under one name has also been necessary because of the large amount of time which would have been required to determine the boundaries of these minor subdivisions. Further reference to variations of soil characteristics in a given soil type will be made in connection with the detailed description of types farther on.

Miami Clay Loam.

This type includes about four-fifths of the total area of the county, occupying in general the areas between the streams. In most places it consists of a light colored soil 8 to 12 inches deep, with a rather high percentage of silt, underlain by a compact yellowish to grayish brown mottled subsoil containing a higher percentage of clay than the soil together with some pebbles and small rock fragments. Occasionally in the areas between the streams, patches of other types are found, as for example, the Carrington black clay loam occupying shallow depressions in the surface, and the Coloma sandy loam or the Miami gravelly loam, which rise either as islands from the mass of morainal material from which the Miami clay loam has been formed, or as accumulations deposited on top of the general morainic surface. In certain places within the area mapped as Miami clay loam frequent strips and patches of dark gray to black soil occur; a majority of such areas within the county have a subsoil very similar to that of the typical light colored areas adjacent; some, however, of size large enough to be of importance to the owner, yet too small to be mapped accurately, have a drab to gray silty subsoil, or even in some cases a subsoil containing abundant sand and gravel. Such variations are, however, not common.

The chief differences between the Miami clay loam in Shelby County and that in Hancock County are (1) the general presence in Shelby County of a larger amount of silt deposited originally as loess; and (2) the presence in places in the southeastern part of Shelby County of a noticeable amount of material derived from the weathering of the underlying bed rock which is here near the surface. In character of original forest growth there is to be noted the presence in Shelby County of an increased number of sassafras bushes and trees, and, especially in the southern part, the presence of a larger number of tulip trees (commonly known as yellow poplar), of large size; stumps of trees of the latter species still remaining show a diameter of trunk of six to seven feet or more.

For a discussion of questions relating to drainage and the use of fertilizers on this type, see the report for Hancock County, pages 55 and 56, the conditions on the Miami clay loam in the two counties with respect to these matters being much the same:

Table XVII. Mechanical Analysis of Miami Clay Loam.

	Coarse Sand. %	Medium Sand. %	Fine Sand. %	Silt. %	Clay. %	Total. %
Soil	7.02	7.82	20.87	51.89	12.68	99.98
Subsoil	3.65	5.63	17.23	50.18	23.29	99.98

Table XVIII. Chemical Analysis of Miami Clay Loam.

	Soil, 0″ to 11″.	Subsoil, 11″ to 3′ 0″.
Reaction to litmus	Neutral	Neutral
Moisture in air-dried soil	1.22%	2.88%
Total nitrogen	0.079%	0.43%
Analysis of soil dried at 105° C.—		
Volatile and organic	2.82%	3.33%
Insoluble in HCl (Sp. g. 1.115)	90.00%	83.74%
Soluble silica (SiO_2)	0.15%	0.22%
Ferric oxide (Fe_2O_3)	2.50%	4.47%
Aluminum oxide (Al_2O_3)	3.12%	6.36%
Phosphor. acid anhydride (P_2O_5)	0.35%	0.24%
Sulphuric acid anhydride (SO_3)	0.02%	Trace
Calcium oxide (CaO)	0.32%	0.48%
Magnesium oxide (MgO)	0.35%	0.77%
Potassium oxide (K_2O)	0.11%	0.26%
Sodium oxide (Na_2O)	0.22%	0.39%
Total	99.96%	100.26%

Sioux Loam.

This type occupies about one-tenth of the total area of the county and includes some of the most productive land now under cultivation. There are here included under this name several variations from the type described under the name Sioux loam by the U. S. Bureau of Soils. The most general characteristics of the type as mapped in this county are (1) the loamy to sandy character of the soil, which extends to a depth of from 10 to 12 inches and contains up to 10 per cent. of gravel scattered through it; and (2) the increasing amount of gravel and sometimes of finer soil particles as well in the subsoil, which sometimes at a depth of three or four feet rests upon beds of stratified sand and gravel. The prevailing color of the soil is light brown; but this shades off in places into gray and even black as the content of organic matter increases; in other places into yellowish or reddish brown colors as the iron oxide present predominates. Topographically, the Sioux loam is level to gently rolling, by far the greater part being nearly level; low hills and ridges 8 to 10 feet above the general surface, however, occur.

In its relation to other types the Sioux loam lies, in general, between the Wabash loam found near the streams, and the Miami clay loam which forms the slopes bounding the valleys, the general elevation of its surface in such cases being intermediate between the two. In the case of the old valleys referred to, which are not now occupied by streams of any considerable size, the Sioux loam often fills the entire valley as shown in the area south of Shelbyville; in other places areas of Carrington black clay loam are surrounded by Sioux loam, as in the old valley northeast of Fairland. Here the change of drainage conditions seems to have left certain depressed areas which, for a long time the site of ponds, have finally filled up by the slow washing in of silt and the accumulation of organic matter.

The drainage is as a rule good; in the case of the terrace-like portions, both on account of its topographic position and on account of the abundance of gravel and sand which lies at a short distance below the surface; in the case of the areas lying lower down in the valleys because of the porous character of the soil alone. Some portions, especially those surrounding former depressions in old valleys, are, however, in some places in need of additional ditches or lines of tile drainage, and the suggestions given on pages 55 and 56 of the Hancock County report apply.

Table XIX. Mechanical Analysis of Fine Earth of Sioux Loam.

	Coarse Sand. %	Medium Sand. %	Fine Sand. %	Silt. %	Clay. %	Total. %
Soil	21.71	11.19	12.95	44.52	9.43	99.80
Subsoil	23.36	10.46	11.91	34.32	20.11	100.16

NOTE.—In the above sample, the following percentages of pebbles and gravel above 2.0 mm. in diameter were found:

Soil, to a depth of 9 inches................................ 9.50%
Subsoil, 9 inches to 1 foot 6 inches........................ 20.40%

The amount of gravel at 1 foot 6 inches below the surface became too great to permit the auger used in obtaining the sample from penetrating deeper.

The Sioux loam is in general considered a rich soil, but the yield of wheat, especially, is very much increased by the use of commercial fertilizers. Fertilizers sold under a guarantee of a minimum of constituents as given below, used on soil of this type in 1911, at the rate of 150 pounds per acre, seemed to produce a notable increase in yield:

Table XX. Constituents of Fertilizers Used for Wheat.

	A.	B.
Total nitrogen (N)	0.8%	1.2%
Potash soluble in water (K_2O)	4.0%	2.5%
Soluble and reverted phos. acid (P_2O_5)	8.0%	8.0%
Insoluble phosphoric acid (P_2O_5)	1.0%	1.0%

Wabash Loam.

This type of soil occupies a little less than nine per cent. of the total area of the county, and consists of a brown to a dark brown or nearly black loam 10 to 15 inches deep, followed by a subsoil which sometimes differs but little in composition though sometimes having an increased proportion of sand. Locally gravel is abundant; in other places the usually loamy character of the soil gives place to strips and patches of a silty or even clayey soil rich in organic matter, the sites of former bayous or other depressions in the flood plains of streams which have gradually filled up with material finer than that of which the flood plain, in general, is composed. These areas in some places approach muck in composition, but in only two points in the county were they found to be sufficiently large and well marked to be indicated on the map. As shown on the accompanying soil map of the county, the Wabash loam occupies the areas next to the streams, forming the low, rich, level first bottoms, which are especially well adapted to corn.

A chemical analysis of soil of this type is given below; for mechanical analysis, and for further details as to topography, etc., see the discussion of Wabash loam in the report for Hancock County, pages 50 and 51.

Table XXI. Chemical Analysis of Wabash Loam.

	Soil to a Depth of 12 Inches.
Reaction to litmus	Neutral
Moisture in air-dried soil	2.19%
Total nitrogen	0.238%
Analysis of soil dried at 105° C.—	
Volatile and organic	7.14%
Insoluble in HCl (Sp. g. 1.115)	82.02%
Soluble silica (SiO_2)	0.12%
Ferric oxide (Fe_2O_3)	3.98%
Aluminum oxide (Al_2O_3)	4.81%
Phosphor. acid anhydride (P_2O_5)	0.32%
Sulphuric acid anhydride (SO_3)	Trace
Calcium oxide (CaO)	0.64%
Magnesium oxide (MgO)	0.56%
Potassium oxide (K_2O)	0.25%
Sodium oxide (Na_2O)	0.23%
Total	100.07%

Coloma Sandy Loam.

This type is represented by a few hills and ridges in various parts of the county, which, in general, rise notably above the general level. As shown by the mechanical analysis below, the percentage of sand grains medium in size is high, but enough finer particles are present to make the soil well adapted to general farm crops. In part these hills seem to be due to the work of the wind. and so far are to be regarded as weathered sand dunes. There is a noticeable absence of all pebbles or rock fragments above the size of coarse sand grains. The color of the soil is light buff to light gray, changing gradually into a somewhat reddish brown subsoil at a depth of 10 to 12 inches. As is the rule with sandy soils in such locations, the drainage is good; as is also usually the case with naturally well drained soils, crops are likely to suffer on account of the lack of sufficient moisture in times of drought. It is to be noted, however, that there is seldom a season in which the moisture is not sufficient in amount to insure at least a fair crop. Corn and wheat are grown successfully on this type, but it is also well adapted to truck farming.

Table XXII. Mechanical Analysis of Coloma Sandy Loam (average).

	Coarse Sand. %	Medium Sand. %	Fine Sand. %	Silt. %	Clay. %	Total. %
Soil	22.88	42.39	12.08	13.02	9.36	99.66
Subsoil	23.84	41.42	12.53	7.79	14.27	99.85

Miami Gravelly Loam.

Like the Coloma sandy loam, the Miami gravelly loam is found only as prominent hills and ridges; but unlike the former it contains an abundance of pebbles and gravel, with occasional boulders. In part the materials of which it is composed are stratified, and sufficiently free from the finer particles of mineral matter to make excellent road material. In part, however, it is unstratified, made up of the heterogeneous mixture of materials characteristic of glacial debris; so that these hills, made up partly of unassorted morainal material, partly of assorted outwash materials, are to be classed as kames closely associated with morainal sheets and ridges. The soil is in general not well adapted to the production of farm crops, but is used largely as pasture land. It will be noted, however, that the total area of this type within the county is small.

Other Types.

The other types found in the county, all small in amount of area covered, are as follows: Carrington black clay loam, Wabash sandy loam, Wabash fine sandy loam, Knox silt loam, Meadow, and Muck; the location of each of these types is shown on the accompanying map. For the description of all except the Knox silt loam and the Wabash fine sandy loam, the report on Hancock County may be consulted, since the characteristics there named are practically the same for the like-named types in Shelby County.

The Knox silt loam, and the Wabash fine sandy loam are each small in area; the former being found in areas sufficiently large to be mapped only in the west central part of the county; the latter in a single tract along the south side of Flat Rock Creek.

The Knox silt loam as here mapped differs from the Miami clay loam found in the southern part of the county chiefly in the larger percentage of silt in the subsoil. As has been remarked already, the percentage of silt at the surface is high, but in the subsoil the increased proportion of finer particles and the common occurrence of pebbles such as characterize the moraines, seem to require the reference of the greater part of the light colored upland soils to the Miami clay loam. In numerous small areas, however, the subsoil has also a high percentage of silt with fewer pebbles, and in such places the soil is referred to the Knox silt loam type. The general characteristics as to topography, crop adaptation, etc., are much the same as for the adjacent areas of Miami clay loam.

The Wabash fine sandy loam differs from typical Wabash loam, which it much resembles, in the larger percentage of fine sand and in the lower percentage of finer particles. It consists of a soil 12 to 15 inches deep of dark brown color, and a subsoil to a depth of 2 feet, 6 inches, containing a rather larger percentage of brownish to grayish sand underlain by a stratum which includes an abundance of gravel. The area is in general well drained, but is not uniformly productive. In the parts lying near to the hills of Miami clay loam to the south and southeast, the proportion of finer particles in the soil increases, becoming a true loam; the transition belt is, however, narrow and has not been separated on the map from the more sandy portion nearer the stream.

SUGGESTIONS.

The suggestions given at the close of the report for Hancock County, page 55, apply also to Shelby County, with the exception that the fact that there is a larger percentage of soil of the Sioux loam type alters somewhat the degree of emphasis placed upon the question of drainage when applied to the county as a whole. But even in the case of the Sioux loam, the extension of systems of drainage is not only desirable but important.

JOHNSON COUNTY.*

LOCATION.

Johnson County is located south of the central part of the State, and is bounded as follows: On the north by Marion County; east by Shelby County; south by Brown and Bartholomew counties; and west by Morgan County. It includes 320 square miles lying in townships 11, 12, 13 and 14 north, ranges 3, 4 and 5, east, of the U. S. Land Survey.

HISTORY.

The area now included in Johnson County, like that of Shelby County, was once a part of the "New Purchase," a tract of land purchased from the Delaware Indians in 1818. At about the same time the first step toward the settlement of the region was taken

* The characteristics of the soils of Johnson County are in many respects quite similar to those of Hancock and Shelby counties, described in the preceding parts of this report. In so far as these characteristics are practically identical, the discussion will not be repeated; such parts of the reports of the two counties last named, however, as should be read in order to give a full understanding of the conditions in Johnson County, will be indicated in the appropriate connection in each case.—A. D. H.

by Jacob Whitzel, who marked out a trail through the wilderness from his home in Franklin County as far west as to the bluffs of White River. Along this "trace" and along an old Indian trail crossing the county from south to north, the earliest settlers came, making settlements in 1820 near Edinburg in the southeast corner of the county, and at the mouth of Pleasant Run in the northwest corner. In 1821 the first settlements were made at or near the present site of Franklin, and in the following year the county was organized and named Johnson County in honor of Judge John Johnson, a judge of the Supreme Court. From this time on the number of settlements increased and the work of conquering the wilderness kept pace here with the precisely similar work being carried on by pioneers in the adjoining counties. As in the adjacent parts of the State, the work of removing the forests, draining the land, building houses, and making roads, called for continued efforts under conditions which were at times most trying; for not only were many of the comforts of life lacking, but also even necessities were at times exceedingly difficult to procure, and added to hardships of all other kinds, was that of the prevalence of malarial diseases in many places, which if not so immediately fatal as some others, nevertheless drew heavily on the resources of strength and hope which are such necessary elements of success for men and women who at any time are in the midst of the accomplishment of great tasks. That the task undertaken by these pioneers has been carried well toward completion, is shown by the fact that of the total area of farm land in the county about 85 per cent. has been cleared and put in good condition for cultivation.

Means of easy communication is provided for practically all parts of the county by a system of roads, most of which are well gravelled and kept in good repair, and by railroads which bring transportation facilities within reasonable distance of even the most remote sections. Of the latter there are three crossing the county, together with one electric line.

The present population of the county as ascertained by the census of 1910, is 20,394 of which by far the larger per cent. is made up of those who live on farms; those whose business interest, therefore, has for its principal object the development of the resources of the soil.

GEOGRAPHY AND GENERAL GEOLOGY.

The surface of the county is made up of two distinct types of topographic features, viz.: (1) level to gently undulating plains, and (2) areas much dissected, hilly and broken. The latter is found especially in the southwestern and western parts of the county, the former in practically all of the remaining part.

The entire county is drained by White River, Blue River, and their tributaries. Roughly speaking, the western one-third belongs to the drainage system of White River, which crosses the extreme northwest corner of the county. Most of its tributaries which rise within the borders of the county cross the county line and join the main stream some miles to the west and southwest. Blue River crosses the extreme southeast corner of the county, but receives within the limits of the county Sugar Creek, which with its principal tributary, Young's Creek, and numerous smaller branches, drains all the remaining area. The highest ground in the county constitutes, therefore, a broad, flattened ridge or watershed extending in a north-south direction three or four miles west of the central line of the county, and bending eastward at both its north and south ends to reach points at or beyond the middle north-south line. The top of this watershed and most of the area lying to the east of it forms the level to gently undulating plain already referred to; the area lying to the west of the watershed is, in the southern half of its extent generally hilly and broken.

The underlying bed rock is, in the western and southwestern portion, a part of the Knobstone group of the Mississippian formation; over the remainder of the county, members of the Devonian. Outcrops of the Knobstone group occur frequently in the valleys, extending in some cases well up to the heads of the streams on the western side of the divide, and contributing to the conditions which have made the broken, hilly topography already referred to. Only to a slight degree has the material of this formation contributed to the constituents of the soil now covering the hills and ridges between the numerous valleys in which the outcrops occur. Outcrops of the Devonian shale are very rare in the county, only one place being cited in the Thirteenth Annual Report of the State Geologist, where the geology of the county is discussed.

The geologic formations of chief importance so far as the soils are concerned are (1) the great sheet of glacial debris of Pleistocene age, and (2) the modified Recent forms which this material has assumed under the influence of agencies operating since the ice withdrew. The amount and character of the glacial deposit varies considerably in different parts of the county, from comparatively thin, notably loessial patches in the southwestern part, to typically morainal deposits farther north which reach a maximum thickness of possibly nearly 200 feet.

Of the morainic areas, perhaps the most striking is the series of ridges and hills extending a little south of east from Greenwood to within two miles of the eastern boundary of the county. One of the most noticeable features about this moraine is the number of granitic boulders to be seen at the surface, some of which are of unusually large size. Some of the largest have been broken in pieces and removed, but records have been preserved of some which had a maximum diameter of over 18 feet. In other parts of the county other features of the drift are more noticeable, as for example the kame-like ridges and hills of gravelly loam in the northwestern part of the county, or the nearly level sheets of outwash along the valleys of Sugar Creek, Blue River, or White River.

Economic Geology.

The economic products from the geological formations in this county are in general limited to the two which are to be found throughout this part of the State, viz.: gravel and underground water.

Gravel.—The distribution of gravel is to be stated practically as in the case of the similar deposits in Hancock and Shelby counties; one difference, however, may be mentioned, that is, that in this county a larger proportion of the gravel used is obtained from pits opened in kame hills, rather than from beds of river gravel or from deposits lying below the ground water surface in level, low-lying areas of glacial outwash. The principal deposits of each kind known in 1905 are described and mapped by Mr. E. J. Cable in the Thirtieth Annual Report of the State Geologist; and while some pits have been opened since that report was written, the general areas in which gravel is found are still the same. No figures are available as to the amount used each year, but the total must be large.

Underground Water.—The general facts recounted in the reports on Hancock and Shelby counties as to the reduction of ground water level in recent years, and the present custom of attempting to secure water for drinking purposes from a depth of from 50 to 100 feet below the surface, need not be repeated here since much the same conditions in regard to the water supply prevailed in each of these three counties at the time of the settlement of the country, and the change from disease-breeding to healthful conditions has likewise followed about the same course. Johnson County has, however, in its southwestern part the advantage of springs of excellent water far greater in number than can be found in those counties in which the topography is more uniformly level.

Climate.

The climatic conditions are but slightly different from those of Hancock and Shelby counties. The following tables give the data from observations made at Franklin, and furnished for this report by Mr. V. H. Church, Section Director of the U. S. Weather Bureau at Indianapolis:

Table XXIII. Mean Temperature and Average Precipitation at Franklin.

Month.	Mean Temperature. Degrees F.	Average Precipitation. Inches.
January	29.5	2.91
February	30.0	2.53
March	40.9	3.58
April	52.7	2.44
May	63.5	3.72
June	71.8	3.78
July	76.6	2.52
August	72.0	2.85
September	65.9	3.04
October	53.9	2.50
November	41.5	3.48
December	33.0	2.90
Annual	52.6	36.25

Table XXIV. Maximum and Minimum Temperatures at Franklin.

Highest temperature recorded, 107° in July, 1901.

Note—This record covers the period from 1887 to 1908, inclusive, but within that time the July records are missing in the following years: 1889, 1891, 1892, 1894, 1895, 1896, 1897, 1898, 1904, and 1906.

Lowest temperature recorded, 17° below zero, February, 1905.

Note—January and February records are complete for the entire period of record, 1887 to 1908, inclusive.

Table XXV. Average Dates of Killing Frosts at Franklin.

Last in spring	April 21
First in autumn	October 18

It will be observed by comparing the data for the three counties here considered that the chief difference in the climatic conditions is the fact that the average annual precipitation is somewhat less in Johnson County than in either of the other two.

Agriculture.

Of the 206,080 acres in the county, 95.8 per cent., or 197,403 acres, is in farms varying in size from less than three to over 1,000 acres. As ascertained by the census of 1910, there are 2,025 farms in the county, of which over one-half include 50 to 175 acres each. The farming land in the county increased nearly 118 per cent. in value in the 10 years from 1900 to 1910, being listed in the latter year at a total valuation of $19,204,550, or an average of over $97 per acre for the entire county; while the total valuation of farm property, including buildings, implements, domestic animals, etc., adds over $5,000,000 to this amount, making an average valuation of land and farm property together of about $125 per acre.

The following tables taken from the report of the census of 1910, show in condensed form the principal crops raised, the acreage, and the yield per acre; and the number and valuation of the principal kinds of domestic animals and poultry:

Table XXVI. Principal Crops.

	Acres.	Bushels.	Tons.
Corn	58,615	2,982,253	
Oats	3,480	91,522	
Wheat	38,862	640,831	
Timothy hay	6,532		9,418
Clover alone	10,275		13,549
Timothy and clover mixed	3,416		4,807
Clover seed		6,645	
Potatoes	339	33,842	

Table XXVII. Domestic Animals and Poultry on Farms.

	Number.	Value.
Cattle	16,019	$512,923
Horses	9,577	996,243
Mules	1,124	135,430
Swine	41,335	288,881
Sheep	11,596	51,997
Poultry	126,381	82,381

Statistics are not available for the acreage and value of tomatoes, sweet corn, etc., which are raised in considerable amount for sale to canning factories; nor for orchard fruits and small fruits which are also produced in larger quantities than in the two other counties on which report is here made. Fruit raising and truck farming have been developed to a greater extent in Johnson County than in Hancock or Shelby, largely because the county has over a larger proportion of its area soil with a higher percentage of sand and silt, and so is better adapted to such crops. Care is needed, however, in this kind of farming as well as in grain raising, to see that a proper rotation of crops is maintained. That this has not always been carefully done is shown by the fact that tomato growers, for example, find that by successive plantings on the same ground the possibilities of yield have been reduced about half; but that after the land is allowed to "rest," it will again produce large yields.

In general, the soil conditions in this county are so similar to those of Hancock and Shelby counties, that the discussion in those reports of other plans of agricultural work will apply in most particulars to Johnson County also.

Soil Types.

The following table gives the names of the soil types found in the county, with the approximate area covered by each:

Table XXVIII Soil Types.

Name.	Acres.
Miami clay loam	179,710
Wabash loam	10,050
Sioux loam	7,950
Carrington black clay loam	3,490
Miami loam	2,500
Coloma sandy loam	2,000
Miami gravelly loam	380

With respect to the degree of accuracy of the boundaries of soil types shown on the accompanying map, the considerations mentioned on page 65 of the Shelby County report also apply to Johnson County; as, for example, as follows: (1) Three to four miles northwest and west of Needham, the boundaries between the Sioux loam and Carrington black clay loam are for the most part not clearly marked lines; the division is indicated on the map in each case at the approximate position of the place where the general character of soil and subsoil changes. (2) One and one-half miles west of Whiteland where the Wabash loam joins Carrington black clay loam, there is also a gradual shading off of the characteristics of the one soil as the other is approached. (3) In some respects even more obscure is the line of separation between the types Coloma sandy loam, Miami loam, and Wabash loam, in the northwestern corner of the county. The relations here are very complex and only the most extended, detailed examination would suffice if the soil types in this area were distinguished with complete accuracy.

Further reference to variations of soil characteristics in a given type as mapped will be made in connection with the detailed description of types farther on.

Miami Clay Loam.

This type occupies about 87 per cent. of the total area of the county, and differs but little from the Miami clay loam as described in the report for Shelby county. The percentage of silt is high in the soil, which usually extends to a depth of from 10 to 12 inches below the surface, but the subsoil is more nearly that of a typical clay loam. Over the larger part of the area occupied by this type the material out of which the soil has been formed is unassorted glacial till, containing some pebbles and some boulders of large size, as in the case of the morainic ridge extending eastward from Greenwood through Rocklane. In a smaller part of the area stratified sand and gravel is occasionally found near the surface. The character of the type changes somewhat in the southwestern part of the county, where the thickness of the covering of drift is less. Here the loess has formed a proportionately larger part of the soil, but except for small areas there is still abundant evidence of its glacial origin. For example, in the extreme southwestern part of the county along Indian Creek, pebbles of crystalline rocks in variety are almost everywhere present in the subsoil, with occasional erratic boulders, constituting thus typical glacial till. In places this subsoil is covered by comparatively thin sheets of almost pure loess, but usually some of the glacial material is present even in the uppermost layers.

The color of the Miami clay loam is, over a considerable part of the county, a light brown to ash gray, with numerous streaks and patches of black in certain sections at the surface. In the southwestern part of the county the color is sometimes decidedly reddish to yellowish, due no doubt to the presence of a larger proportion of iron supplied by the fragments of underlying bed rock which have been incorporated into the soil.

The drainage of this type is in general not good, and while on some farms systems of practically perfect tile drains have been put in, there is yet much more such work to be done before the possibilities of the soil can be realized. One sign of this lack of adequate drainage and aeration of the soil is the presence of numerous small iron concretions which in cultivated fields appear after a rain as little brown balls one-sixteenth to one-fourth of an inch in diameter. Such concretions were noted in abundance at several places, as for example in fields on the east side of the Illinois Central Railroad half a mile south of Frances Station, and again in the east half of the northwest quarter of Sec. 16, T. 13 N., R. 3 E.

For further details in the discussion of this type see the reports for Hancock and Shelby counties, pages 48 and 66.

Table XXIX. Mechanical Analysis of Miami Clay Loam.

	Coarse Sand. %	Medium Sand. %	Fine Sand. %	Silt. %	Clay. %	Total. %
Soil	11.96	21.06	24.88	28.90	12.51	99.31
Subsoil	10.69	15.87	21.19	30.35	21.57	99.67

Table XXX. Chemical Analysis of Miami Clay Loam.

	Soil.	Subsoil.
Reaction to litmus	Neutral	Neutral
Moisture in air-dried soil	1.21%	1.90%
Total nitrogen	0.108%	0.051%
Analysis of soil dried at 105° C.—		
Volatile and organic	3.81%	7.72%
Insoluble in HCl (Sp. g. 1.115)	88.26%	73.33%
Soluble silica (SiO_2)	0.20%	0.20%
Ferric oxide (Fe_2O_3)	2.62%	4.20%
Aluminum oxide (Al_2O_3)	3.93%	6.15%
Phosphor. acid anhydride (P_2O_5)	0.10%	0.55%
Sulphuric acid anhydride (SO_3)	0.01%	0.01%
Calcium oxide (CaO)	0.34%	4.68%
Magnesium oxide (MgO)	0.38%	2.18%
Potassium oxide (K_2O)	0.13%	0.34%
Sodium oxide (Na_2O)	0.18%	0.35%
Total	99.96%	99.71%

Wabash Loam.

This type occupies about five per cent. of the total area of the county, the greater part forming the rich, level first bottoms along White River, Blue River, and Sugar Creek; smaller and less typical belts being found along some of the smaller streams. It presents no new characteristics in this county, so that the descriptions and discussions referring to this type in the reports for Hancock and Shelby counties, pages 50 and 69, may with equal correctness be applied to the form in which it occurs here.

Sioux Loam.

This type occupies a little less than four per cent. of the total area of the county, and presents no peculiarities beyond those found in the same type in Shelby County; indeed, by far the greater part of the area classed as Sioux loam in this county, lies along the eastern side and is a continuation of the more extensive areas already described in the report for Shelby County, page 67.

There is, however, added here the results of a chemical analysis of a sample of Sioux loam soil taken from this county:

Table XXXI. Chemical Analysis of Sioux Loam.

	Soil.
Reaction to litmus	Neutral
Moisture in air-dried soil	0.71%
Total nitrogen	0.081%
Analysis of soil dried at 105° C.—	
Volatile and organic	2.72%
Insoluble in HCl (Sp. g. 1.115)	91.60%
Soluble silica (SiO_2)	0.15%
Ferric oxide (Fe_2O_3)	2.04%
Aluminum oxide (Al_2O_3)	1.84%
Phosphor. acid anhydride (P_2O_5)	0.33%
Sulphuric acid anhydride (SO_3)	0.02%
Calcium oxide (CaO)	0.40%
Magnesium oxide (MgO)	0.24%
Potassium oxide (K_2O)	0.11%
Sodium oxide (Na_2O)	0.13%
Total	99.58%

Miami Loam.

The name Miami loam is here applied to a poorly defined area in the northwestern part of the county which is pretty generally characterized by a somewhat loose, deep, loamy soil (12 to 15 inches), of light brown color, and a more compact subsoil which, however, soon shows first an increase in the amount of sand present, then an increase in the amount of gravel and pebbles which in some places is too great to permit an auger to penetrate to a depth of three feet. In color the subsoil is at first somewhat more yellowish than the soil, but often changing to a brownish shade. The proportions of pebbles, sand, and finer particles is variable; where the sand predominates the yellow color is likely to be found; where pebbles with silt and clay are more abundant a brownish color usually prevails.

The topography of this area is rolling to nearly level, and is generally well drained.

The area as mapped is not uniform over its whole extent. In some places true clay loam is present, and drainage conditions are poor as shown by an abundance of small iron concretions on the surface. In other places there are patches of sandy to sandy loam soils. The boundary as shown on the map is, therefore, only approximate, but is located at about the position where the change in soil characteristics takes place.

Other Types.

The other types occurring in this county have all been described in the reports for Hancock and Shelby counties, and their general characteristics are not, therefore, repeated here. One type, the Coloma sandy loam, should, however, be mentioned since it is here mapped to include considerable areas of level to gently undulating land as well as the prominent hills which, as in the case of the soil of this type in Shelby County, are evidently to be regarded as weathered sand dunes. As has been remarked already in another place the boundary of the area mapped in this county as Coloma sandy loam is to be regarded as only approximately marking the position of change in the characteristics of the soil.

SUGGESTIONS.

The most important practical suggestions for the treatment of soils in this county must be directed first to improvements in the drainage systems of the uplands, and second to other matters of farm management, of which the use of commercial fertilizers constitutes an important part. For a detailed discussion of these points, see the report for Hancock County, pages 55 and 56.

Soil Survey of Morgan County.

By J. B. Edmondson.

LOCATION AND DESCRIPTION.

Morgan County is situated in the south central part of Indiana. It is bounded on the north by Hendricks and Marion counties, on the east by Johnson County, on the south by Brown and Monroe Counties, and on the west by Owen and Putnam Counties. It comprises an area of 415 square miles, or 265,600 acres. Morgan County is within easy shipping distance of the city of Indianapolis, the Vandalia Railroad extending southwest through the central part and the Indianapolis and Martinsville Interurban running from Indianapolis to Martinsville.

The topography of the county is varied. The northern third is level to rolling, with evidence of heavy glaciation. The southern and central parts, however, are very rough and broken and are but poorly adapted for agricultural uses. In the central western part, the "Flats" extend into the county from Owen, comprising a level area of about 25,000 acres.

Morgan County lies entirely in the drainage basin of the White River with the exception of the extreme northwestern corner which is drained westwardly into Eel River. White River crosses the eastern boundary three miles south of the northern line, flows in a tortuous course southwest through the central part of the county and passes into Owen County at the extreme southwest corner. The tributaries from the north are White Lick Creek, Sycamore Creek, Lambs Creek, and Burkharts Creek, while the affluents from the south are Crooked Creek, Stotts Creek, Indian Creek, Little Indian Creek and Bryants Creek. The general slope of the county is to the southwest, the fall of White River being slightly over three feet per mile with an average elevation of 624 feet.

Where the surface is rolling the natural drainage is good, yet in many places the close texture of the soil renders drainage very difficult. These areas are usually marked by a light gray to whitish-colored soil with the surface covered with small, soft iron concretions, locally known as "buckshot" or "turkey gravel."

There are also wet areas of poorly drained soils found in the second bottoms of White River and the smaller streams in the southern part of the county—the "white slash" soils.

In the northwest part of the county is found a wide, low, inland valley, locally known as the "Lakes." From its outlet, into Eel River, west of Eminence, it extends in a northeasterly direction across Adams Township, touches the northwest corner of Gregg Township and reaches into Monroe Township to a point northwest of Monrovia. Here the wide ridge of rolling upland extending northward from the White River valley, several miles to the south, forms the divide between this and the level country farther to the northeast. (Hence, the statement made by a former geologist,* that the valley extends entirely across Morgan County and joins the White River valley in Marion County, is hardly possible.) The Lake region which was formerly covered with water the greater part of the year was slowly being reclaimed by the growth and decay of vegetation before the advent of the white man. By the use of large dredges and ditches this swamp has subsequently been converted into one of the richest farming regions in the State. Mud Creek, the only natural drainage basin of this valley, touches only the northern edge. Due to its low banks and shallow bed, its waters during the spring freshets spread out over miles of the surrounding country. A plan has been under consideration for some time to dredge out the bed of the creek through this region, in an attempt to prevent these destructive floods.

The lowest part of the valley extends east across the central part of Adams Township, nearly two miles south and approximately parallel to Mud Creek. This was the original outlet to the area, but the gradient being so slight it availed little as an outlet, becoming so filled in that drainage was stopped and the region was covered with the run off from the surrounding uplands a good part of the year. A few years ago, however, this old drainage course was reopened by a large dredge ditch and the drainage difficulties have been largely solved. The dredge or "Lake Ditch," begins in Monroe Township, northwest of Monrovia, and follows the lowest part of the valley in a southwesterly direction across the townships of of Monroe, the extreme northwest corner of Gregg, and across the central part of Adams, emptying into Eel River, northwest of Eminence. The ditch is about twenty miles long and is estimated to drain 64,000 acres of extremely fertile soil. Emptying into it

* Geological Report 1883.

is a number of State ditches and many tile drains. In addition to this, the drainage facilities of the region have been much facilitated by the removal of an obstructing dam from Eel River and the straightening of its channel. By these means the water table in this area has been materially lowered although crops still suffer frequently from floods after excessive rains.

GEOLOGY.

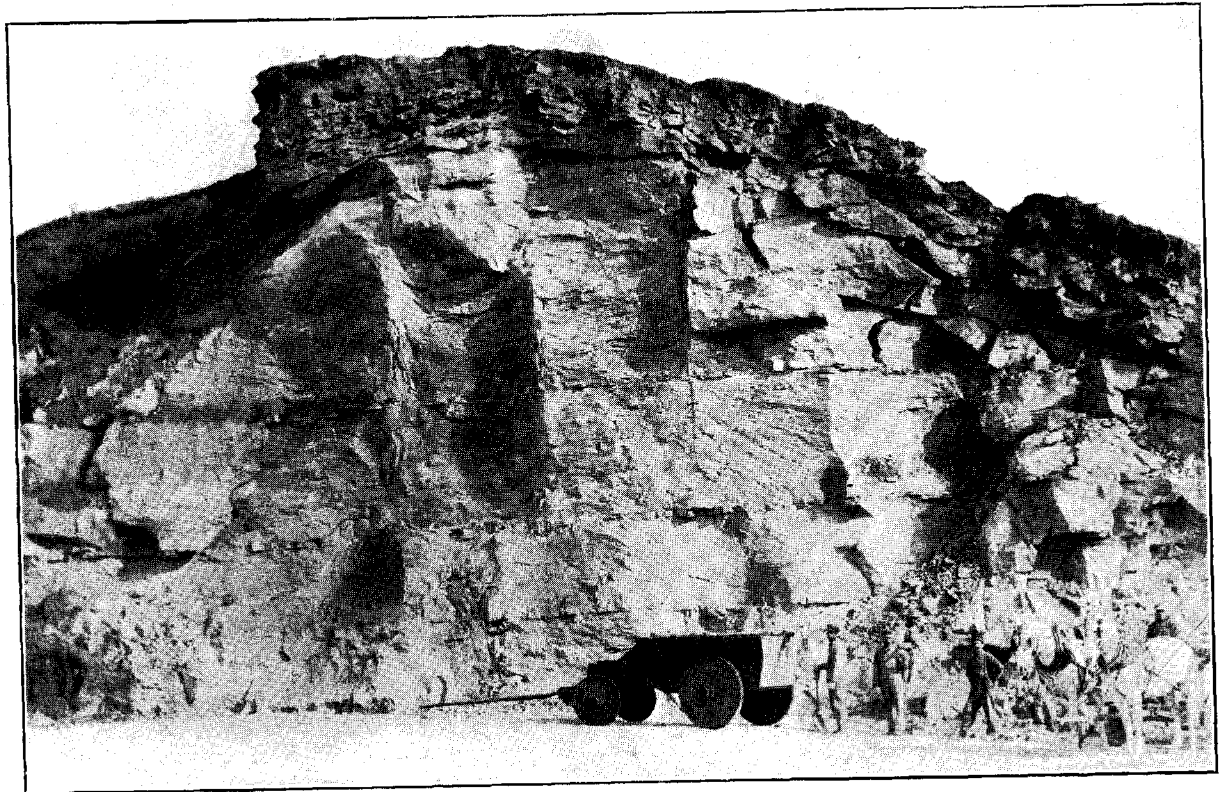
Morgan County is entirely within the glaciated area. However, the topography of the southern part of the county has been but little affected by the ice invasion, for the drift deposit is comparatively slight. The southern limit of the Wisconsin ice-sheet extended in an irregular southeastern direction, crossing the western boundary near the southern limit of the "Lakes" and extending east to the White River. Here it dips sharply to the south and crosses the county line at the extreme southeastern corner. The water which resulted from the melting of this ice-sheet in the western part of the county sought an outlet to the west and carried away the soil, leaving the long inland valley mentioned above. Along the southern bank of the valley, in the vicinity of Hall, an immense number of large granite bowlders is found. These are so numerous in many places as to interfere seriously with cultivation. The hummocky, uneven character of the surface in this region bears evidence of unweathered glacial material. This strip of glacial debris is not more than half a mile wide here, but farther east the bowlder line extends north to the county line, numerous large ones being found in Harrison, northern Clay and Madison townships. South of this irregular line, the topography of the county is much more broken and hilly.

The early, or Illinoian ice-sheet extended entirely over Morgan County, the foot resting in Monroe County, a short distance south of the Morgan County line. The drift laid down by this glacier contained little sand and gravel, the body of it being of finer material—silt and clay. This deposit has had but little influence on the original drainage system of the area, and the underlying Knobstone formation was left with its deep, narrow ravines and water courses practically unaltered.

Indian Creek, flowing west across the southern part of the county, is characterized by a wide valley in which is found extensive areas of sand. This feature is especially in evidence in the region south and east of Martinsville, where the sand occurs in high rounded hills skirting the valley and extending for more than a mile back from the present valley site, in the form of high, dune-like mounds. This sand may have been deposited here by the Illinoian ice-sheet, which evidently rested for a long period against the high Knobstone bluffs, rising for 200 feet above the Indian Creek on the south; or, more probably, it was transported to the present position by the waters of White River when that stream was a great glacial river, the sand either being derived from the disintegrating Knobstone sandstone or from the glacial debris. Doubtless the wind has assisted in fashioning the sand into the high rounded mounds we find in this region. The same formations are also found along the bluffs of the White River valley along its entire course through the county. The White River valley is very wide, the greatest width at Paragon being nearly four miles. In this region, the river valley lies 150 feet below the general level of the country and is marked by steep, precipitous bluffs. The bluffs, however, gradually decrease in height and abruptness as one proceeds up the river towards the northeast part of the county. From Martinsville north to the county line the greater part of the bottoms is underlaid with gravel sufficiently close to the surface to cause excessive drainage.

The entire county, with the exception of a small area in western Ray Township, is underlaid with the Knobstone formation. South of the line marking the limit of the Wisconsin ice-sheet, this formation is very much in evidence along the stream courses. Due to the soft character of the upper strata, the work of erosion has influenced the topography of the area very greatly. Into the larger stream valleys many deep, narrow ravines empty, which extend for long distances into the upland, gradually becoming deeper as they approach the streams until the valley level is reached. Large areas of such hills cover the greater part of Washington, Baker and Gregg townships, much of it being too rough for cropping. Numerous narrow, V-shaped valleys have been cut through the soft shale to a depth of 150 to 200 feet, giving the country a very rugged aspect. This feature is especially prominent in the region south of Martinsville.

The northeast part of the county is heavily glaciated, much of the material being as yet unweathered. The soil is interspersed with gravel and small bowlders, the gravel being especially prominent on the higher points. The surface is underlaid with a deep layer of bowlder clay. The townships of Madison, Brown, northern Clay and Gregg and eastern Monroe are included in this area.



Exposure of Knobstone Shale, found one-half mile north oı Martinsville, showing the thin covering of clayey soil above. This shale is used by the Martinsville Brick Company.

Along the western border of the county, in northern Ray and southern Ashland townships, the Mitchell and Harrodsburg limestone form the surface rock for some distance into Morgan County, being a continuation of the same strata so evident in eastern Owen County. The presence of the former stratum is easily recognized by numerous sink-holes, the luxuriant growth of bluegrass and clover, the loose, brown, loamy appearance of the soil, and the magnificent growths of sugar and walnut trees. This region presents a strong contrast to the surrounding Knobstone area with its stunted growth.

CLIMATE.

The climate of Morgan County is moderate and healthful. Neither extreme of temperature is reached. The direction of the prevailing wind for the year is from the southwest, the percentage of sunshine throughout the year being 54. There is no weather bureau stationed in Morgan County, hence the following data is taken from the station at Indianapolis, ten miles to the northeast:

Precipitation in Inches, Monthly and Annual; also Monthly Maximum and Minimum Temperatures as Recorded by the Indianapolis Station.

Month.	Precipitation, Inches.	Maximum Temperature, °F.	Minimum Temperature, °F.
January	2.96	70	–25
February	3.09	72	–18
March	4.04	82	0
April	3.39	87	19
May	4.00	96	31
June	4.23	100	39
July	4.06	106	48
August	3.21	101	46
September	2.99	98	30
October	2.66	89	22
November	2.98	76	–5
December	2.98	68	–15

FROSTS.

	Average Date of Killing Frost.		Earliest Date of Killing Frost in Autumn.	Latest Date of Killing Frost in Spring.
	Earliest in Autumn.	Last in Spring.		
Indianapolis	October 19	April 16	September 21	May 21.
Bloomington	October 20	April 19	September 20	May 10.
Washington	October 19	April 16	September 27	May 2.

The growing season is approximately six months long, with the precipitation well distributed through the year. The greatest rainfall occurs in June and the least in October.

HISTORY AND AGRICULTURAL DEVELOPMENT.

Morgan County was the undisputed home of the Miami tribe of Indians, before the advent of the white man. In 1818, a large tract of land in central Indiana, including the present county of Morgan, was ceded to the whites by the Indians. After this treaty, the settlers came rapidly to the "New Purchase" in search of homes. The first permanent settlement is alleged to have been made on the southeast side of White River, a short distance below the present site of Waverly. Cyrus Whetzel, who located near the mouth of Bluff Creek, made this section familiar to all immigrants coming west to central Indiana, for as early as 1818 he opened a trail through the wilderness from older settlements on White Water River in the eastern part of the State to the Bluffs on White River. This trace was the first public highway in this part of Indiana and became famous at "Whetzel's Trace."

The areas along White River were settled long before the more remote sections. Adams Township was not settled until well in the thirties. The early settlers had the same struggle for existence as confronted all pioneers of that day, with which the present generation is so familiar. The broad fertile valley of White River was occupied first, then the rolling areas in the east and north. The rough, hilly sections were looked on with favor only by the hunters and trappers, who found an abundance of game.

Settlers found the Indians already raising small patches of corn in the valleys. As soon as possible the dense forests were cleared away and fields of corn and wheat were planted. Although the methods were crude, the native richness of the soil made possible good yields. Corn has always been the leading crop of the county. Not only are the wide stream bottoms especially adapted for the raising of this crop but the rich black soil of the Lake region is also unexcelled for the production of corn. In 1909, almost a million and three-quarters bushels of corn were raised in Morgan County on slightly over fifty thousand acres. Both the acreage and yield per acre have increased during the past thirty years. Very little commercial fertilizer is used with this crop, although many of the upland farms are in need of some such reinforcement. However, large amounts of barnyard manure are produced annually and practically all of it is used on the corn ground. Considerable corn of the white variety is raised, although there is some complaint against it as being "chaffy" especially in the stream bottoms.

Wheat is an important crop but has suffered a decided decline since 1880. In that year there were 33,944 acres which produced 487,434 bushels. In 1908, 26,502 acres were sown producing 377,-487 bushels. This decline in the culture of wheat has come as a direct result of the failure of the soil to return profitable yields. Farmers can remember well the good old "wheat days," but many are sowing it now only as a means of getting their fields set in grass. The failure to observe the proper crop rotations and the indifference shown as to the needs of the soil in the past have resulted in this decline. Commercial fertilizers are generally used with this crop, usually one rich in phosphorus and potash. Bone meal and acid phosphate are used extensively, which contains from 12 to 15 per cent. of phosphoric acid. Where a legume is not grown regularly in the rotation, the nitrogen content of the soil is in imminent danger of being depleted where no attempt is made to restore it.

Oats are not raised extensively in Morgan County, the acreage usually being confined to the actual needs of the farms. In 1909, about six thousand acres were sown to this crop, with a yield of approximately twenty bushels per acre. Oats usually follow corn, and the ground is either plowed in the spring or the oats are "disked in" with a disk harrow. Where the spring work is rushing and the ground is of a loose friable nature the latter method is to be recommended.

Timothy is the prevailing hay crop, with an acreage in 1909 of 14,904 acres. Some of the heavy flat areas produce timothy more successfully than any other crops. Clover is excluded from many sections of the county by the lack of drainage and the acidity of the soil. There is a great need for an increase in the clover production and a more general use of cowpeas or soy beans as a soil renovator. In order to supply this need, the "sick" condition of the soil must be corrected by more thorough drainage and a liberal use of ground limestone.

Tomatoes are receiving a great deal of attention in the vicinity of Martinsville. Nearly 800 acres were devoted to this crop in 1911, with an average net return of $65 per acre. They were raised to some extent in the White River valley, but for the most part they were produced in the uplands. The Van Camp Canning Factory located at Martinsville is doing much to encourage farmers in this enterprise. A carload of special fertilizer was used on this crop, the rate of sowing being about 200 pounds per acre. This not only hastens the ripening, thereby eliminating danger from frosts, but the quality of tomato is much better. A more definite system of crop rotation needs to be worked out and practiced, especially in the uplands.

In addition to this, about 600 acres each of peas and sweet corn were raised in the White River bottoms. The former crop is an important one as a soil enricher since it belongs to the legume family. The products of these crops are disposed of at the Van Camp Canning Factory.

One of the points of special interest is the operation of a ginseng farm a few miles southeast of Martinsville, in the heart of the hilliest of the county. It is operated by T. J. David who, in partnership with Mr. Green of Martinsville, owns the farm. They have nearly an acre and a half under cover of an arbor made of a framework over which is stretched laths woven together by wire. The purpose of this is to protect the shade-loving plants from the sun. The ginseng is planted in beds under the "arbor," in rich, loamy soil. It requires from seven to eight years after planting the seed for the roots to become of marketable size. Besides the roots, many thousands of seeds and young rootlets are sold every year to other growers throughout the country. Several thousand dollars worth of the product is sold yearly from the farm. This novel little farm nestled in among the hills is one of the most interesting spots in the county.

The northern half of the county produces a large amount of live stock, especially hogs and cattle. Much of the grain raised is fed on the farm and the manure returned to the soil. Where the region is not favorable to the raising of grain, however, much of the stock is disposed of when young. Dairy farming has received a great deal of attention in eastern Morgan County during recent years. Practically every farmer who operates his own farm has constructed a silo for preserving his feed, and large amounts of fodder are cut and shredded every year. Some of the most prominent dairy herds in the State are found in this section. Much of the milk is hauled to the stations and shipped to Indianapolis, but in the more remote districts milk routes have been established for gathering up the milk.

The horticultural interests of the county are not large. Fruit growing has received but little attention, although its soil is peculiarly adapted to the growing of fruit trees. In many hilly regions where the land is lying idle at present orchards could be planted which, after a few years of proper care, would prove a profitable investment. One of the most successful peach orchards found in the county was on one of the steep hillsides south of Martinsville.

Martinsville, the county seat, is located on the east side of White River in the south central part of the county. It has a wealth of natural resources, the greatest of which are its mineral waters and clays. The city is located on the Pennsylvania Railroad and a branch of the Big Four. It contains seven sanitariums which are accommodated to give treatment for individuals by virtue of the medicinal qualities of the mineral water. These sanitariums have gained a wide reputation as proficient health resorts and are drawing guests from every part of America. Probably 25,000 guests visit these sanitariums annually, bringing to the town not less than a million dollars. The Martinsville and Adams Brick Works are located north of the city and together are turning out daily 120,000 brick of the best quality. The Van Camp Canning Factory is doing much in furnishing a market for the crops of the region. Martinsville has a population of 4,500.

Mooresville, a town of 1,608 population, is located on White Lick Creek in the eastern part of the county. It is an excellent trading center, there being excellent shipping facilities to Indianapolis from this point. Eastern Morgan County has become an important dairy section and large quantities of dairy products are shipped from Mooresville.

Brooklyn has 572 inhabitants, and is known chiefly by the close proximity of Bethany Park. The Indiana Drain Tile Company is located here, which is making a high grade of tile from the shale found in abundance south of the town.

Other towns of local importance are Morgantown, in the extreme southeastern corner of the county, Paragon, seven miles southwest of Martinsville, Monrovia, in eastern Monroe Township, and Eminence, in southern Adams Township.

SOILS.

The soils of Morgan County are quite diversified, due to the varying influences which the southern invasions of the ice-sheets had on the different parts of the county. The soils of the northern half, which bears the drift of the later Wisconsin glacier, are much coarser in texture and have much greater depth. Those derived from this source are also much stronger agriculturally than the soils found south of the line marking the southern limit of this glacier.

The soil of the southern part of the county is the typical loessial formation that covers the greater part of Owen and Greene counties farther south. The underlying Knobstone formation, however, is never far beneath the surface and in the extreme southern part of the county it has influenced the soil to some extent by its contribution of weathered shale. This soil is poorly adapted for farming, both on account of the rugged topography which characterizes the area and the poor quality of the soil.

There are nine types of soil recognized in Morgan County. Most of these are readily recognized as distinct types, although some are closely related in general appearance and texture. The Knox silt loam includes practically all the upland soil of that part of the county lying south of the Wisconsin drift. It is also found north of this line in small areas. The Waverly silt loam is a closely associated type, although it owes its present position to different agencies. The greatest area is found in the central western part, in the vicinity of Lewisville. This comprises the eastern portion of the "Flats," the body of which lies across the line in Owen County. The type is also found in the different stream bottoms.

The Coloma sandy loam is the rather coarse upland soil of northeastern Morgan County, representing heavily glaciated areas. The Wabash loam is the typical soil of the stream valleys. The Carrington silt loam is found principally in the "Lake" region and small areas of low ground at other points in the northern part of the county. The Knox sandy loam comprises the conspicuous dune-like sand hills skirting the valley of the White River, principally on the eastern side. The Sioux sandy loam is found in White River bottom from Waverly northward to the county line. Its gravelly subsoil is characteristic. The Miami clay loam and Dover silt loam are types of upland soil in central Morgan County.

Waverly Silt Loam.

The largest area of Waverly silt loam is found in Ashland Township, east of Lewisville. It is an ashy grey to white fine silt loam, averaging in depth from five to eight inches. There is no demarcation between the soil and subsoil, the latter gradually verging into a heavy, stiff, silty loam of practically the same color. At a depth of 18 inches, brown streaks of clay, iron stains and iron concretions mottle the subsoil. The soil is heavy and compact and is usually saturated with water for long periods during the winter and spring.

The type is found rather extensively in the Indiana Creek bottom, through Washington Township, and also in the valley of White River, along the boundary between Baker and Ray townships. In this region, the erosion of the hills has been excessive and the product which was carried down has been redeposited along the terraces of these streams. In the White River bottom, the type is rarely found in the first bottom, but along Indian Creek it constitutes the principal soil on the south and west side of the stream, through Washington Township. This is accounted for by the close proximity of the high, badly eroded bluffs on that side, while on the opposite side the valley is wide and sandy, with no abrupt bluffs subjected to the erosive process.

The drainage facilities of this area are very poor. It occupies level regions, which in the valleys are low and difficult to drain artificially. The natural humus content is very low and the heavy sodden condition of the soil makes further incorporation of organic matter into it a difficult problem, since it is burned out rapidly by the sun. The type has probably never supported vegetation in abundance, and the growth of hardwood timber has done little towards increasing the amount of humus. White oak, jack oak, beech, elm, hickory and poplar trees originally grew on this type.

The agricultural value of the Waverly silt loam depends on local influences as well as the season. During wet seasons, or after a cold wet spring, this type is greatly handicapped, due to the lack of drainage and the cold, sour condition of the soil. However, in dry years, it is a fair agricultural soil. Corn averages about 30 bushels per acre and wheat 12. The most successful crop, however, is timothy, which is used both for hay and for pasture. Oats are grown rather extensively, yielding 20 to 25 bushels per acre. Little clover is grown on this type, it being practically eliminated by the poor drainage and acid condition of the soil. A considerable number of sheep and cattle is raised on the rolling pasture land.

The Waverly silt loam cannot be farmed successfully until drainage is made more effective and the soil acidity corrected. Practically all the soil of this type is lacking in lime, a deficiency which must be supplied before further operations will prove satisfactory. A third need which must be supplied in some way is the addition of organic matter, preferably through the plowing under of some rank growing legume, such as cowpeas or soy beans.

The results of mechanical analysis of the Waverly silt loam are as follows:

Location.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
Section 20, Baker Twp...	Light grey, wet.....	.45	.10	3.0	5.7	21.5	59.9	11.4
Section 20, Baker Twp...	Mottled with red clay.............	.0	.0	.6	6.7	21.6	68.5	7.05

Carrington Silt Loam.

The Carrington silt loam is a dark brown to black loose mellow silt loam with an average depth of 15 inches. This is underlaid by a heavy stiff clay subsoil which, at first grey, gradually becomes lighter as the organic matter decreases until it is a light yellow color. The subsoil contains more sand than the surface soil and small water-worn pebbles are frequently encountered. In some places the subsoil changes to a stiff, bluish clay, under which it becomes quite sandy. The water table is never far below the surface and is often found at a depth of two feet. In the eastern edge of the area, small gravel is scattered over the surface and is found interspersed through the heavy subsoil.

The most important area of Carrington silt loam is found in the "Lakes," in the northwestern part of the county, comprising the typical black soil of that region. It contains a large amount of organic matter, the greater part of it formerly being a low, wet swamp. At a depth ranging from 10 to 15 feet below the surface is found a thick bed of coarse, water-bearing sand and gravel. This doubtless marks the original bed of the lake before the subsequent filling in process began. This coarse material is found throughout the area and at some points is so coarse that it is pumped out for road material. A gravel pit of this kind is found in Monroe Township, in Section 8, and another in Adams Township, in Section 6. The per cent. of sand, however, is too great to warrant its extensive use for road metal. The area, except at its lowest points, is spotted with slight elevations rising from 10 to 30 feet above the general level of the lowland. These hills are in many cases taken advantage of by the farmers as favorable locations for building sites. In the field the soil is difficult to handle, since it is so widely different from the surrounding black loam. It is usually a light yellow to grey loose loam, with usually a large per cent. of sand. These points, as a rule, receive the bulk of the barnyard manure produced on the farms. Other low mounds of almost pure sand are found in the northern part of the area.

These were doubtless thrown up by wind and water at an early period.

Ordinarily, the soils of this area are loose and mellow, but if given improper treatment, a poor physical condition will result. If the fields are tramped by stock through the winter, or the ground is plowed when too wet, it becomes extremely difficult to reduce to proper tilth. While the area is fairly well drained at present, there are many sections which would be greatly benefited by a more thorough system of underground drainage. The open, porous nature of the soil makes this process very effective, and in no soil in the county can tile drainage be installed to a greater financial advantage. The many open ditches throughout the area assist greatly in the drainage problem and furnish excellent outlets for the tile drains. The one thing above all others, however, that has developed this area was the construction of a deep dredge for a distance of 15 miles, through the heart of the region. This ditch is estimated to be worth a million dollars to the townships through which it runs. It is known as the "Lake Ditch" and has assumed the proportions of a good-sized creek.

The Carrington silt loam is preëminently a corn soil. In this region, corn is the principal crop and thousands of acres are raised, producing from 50 to 80 bushels per acre. In the past, the benefits accruing from crop rotation have been largely ignored, and corn has been raised year after year. But even this rich, black soil is beginning to show the effects of such exhaustive systems, and more attention is being given to the raising of other crops. Wheat is raised rather extensively and where the growth is not too rank very good yields are obtained. During wet seasons, however, there is great danger of lodging. In more favorable seasons, the yield ranges from 15 to 25 bushels per acre.

Clover grows well, producing an abundant growth. When sown thickly, it makes an excellent quality of hay. This crop could be used to great advantage as a green manuring crop preceding the corn crop. Timothy is not grown extensively for hay, since the quality of hay is too coarse for best use. Oats are raised, usually for home consumption only, producing from 25 to 50 bushels per acre. In this region of much corn, a great number of hogs and cattle are raised annually. However, the grain produced is not all fed on the farms, for much of it is sold to feeders, nearer the markets.

Very little commercial fertilizer is used on this type. A more general use of the leguminous crops, for the necessary nitrogen supply, is to be urged, as well as a more systematic rotation of crops. Farmers in some localities are experiencing trouble with "wilt" or erroneously called "alkali" spots, in their fields. Such areas are common in black soils and are due to a deficiency in the potash content of the soil. This is easily demonstrated by scattering over these spots a quantity of wood ashes, before planting the corn, and noting the beneficial results. The application of muriate of potash at the rate of 60 to 75 pounds per acre will usually correct this deficiency. However, this type responds readily to careful treatment. As on example, Mr. Elvin Hurt, a young farmer living west of Hall, has paid particular attention to the thorough drainage of his farm and to its fertilizer demands. As a result, he has repeatedly raised corn averaging 90 bushels, and on one occasion reached the 100 bushel mark.

The results of the mechanical analysis of the Carrington silt loam are as follows:

Location.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
Surface 12 in., Central Sec.11, Adams Twp..	Black, loose silty loam............	.2	.3	2.0	9.1	26.8	57.7	4.5
Subsoil.................	Compact, stiff dark grey............	.7	1.3	13.6	23.9	29.0	27.7	3.9

Chemical Analysis of Carrington Silt Loam.

Collector, Edmondson.

Reaction to litmus .... Neutral
Moisture in air-dried soil 2.61%
Total soil nitrogen 0.413%

Analysis of fine soil dried at 105° C.—

Volatile and combustible 10.37%
Insoluble in 1.115 HCl 79.81%
Soluble silica (SiO_2) 0.10%
Ferric oxide (Fe_2O_3) 1.79%
Alumina (Al_2O_3) 5.75%
Phosphoric acid anhydride (P_2O_5) 0.32%
Sulphuric acid anhydride (SO_3) 0.10%
Calcium oxide (CaO) 1.10%
Magnesium oxide (MgO) 0.44%
Potassium oxide (K_2O) 0.14%
Sodium oxide (Na_2O) 0.27%

Total 100.19%

Knox Sandy Loam.

The Knox sandy loam is a dark grey to nearly black, loose sandy loam, ranging in depth from eight inches in some localities to 24 inches in other places. The subsoil is a light yellow, stiff sandy loam, usually with enough clay present to make it compact and rather tenacious. Fine gravel is often mingled with the subsoil. In regions where the soil is deep, the subsoil usually grades into a loose, yellowish brown sand, with a small per cent. of silt and clay. This is often the case on the higher points. On the crests of the ridges and knolls, the surface is dark grey in color and contains a relatively large amount of humus. The soil is very loose and loamy, carrying a large per cent. of medium sand.

The type occurs chiefly along the bluffs of the White River in a somewhat broken strip of varying width, through the entire county. The topography is characterized by rounded mounds of low relief rising from the valley floor near the bluffs, or they may extend as high as the bluffs themselves, which are 100 to 150 feet above the river. Often the sandy soil extends back for some distance in the upland, making a gently rolling, hummocky surface. The widest area is found east of Martinsville, bordering the extensive valley of Indian Creek. Here the sand extends for more than a mile east of the valley and is found in high, prominent, dune-like mounds or high narrow ridges.

The Knox sandy loam was probably derived from glacial material which was assorted and laid down by the water. Without doubt, much of this deposition took place during the recession of the ice-sheet, when the channel of the White River carried enormous volumes of water. While the wind may have been an active agent in the formation of the high "dunes," yet the frequency with which the heavier material is found, both on the surface and in the subsoil, points rather to the action of the water as the chief agent. In one of the lower mounds, east of Martinsville, the material is sufficiently coarse to warrant the opening of a gravel pit.

The surface of the Knox sandy loam is very open and loose, due both to the predominance of sand and the influence of the humus content. The drainage is excessive in some places and crops burn out easily. Due to the openness of the surface soil, it does not wash badly, since the surface waters quickly percolate through the soil.

This type is a fair agricultural soil, although in the more sandy phases the lack of moisture is a limiting feature. Corn is grown rather extensively, with an average yield of 40 bushels per acre.

Wheat is also a staple crop, yielding 8 to 14 bushels per acre. The type, however, is well adapted for blue grass and clover and should be used more extensively as pasture land. It should be protected by vegetation and exposed just as little as possible to the rays of the sun, since the humus tends to burn out badly. Little commercial fertilizer is used on the type, it being the common belief that such treatment fails to prove profitable. However, this type is relatively low in nitrogen, which is usually the limiting element, and should be supplied through a greater use of the legumes, especially cowpeas and soy beans. These crops not only furnish the soil nitrogen, but afford a large amount of organic matter if the crop is turned under. The type is especially adapted for the raising of watermelons, many of which are grown in the vicinity of Martinsville. It is a warm soil, and suited likewise for any quick growing crops that mature before the dry season advances.

The mechanical analysis of the Knox sandy loam is given in the following table:

Location.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
N. E. Sec. 26, Harrison Twp.	Dark grey fine sand.	.0	.1	.6	21.1	50.0	16.8	8.9
Subsoil	Light yellow, fine sand	.0	.0	2.0	28.1	54.1	8.0	7.4

Waukesha Sandy Loam.

The area of Waukesha sandy loam comprises the northeastern part of the county. It is a type of variable texture, the higher points resembling very much a gravelly loam, while the level areas are much finer in texture. The surface is a light brown to reddish brown sandy loam, with a considerable amount of gravel scattered over the surface. The gravel is usually not more than one to two inches in diameter on the level or sloping areas, but on the crests of the ridges and hills it becomes considerably larger. The subsoil is a stiff, reddish brown, heavy sandy loam, somewhat coarser than the surface. At 30 inches, a heavy gravelly substratum of coarse sand, gravel and clay is encountered. This becomes very hard and oftentimes resembles hardpan. The heavy gravelly subsoil is present throughout the area, although the color of the surface soil changes sometimes from a reddish brown to a dark grey, this phase usually being found in the depressed areas.

The topographic features of this type are marked by a gently rolling, uneven surface, or by sharply rolling to hilly areas in regions where erosion has been great. The low mounds and hills, that characterize the type, usually contain large quantities of sand and fine gravel, which gradually decrease as the level is reached. The higher hills or ridges, however, which are often 50 to 75 feet in height and resemble moraines in appearance, contain much coarse material. These are oftentimes so rocky and broken that they are very difficult to cultivate. The soil tends to wash badly and the slopes are in many cases badly broken by gulleys.

The Waukesha sandy loam represents the glacial deposits of the Wisconsin ice-sheet. Much of it has been reworked by wind and water, but the greater part is residual. Bowlders are very numerous throughout the area, many of them being of enormous size. The "Big Bowlder," noted formerly by Prof. Brown,* is found in Madison Township, in Section 4, measuring "in length, 15 feet, 4 inches; greatest breadth, 13 feet; height above ground, 11 feet, 9 inches."*

The Waukesha sandy loam is an average agricultural soil. The worst feature is its incapacity to retain moisture during the dry seasons. Consequently, crops are liable to suffer from droughts. This is more true of the more sandy or gravelly phases, however, for much of it has sufficient body to prevent excessive drying out. Corn, which is grown quite extensively, yields 35 to 50 bushels per acre. Much of the corn in this area is made into ensilage or is cut and shredded. While this method is an excellent means of preserving the roughage of the farm and makes possible a greater production of manure, it on the other hand decreases the amount of vegetable matter to be returned to the soil. This being the case, the manure should be carefully conserved and a covering of vegetation turned under as often as possible, in order to prevent a deficiency in the humus supply. Dairy farming is engaged in rather extensively in this section, and the farming methods are somewhat more intensive than are found in other parts. Mr. H. B. Johnson, who operates a large dairy near Mooresville, has worked out the following rotation; corn for two years, wheat one year and clover one year. The entire clover crop is turned under for the first crop of corn and barnyard manure fertilizes the second crop. Most of the corn itself is made into ensilage. With the wheat is sown 250 pounds of commercial fertilizer. By this system, there is little trouble experienced in maintaining the productiveness of the soil.

Wheat was formerly held in much greater favor than at pres-

*Geological Report, 1883.

ent. In its virgin condition, this type was able to yield 20 to 30 bushels per acre. But in recent years, the yield has slowly declined and with it the acreage. Wheat yields, on the average, about 14 bushels, but when the crop is fertilized the yield is much higher. Large amounts of commercial fertilizer are used on both corn and wheat. The grade which is used most extensively and which probably most nearly meets the needs of the soil is one containing 10 to 12 per cent. of phosphoric acid and two to four per cent. of potash. Where the nitrogen is supplied by leguminous crops and barnyard manure, the productiveness of the soil is easily maintained.

Clover grows well in some localities, but in others it does not thrive. This fact, together with other indications, points toward acid conditions in some of the level, poorly drained sections. Wherever this is suspected, an application of lime should be made. The land is valued at $75 to $110 per acre.

The results of the mechanical analysis of this type are given in the following table:

LOCATION.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
N. E. Sec. 16, Madison..	Light brown, gravelly..............	11.5	.8	3.2	1.8	13.6	49.3	19.1
Subsoil.................	Reddish, stiff sandy clay.............	4.3	1.3	24.0	22.5	21.2	18.8	7.8

Chemical Analysis of Waukesha Sandy Loam.

Collector, Quinn.

Reaction to litmus	Neutral
Moisture in air-dried soil	1.86%
Total soil nitrogen	0.187%

Analysis of fine soil dried at 105° C. —

Volatile and organic	5.24%
Insoluble in 1.115 HCl	86.07%
Soluble silica (SiO_2)	0.13%
Ferric oxide (Fe_2O_3)	1.51%
Alumina (Al_2O_3)	5.45%
Phosphoric acid anhydride (P_2O_5)	0.41%
Sulphuric acid anhydride (SO_3)	0.05%
Calcium oxide (CaO)	0.23%
Magnesium oxide (MgO)	0.33%
Potassium oxide (K_2O)	0.19%
Sodium oxide (Na_2O)	0.24%
Total	99.85%

Sioux Loam.

This type occurs as a long, narrow strip in White River bottom, north of Waverly. It is a dark brown, loose sandy loam, with an average depth of 10 inches. The texture becomes coarser as the depth is increased, until at 24 to 30 inches beds of gravel are reached. This substratum of gravel often extends to a depth of 8 to 10 feet. It is waterlaid and the gravel is usually not more than 1½ inches in diameter.

The type occurs as a long, narrow terrace, extending along the western side of the White River valley. The surface is usually level, but sometimes is gently rolling. Gravel is scattered over the surface, and is especially prominent on the elevations and near the edge of the terrace, bordering the Huntington loam. The terrace is elevated 10 to 15 feet above the first bottom.

The type is not of any particular importance as an agricultural soil. The coarse nature of the subsoil and its close proximity to the surface make it unable to endure drought. However, the general farm crops are raised on it and in years of well distributed rainfall fair yields are obtained. The gravel in the subsoil is used extensively for road metal and for concrete.

Wabash Loam.

The Wabash loam is the typical soil of the stream valleys, confined usually to the first bottoms. It is a dark brown to grey loose loam, with an average depth of 12 inches. It is rather variable in texture, but usually contains a relatively large per cent. of medium sand. The subsoil is not sharply defined. It grades gradually into a lighter colored, slightly heavier, sandy loam, with the texture differing but little from the surface soil. The type contains a large amount of humus, the lighter phases of the soil indicating a lower humus content. In the regions where the bluffs are high, erosion has influenced the type considerably. This is especially noticeable along the bluffs north of Martinsville, where the soil is made much heavier by the washing down of the clay and silt. The most extensive area of this type is found in the valley of White River, but others occur in the valleys of Eel River, the eastern part of Indian Creek, White Lick Creek, and those of the smaller tributaries. The surface is level and low in places, which makes it rather difficult to drain.

The Wabash loam is derived from glacial till, which has been carried down and redeposited by the water of the stream along which it is now found. The greater part of it is still subject to overflow, which deposits the sediment that tends to maintain the high state of fertility. It is especially adapted for the raising of corn, and a large part of the type is devoted to this crop every year. Systematic crop rotations have been sacrificed on many farms to the extent that not a few are showing evidences of exhaustion. The average yield of corn is about 50 bushels per acre, with maximum yields of 70 to 80 bushels. The white varieties of corn are held in favor on this type.

Wheat and oats are not grown extensively, the danger from floods and the tendency to lodge making these crops unprofitable on this type. Wheat, when favored with a good season, yields 15 to 20 bushels per acre, although the quality is usually not so good as that produced on the upland. Clover does well in areas not subject to overflow, and should be grown more extensively. Timothy is little raised on this type on account of its rank growth and the damage incurred from overflow.

A considerable acreage of tomatoes is grown on this type, in the vicinity of Martinsville. The yield is large and the quality fair. Peas and sweet corn are also raised to some extent in this region. The type is especially adapted for the former crop, and large financial returns are realized from its culture.

Commercial fertilizers are not used extensively. Where the soil has been cropped continually for a long period, some farmers are resorting to this method of improvement. Fertilizers containing potash and phosphoric acid are used with good results. The refuse from the canning factory at Martinsville, composed largely of pea vines, is being used to great advantage as a manure in improving the run down condition of the soil. A systematic rotation of crops is essential in keeping the soil in its highest state of production. The land is valued at $90 to $150.

The mechanical analysis of the Wabash loam is given in the following table:

Location.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
Sec. 33, Washington Twp.	Soil	.0	0.6	1.1	14.0	34.1	40.2	9.0
Sec. 33, Washington Twp.	Subsoil	.6	1.1	2.0	14.4	22.2	51.4	7.6

Chemical Analysis of Wabash Loam.

Collector, Edmondson.

Reaction to litmus	Neutral
Moisture in air-dried soil	1.43%
Total soil nitrogen	0.135%

Analysis of fine soil dried at 105° C.—

Volatile and combustible	4.33%
Insoluble in 1.115 HCl	84.93%
Soluble silica (SiO_2)	0.12%
Ferric oxide (Fe_2O_3)	2.40%
Alumina (Al_2O_3)	5.93%
Phosphoric acid anhydride (P_2O_5)	0.44%
Sulphuric acid anhydride (SO_3)	0.08%
Calcium oxide (CaO)	0.46%
Magnesium oxide (MgO)	0.75%
Potassium oxide (K_2O)	0.26%
Sodium oxide (Na_2O)	0.29%
Total	99.99%

Miami Clay Loam.

The Miami clay loam is a heavy, greyish yellow loam with a high per cent. of clay. When wet, it is dark grey but on drying out it changes to a light ashy grey. The soil has a smooth floury feel to the touch, and contains but a small per cent. of sand. It varies in depth from five to eight inches, with the greater depth in the depressed areas. The subsoil is a heavy, light yellow clay loam, which is stiff and tenacious when wet but on drying becomes very hard and compact. It is inclined to break into cubical fragments to a depth of 20 inches after which it becomes more stiff and heavy. Below this depth, the subsoil is mottled with streaks of greyish white which become more distinct as the depth is increased. The per cent. of medium sand increases in the subsoil although the finer materials determine its character.

The Miami clay loam is found in the eastern part of the county. Its largest area lies northeast of Martinsville, and smaller ones occur farther north in Madison Township. In the former area it occurs as a comparitively thin mantle overlying the residual Knobstone shale. The depth varies from three to 15 feet, the greater depth being at the foot of the slopes. Where the shale has been weathered, it has influenced the overlying soil, making it heavier, with a lighter color.

With the exception of the residual material, derived in the above way, the Miami clay loam is of glacial origin. Numerous bowlders are found in the northern areas, but this feature is not so prominent at the southern extremity.

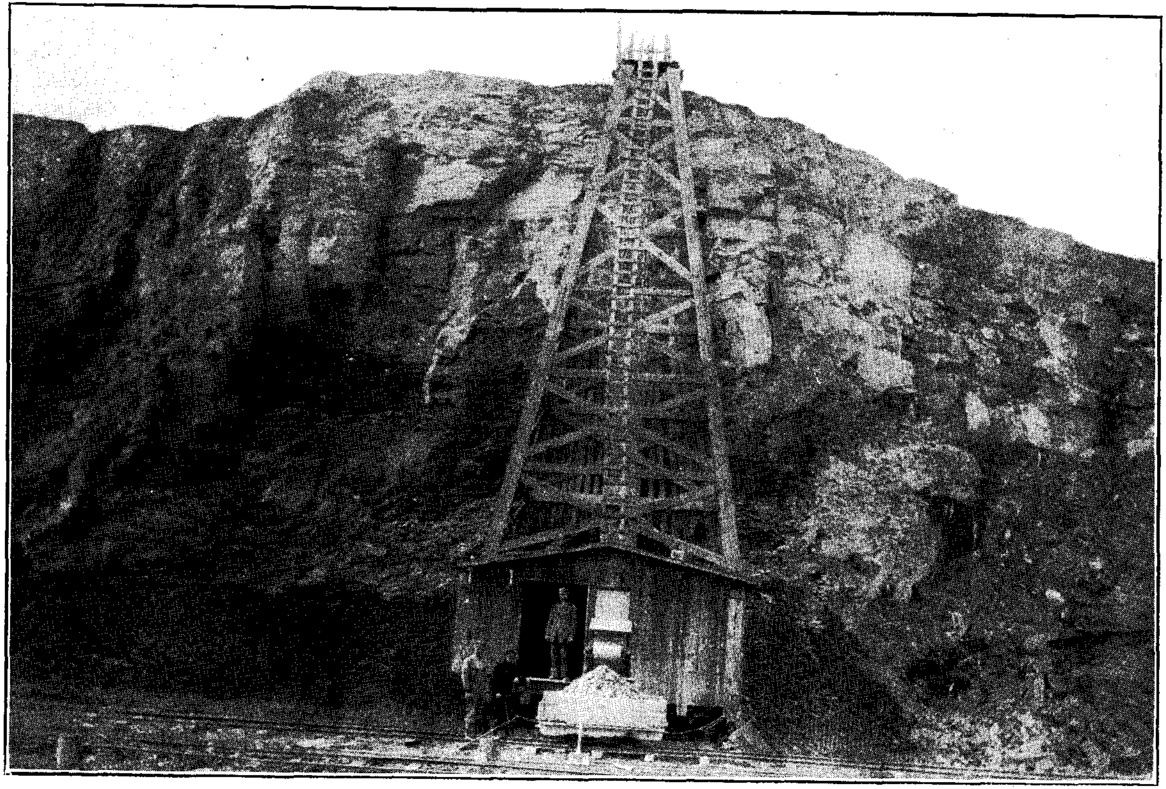
The surface configurations are marked by gently rolling areas in the north and a rough broken region in the south. The glacial invasion apparently had but slight effect on the topography of the latter region, and the old drainage system remains practically unaltered, although the mantle of drift is well distributed over it.

The Miami clay loam is a fair agricultural soil, in its better phases. In level or depressed areas, the natural drainage is poor and must be supplemented with artificial drains. It tends to wash badly and in the rough areas, this presents another problem in its management. Corn is raised with some success, although the yields are usually small, ranging from 20 to 30 bushels per acre. Wheat, when sown with fertilizer, produces from 10 to 18 bushels per acre of good quality. Timothy makes a rather short growth but yields an excellent quality of hay. In some localities, the type shows indications of acidity and doubtless the greater part of it would be benefited by an application of lime, with a corresponding increase in the efforts to introduce a larger amount of organic matter into the surface soil.

The type formerly supported forests of beech, sugar, poplar and elm. Most of these trees have been removed, but the rougher areas are still covered with second growth timber.

This type is deficient in organic matter and efforts should be made to turn under as much vegetable matter as possible. Of the plant food elements, doubtless phosphorus is the most nearly depleted, although the nitrogen content is low unless supplied by clover and legumes. A good crop of cowpeas or soy beans turned under would do much to insure a successful corn crop. The soil also responds quickly to any form of organic matter that is added to it in the form of manures.

This type has proven to be well adapted for tomato culture, by the farmers in the vicinity of Martinsville. A large acreage is devoted to this crop every year with returns as high as $85 to $90 per acre. These high profits are realized, however, after the careful starting of the young plants, proper fertilization and cultivation. The quality of the crop produced is of the best. If the tomato crop was worked into the rotation with wheat or oats and clover, excellent results would be obtained. At present, few farmers are adhering to any definite rotation.



Knobstone Shale Bluff near Brooklyn, Ind. Shale is used by brick plant at that place.

Fruit growing should be developed on this type. It is well adapted to the growing of fruit trees and the quality of fruit produced is superior.

The results of the mechanical analysis of the Miami clay loam are given in the following table:

Location.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
E. Center Sec. 26, Washington Twp..........	Dark grey, compact	0	0	.25	2.1	2.1	63.1	32.0
Subsoil................	Lighter yellow, stiff clay............	0	0	.10	5.9	14.8	60.9	17.7

Dover Silt Loam.

The Dover silt loam is confined to a small area along the western line of the county, south of Lewisville. It marks the region where the Mitchell limestone comprises the surface stratum, and is the same type that extends westward over wide areas in Owen County. It is a loose, friable silt loam, about 10 inches in depth, with a light brown to reddish brown color. There is no sharp line between the soil and subsoil, the texture remaining much the same, with a slight increase in the sand content. The color gradually changes to a light, yellowish brown, and is often mottled with gray streaks.

The Dover silt loam is a loessial soil which has been favorably influenced by the weathering of the soft limestone underlying it. Outcrops of the limestone ledges are frequent on the sharp elevations and in the vicinity of the stream courses. The topography is rolling, but is seldom sufficiently broken to prevent cultivation. Numerous sink holes are found throughout the area, which are often a great hindrance to the farmer where they occur in the fields.

This type is a strong agricultural soil. It is especially adapted to the growing of grass and clover. Consequently, the area is almost unexcelled as pasture land. Corn grows well and produces 35 to 50 bushels per acre. Wheat is grown extensively, the yield ranging from 12 to 20 bushels of excellent quality. Much of the type is used as blue grass pasture for sheep and cattle.

The characteristic trees of the type are black and white walnut, sugar and poplar. Practically all of this valuable timber has been removed, although considerable smaller and second-growth timber still remains in the woodlots on the farms.

KNOX SILT LOAM.

The Knox silt loam is a light brown to ashy gray silt loam with an average depth of seven inches. It is underlaid by a heavy, stiff, light yellow subsoil which at a depth of 15 inches becomes mottled with gray and white streaks. The color of the soil is determined largely by the drainage facilities in the different areas. Where the drainage is poor over large areas or even in small spots, the soil is ashy gray or almost white with iron concretions often on the surface or found through the body of the soil.

The Knox silt loam is composed of glacial material which has drifted to its present position by the action of the wind. This fact accounts for the absence of coarse material on the surface. The greatest area is found extending irregularly across the central part of the county, south of the line marking the southern limit of the late ice sheet. The line dividing the Knox silt loam from the Miami clay loam on the north is difficult to determine accurately, the chief difference between the two types being the presence of glacial pebbles and bowlders on the surface of the latter area and with a subsoil of bowlder clay.

The Knox silt loam is an important agricultural soil where the topography is not too broken, as in the case in the southern part of the area. The productiveness of this type also depends a great deal on the methods practiced in farming it. The soil is easily exhausted where no care is taken towards the maintenance of its productiveness and many farms are suffering in this respect at present.

The type was originally covered with forests of poplar, beech, oak, elm and sugar trees. Consequently, other vegetation has been comparatively slight, and with the clearing of the forests the soil was left with comparatively little humus, a deficiency which is apparent after years of farming, where no efforts are made to replace the organic matter. Stable manure produces excellent results, due both to the addition of humus to the soil and the increase in the nitrogen supply, which is almost universally low.

Many sections of this area are poorly drained, and before they can be improved, tile drains must be installed. There are often indications of acidity in the soil, the chief of which is the failure of clover to grow normally. This fact practically precludes the possibility of applying the most efficient method for improving the soil—the use of legumes, especially clover, cowpeas and soy beans, for pasture or for turning under. Ground limestone applied at the rate of 1,500 to 2,000 pounds per acre, where acid conditions are suspected, will remedy this defect.

Corn is grown on the Knox silt loam rather extensively, yielding 20 to 40 bushels. Little fertilizer, except stable manure, is used on this crop, the latter having very beneficial results. An excellent quality of wheat is raised, although the average yield is about 12 bushels. Oats are raised only for home use and yield from 20 to 30 bushels.

Fruit growing is engaged in to some extent on this type, and should bé encouraged as the soil is specially adapted for this use.

The mechanical analysis of this type is as follows:

LOCATION.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
Sec. 17, Jackson Twp....	Loose, light grey...	0	0	.15	1.95	4.8	67.7	24.6
Sec. 17, Jackson Twp....	Red, silty..........	0	0	.15	.74	4.1	72.8	15.0

Soil Survey of Owen County.

By J. B. Edmondson.

LOCATION AND DESCRIPTION.

Owen County is situated midway between the central and southwest part of Indiana. It is bounded on the north by Morgan and Putnam counties, on the east by Morgan and Monroe counties, on the south by Greene County, and on the west by Clay County. It contains 396 square miles, or 253,440 acres.

The topography of the county varies from a low, flat area in the northeastern part, comprising about one-eighth of the county, to a rolling upland in the southwest, and to a region rivaling any in the State for its rough, broken surface, including a strip of territory six to ten miles wide extending in a southeasterly direction across the entire county. The great diversity found in the topography is due to a number of causes. The broad, level plain in the northeastern part marks the site of a filled-in lake bed which was undoubtedly formed by the later ice-sheet, the foot of which seems to have rested for a long period against the high ridges of limestone to the south and west. In the less hilly region of southwestern Owen, the general slope of the surface is considerably less than farther east and north. As a result, the enormous volume of water which issued from the melting ice-sheet, after cutting through the great barriers of sandstone and limestone, was compelled to give up a portion of its load of silt and clay, on reaching the lesser slope. This resulted in a gradual filling of the stream valleys which, together with the erosion of the hills, has had a decided leveling effect on the topography of that region.

The wide range of hills extending obliquely across the county is of peculiar interest, both on account of its wildly picturesque scenery and the varied geological formations which are exposed in numerous bold outcroppings along the stream courses.

DRAINAGE.

The county is drained by the White River and Eel River and their tributaries. The White River flows in a southwesterly direction across the southeastern corner of the county, entering just east of Gosport and crossing the southern boundary at about the central point. The affluents from the south are Raccoon Creek, Mills Creek and McCormack's Creek, on the north it receives Indian Creek, Limestone Creek, Mill Creek, Rattlesnake Creek, Fish Creek and Lick Creek. Some of the stream bottoms, especially those of Fish and Lick Creeks, which have received the products of erosion from the already badly eroded uplands, have poor natural drainage, due to the high silt and clay content of the washed-in material.

In the region underlaid with Mitchell limestone, the drainage is very largely underground. The surface waters from such areas find their way through the numerous sink holes into subterranean channels, and ultimately burst from the hillsides as spring or flow from the mouths of caves.

The streams in the southeastern part of the county are entrenched in deep, narrow valleys, often with steep, precipitous bluffs of limestone on either side showing evidences of enormous quantities of water which these streams must have at one time carried. The White River in this region flows from 100 to 250 feet below the high bluffs that skirt the narrow, fertile valley.

In the western part of the county, the streams are inclined to be sluggish, and often have shallow, ill-defined valleys. This is especially true of Fish Creek, the gradient being so slight that the channel is being gradually filled with brush, water plants and sediment. There has been a noticeable decrease in the size of the stream, even during the time of the older inhabitants of the region.

CLIMATE.

The climate of this area is not different from that of central Indiana. Since there is no weather bureau stationed in the county, the table below gives the data obtained at Worthington, which is only seven miles south, in Greene County.

Normal Monthly and Annual Precipitation and Monthly Temperature (maximum and minimum).

Month.	Rainfall. Inches.	Temperature. Maximum, °F.	Minimum, °F.
January	3.04	71	-23
February	3.47	80	-24
March	4.21	86	1
April	3.48	89	21
May	4.02	93	30
June	4.39	97	39
July	3.66	109	47
August	3.40	100	47
September	3.03	106	22
October	2.52	93	18
November	3.79	89	-6
December	3.21	67	-13
Year	42.22		

Average Date of the Earliest and Latest Killing Frosts.

Place.	Length of Record, Years.	Last in Spring.	First in Autumn.
Indianapolis	30	April 16	October 19
Bloomington	12	April 19	October 20
Worthington	15	April 22	October 24
Washington	12	April 16	October 19

The dates of the first and last frosts in this vicinity correspond closely with those of other points in central Indiana. The growing season is practically six months long. The rainfall is rather evenly distributed through the year, the greatest precipitation being in March and June and the least in October. The prevailing direction of the wind during the year is as follows: winter, northwest; spring, southwest; summer, southwest, and autumn, west.

GEOLOGY.

Geologically, Owen is one of the most interesting counties in the State. Owing to its peculiar position with respect to the foot of the Wisconsin ice-sheet which rested a few miles to the north, the glaciology of the region while not heavy is quite pronounced. On the other hand, the mantle of drift soil deposited is sufficiently thin to allow frequent exposures of the underlying strata. This was made more pronounced by the remarkably deep trenches and gorges cut through the underlying strata by the glacial waters which sought an outlet to the southwest. It was this agent that left the rough, broken topography we find today in portions of Owen County, making it a region unsurpassed in Indiana for its romantic beauty and inspiring scenery. Nature seemed to have at hand all the necessary material upon which to exercise the power of her mightiest of agents in fashioning this land into what has been justly termed "The Switzerland of Indiana." The results of her handiwork are seen in precipitous hills divided by deep, narrow ravines, in thousands of springs bursting from the ledges on the hillsides, in a surface honeycombed with sink holes and undermined by great caverns of unknown extent, and in caves of romantic beauty and grandeur. A remarkable phenomenon is found five miles southwest of Spencer in the form of a natural bridge, spanning a gorge 22 feet wide, with a ledge of limestone 10 feet wide and 18 feet high. Caves abound throughout the region, some of the most notable being Boone's Cave, Porter's Cave, Spring Cave and Freeman's Cave.

There are seven geological formations within the county, the productive coal measures being the latest formation. Coal is found in a strip five to six miles wide along the western line, in the upland areas. The Mansfield sandstone underlies it and outcrops to the east, along Lick Creek covering eastern Jefferson and the uplands of Lafayette Townships. It is also found in the southeastern part of the county capping the hills above the Huron limestone. It is especially prominent in Clay Township and extends through Jefferson into Marion and Jackson townships.

The Huron limestone, joining the Mansfield on the east, extends north through the central part of the county. Frequent outcrops are found in western Jefferson, in Franklin and Lafayette Townships. Much of the road material of the region is made from this limestone.

The Mitchell limestone forms the bed of White River south of Spencer and is found in northern and eastern Clay Township, outcropping along Raccoon Creek. At the old site of Green's Mill in Section 20, west of Freeman, the stream runs between sheer walls of limestone, capped with sandstone, 80 feet in height. The bluffs are beautifully clothed with a noble forest of Hemlock (Tsuga canadensis (L) Carr) which clings to the almost perpendicular rocks. The Mitchell limestone forms the surface formation in practically all of Washington Township, east of the White River. Here again is found some beautiful scenery. Some of the largest sinkholes in the county are found in this region, the surface being very rough and broken. The McCormack's Creek, issuing from the broad, level "Flatwoods," has cut a remarkable gorge through the limestone to a depth of over 100 feet. This spot can not be surpassed in the State for its wild and romantic scenery. The Mitchell limestone also forms the surface rock of the rich, rolling "Kentucky blue grass plains" through Wayne and parts of the adjoining townships. The outcrops are not so bold nor so numerous in the northern part of the county, owing to the thick mantle of glacial drift overlying it. The Falls at Cataract, at which place the waters of Eel River plunge a distance of 80 feet in a series of rapids and two successive falls, are formed by ledges of Mitchell limestone.

The Bedford Oölitic limestone outcrops near Romona, at which place is located one of the large quarries of the county. This limestone is also found in the region northwest of Gosport.

The Harrodsburg formation is found in the northeastern part of the county in the vicinity of Gosport, and north through eastern Wayne and Harrison Townships. In this region, the overlying strata are deeply buried under a layer of silt and clay carried in from the uplands, which has resulted in the so-called "Flats."

The Knobstone, the oldest formation in the county, is found only in a narrow strip east and northeast of Gosport. This strip marks the irregular western boundary of this formation which comprises the surface rock of practically all of Morgan County to the east.

The Flat Woods.—This region is a peculiar geological feature located southeast of Spencer, in the southeast corner of Washington Township, and extending into Monroe County. It is a low, level basin, covering an area of 14,000 acres within the boundary of Owen County. It is completely surrounded by high hills which rise abruptly from the floor of the basin. There are but two breaks in this rim in Owen County, through which McCormack's Creek and Ellison's Creek pass. The former furnishes the principal drainage system.

The geology of the area has been a subject of considerable study. Prof. Collet[1] pronounced this basin to be a portion of the original valley of the White River, which he believed to have flowed through the present channel of McCormack's Creek and continuing southwest through the Raccoon Creek channel, joining its present channel where that creek empties.

This theory, however, has been subsequently disproved by Hopkins and Siebenthal[2] after comparing the different elevation of

[1] Geological Report, 1875.
[2] Geological Report, 1896.

the region. In order for White River to flow down the above channel, it would have to run at a level of 150 feet higher than at present. Yet Bean Blossom Creek, which empties into the White River a few miles to the north, is clearly a post-glacial stream and could not possibly have flowed in that direction if the above were true, and at the same time cut down to its present depth.

The later explanation advanced by these men is that the Flat Woods is the site of a shallow, glacial lake. The McCormack's Creek gradually pushed farther to the southwest, until it finally "tapped" the enclosed body of water and drained it. The large amount of water thus liberated and the fall of about 150 feet in two miles account for the narrow, deep gorge of McCormack's Creek.

The soils of the Flat Woods were quite uniform and the greater part was classed as Waverly silt loam. They are discussed fully in this report under the soils.

HISTORY AND SETTLEMENT.

As far back as history and tradition go, Owen County has been a favorite resort for the red man. The region supplied all that he could wish in game, fish, wild fruit and rich river valleys. Over the area roamed the Pottawatomie, Miami and Delaware tribes. Many traditions of Indian origin are still afloat in Southern Owen of enormous lead and silver mines, which as yet have not been located.

The first settlement was made in the county in 1816, just northeast of the present site of Spencer, seven years after the territory was ceded to the Whites by the treaty of Ft. Wayne. The first settlers were Philip Hart, accompanied by his family, and James Bigger. By 1820 quite a number of settlers had located in this neighborhood. At this time the country was infested with wild animals and treacherous Indians. The hills were covered with a magnificent forest of poplar, sugar, walnut, oak, beech and elm, few of which have withstood the ravages of the white man to the present time.

The task of clearing the land was indeed no small one. But the stout-hearted pioneers hesitated at no task, and gradually the forest gave way to the plow. The methods were necessarily crude, the "jumping shovel" plow being used to break the rough, stumpy ground. Corn was the main crop, and due to the native richness of the soil good yields were obtained.

Owen County was organized in 1818 and named in honor of Maj. Abraham Owen, a veteran who lost his life in the Battle of Tippecanoe. The site of the county seat was located on the north bank of White River and was named in honor of a Captain Spencer, another hero of the same battle.

The settlers generally came from the south—Kentucky, Tennessee, or Virginia. While the new country was destined to become an agricultural one, yet much time was spent by these sturdy woodsmen in hunting and fishing, many of whom found greater pleasure and profit in this, their favorite pursuit, than in devoting their time and attention to matters pertaining to the farm. As the country became more and more settled and the soil began to show signs of exhaustion, the difficulty was met by merely clearing new areas, and abandoning the old fields. This system, which was practiced for many years, especially in the rougher and more thinly settled regions, resulted in inestimable injury to the soils for the future generations. The steep hillsides were cleared of every tree, shrub and vine that would tend to hold the soil together, and as a consequence a few years of careless tillage resulted in the washing of the surface soil down the slopes, leaving exposed the bare unproductive subsoil. In the regions where the Mansfield sandstone is close to the surface, on hundreds of hillsides the vestige of fertility has been carried away, leaving a bare surface of sterile sand and clay, overstrewn with bits of broken sandstone. In other places, where the loessial drift is deeper, the exposed subsoil is slowly being converted into a productive soil again, through natural agents. This is accomplished by the profuse growth of fine grass—locally known as "dog hair" grass—which is followed by dewberry and blackberry briers and sassafras shrubs. In this manner, hundreds of acres of abandoned land have been overrun and is being protected from the further destructive action of water.

The farmers of Owen County, for the most part, own their farms, and during the past few years have been making an intelligent effort to increase the productivity of their soils. This movement has not been without results, as evidenced by the increased yields and other indications of increased prosperity when compared with conditions ten years ago. During the past few years, however, there has been a restless feeling among the farmers of Owen County, which has resulted in many "selling out" to seek more promising locations. Their farms, in very many cases, have been sold and added to the neighboring farms. Through this process, there has been a decided increase in the size of the farms, with a corresponding thinning out of the rural population. It is a deplorable sight to note the number of houses thus abandoned throughout southern Owen County, many of which are still in excellent repair. This movement means that instead of a tendency towards more intensive methods of farming, which would lead to the rapid development of the agricultural welfare of the county, the tendency has been in the opposite direction—towards extensive methods. This condition is to be deplored, for a "land poor" farmer contributes much towards keeping a county poor.

The people are noted for their generous hospitality and friendliness. While there are few so-called wealthy farmers, yet the great mass of the people are intelligent, independent and industrious and are now making rapid strides towards better methods of farming.

Spencer, the county seat, is situated in a beautiful valley on the north bank of White River, in Jefferson Township. It is a city of 2,150 inhabitants. The Vandalia Railroad passes through it, which affords a good outlet for the products of the surrounding country. Formerly traffic was carried on on the White River before it became unnavigable for flatboats. The new court house has just been completed, which is the pride of the county.

Gosport is a town of 776 inhabitants, situated some ten miles up the river from Spencer, on the same side. It has two railroads, the junction between the Vandalia and Monon Railroads being at this place. It assumed considerable importance as a shipping point during the early history of the county. It is located in the richest section of the county, the wide, fertile valley of the White River stretching away to the southwest, and a rich limestone region to the north and west—the latter a veritable "Kentucky bluegrass soil."

Coal City is situated on the Indianapolis and Evansville Railroad, in one of the rich coal fields of the State. It has 325 inhabitants, and is a prominent trading and shipping point.

Quincy, located in Taylor Township, on the Monon Railroad, was formerly of considerable importance as a trading point. The town has made but little progress however during the past forty years.

Patricksburg, a thriving town of 500, is situated in Marion Township, on the Indianapolis and Louisville Railroad. It early came into prominence as a trading point and a number of industries have been located here. It is also in the region of the rich coal belt.

Freedom, one of the oldest towns in the county, is located on the Vandalia Railroad, in the valley of White River. It has 325 inhabitants, but is of little importance commercially.

Besides these there are numerous villages nestled in among the hills, usually consisting of a store or two, a schoolhouse, and possibly a church. Most of these villages have "seen better days" for before the advent of the rural routes, postoffices were located at these points and served as a gathering place for the farmers of the vicinity. Some of these villages are White Hall, Freeman, Arney, Cuba, Atkinsonville, Farmers, Hausertown, Cataract, Cunot, Adel and Jordan Village.

AGRICULTURE.

Agriculture follows the general lines, with but little attention devoted to special crops. The prevailing crops are corn, wheat, oats and hay. Corn is raised throughout the county, but the creek and river valleys afford the best soil for this purpose. In the rougher districts, corn is not being grown so extensively as formerly, since repeated cultivations result in destructive erosion of the soil on the steep slopes. In the western and northeastern sections, however, where the surface is more level, corn is grown extensively on the upland with fair yields. Considerable commercial fertilizer is used with this crop, and many instances of remarkable increases in yield have been noted where even a light application of nitrogen and phosphatic fertilizers was made. In the southern and western part of the county, farmers are relying more and more on these fertilizers for profitable crop returns. Generally the most approved methods are employed in the farming operations, yet there is need for further improvement in various ways. The old type cultivator with broad shovels should be discarded and a system of shallow, level cultivation substituted. The latter method lessens the danger of washing, decreases the amount of soil exposed to the drying effect of the sun and wind, and lessens the danger of injuring the roots of the growing corn.

The acreage of corn grown in the county has varied but little during the past thirty years. However, the yield per acre has increased materially. In 1880, 22,108 acres were grown, yielding 505,392 bushels, while in 1910, 22,711 acres produced 686,672 bushels.

Wheat was at one time grown much more extensively than at present. In 1880, the acreage was 23,787, yielding 295,378 bushels, while in 1910 only 10,608 acres were sown, with a yield of 124,398 bushels. Wheat is confined chiefly to the more level regions of the western and northern parts. The practice of sowing commercial fertilizers with this crop has been a general one during the past few years. On the upland, usually a fertilizer rich in phosphoric acid and potash is used. This, where clover has a regular place in the rotation, gives good results, but where no successful attempt is made to supply the nitrogen with a leguminous crop, the soil, naturally deficient in organic matter, is soon depleted of this important element. The poor management of the soil during the earlier days is responsible for the later decline of the wheat crop. The yield per acre ranges from 8 to 25 bushels, the better farmers who are making special effort to conserve their soils obtaining the larger yield.

Oats are raised in practically all parts of the county but more extensively in the level regions. In 1880, 8,161 acres were grown, producing 106,474 bushels as against 8,566 acres yielding 59,476 bushels in 1910. Very little commercial fertilizer is used with this crop. The soil is well adapted to oats if greater care is exercised in sowing the crop.

Grass is grown extensively throughout the county. The soil is especially adapted to the raising of timothy, more particularly in the flat regions. While the acreage has increased during the past thirty years, the yield per acre has decreased somewhat. In 1880. 15,037 acres were grown yielding 22,368 tons, as against 20,524 acres producing 18,965 tons in 1909. The extensive use of this crop in the rotation to supply the hay to the exclusion of clover is significant when correlated with the present low state of productiveness of many of the farms. Clover has never been held in favor as a grass crop, chiefly because the condition of much of the soil has been unfavorable to its growth. In 1880, 3,972 acres were raised, as against 2,170 acres in 1909. The soil conditions which are holding the farmers down to a 30 bushel corn crop, a 10 bushel wheat crop and practically excluding the all-important clover crop are discussed under the soils proper.

Fruit growing in Owen County has received but little attention, yet opportunities along this line are excellent. The soil is well adapted for fruit trees and much of the upland which is of little value for farming could be profitably turned into orchards. The superior quality of the fruit that is being produced from the well cared for orchards warrants a more serions consideration of this proposition. The great need at present, however, is for more attention being given to the fruit trees which have already reached the bearing age. It is apparent from the appearance of the trees, that very little attention has been given them and as a consequence many orchards are suffering from the ravages of various pests.

The soil of central Owen County has been recognized for some time as being peculiarly adapted to tobacco raising. Many tobacco growers from the Southern States have located here and are growing an excellent quality of tobacco. It is usually marketed at Louisville.

Owen County has never been an extensive stock raising or dairy section. This is due largely to the poor adaptation of the soil for heavy grain farming, which naturally prevents winter feeding. Consequently, much of the stock is sold when young to more favorably located feeders. In the broad, rolling limestone area, comprising the greater part of Wayne Township and stretching west and north into the adjoining townships, is found excellent pasture land. In this section, cattle and sheep are raised rather extensively.

Dairying is slowly becoming recognized as a profitable business and will do much toward improving the soils. Silos are being built in many parts of the county and greater care is being exercised in preserving the feed on the farms. One of the great needs of the county is more and better live stock.

SOILS.

The soils of Owen County show great uniformity in texture, the different types varying comparatively little in this respect. Practically the entire area is classified in the silt loam group. Very little sand or gravel is found distributed through the soil, although it is more in evidence in the northern part of the county.

There are seven soil types recognized in the area. However, there are considerable variations in each type which, when not sufficiently prominent to warrant the introduction of a new class, are considered as phases of the type in which they are found. The classes of soil which are recognized in Owen County are as follows: The Knox silt loam, by far the most extensive soil in the county, comprising most of the upland soil or nearly four-fifths of the county; the Wabash silt loam, the soil of the White River bottom and some of the other streams; Wabash fine sandy loam, found chiefly in Eel River bottom; Waverly silt loam, the built-up soil in various depressed areas; Carrington silt loam, small areas of black soil in low regions; Knox sandy loam, occupying a series of low mounds and ridges along White River valley; and a small area of peat found in the northwestern part of the county.

Knox Silt Loam.

The Knox silt loam represents the prevailing soil type of Owen County. With the exception of small areas of Knox sandy loam, practically all the upland soil falls in this class comprising about four-fifths of the county. It is a light yellow to greyish white silt loam from 8 to 12 inches in depth. When wet, the soil changes to a dull grey. The subsoil is a compact yellowish-red silty loam, somewhat heavier than the surface soil. It is mottled with streaks of light grey or white. These are sometimes very faint, but in some places the yellow and white are about evenly divided, especially in the poorly drained areas. In wet regions, the soil is invariably lighter in color, due to the absence of the iron compounds which are often extracted from the body of the soil in the form of small, soft, inert concretions found scattered over the surface. Small areas of this nature are found throughout the extent of the Knox silt loam, and are usually very difficult to manage. At a depth of 24 inches, the subsoil becomes heavier and tends to break into cubical fragments.

The Knox silt loam contains but little sand or gravel. Under cultivation it is very easily handled if not worked when too wet. The soil on the surface is loose and friable, with a "floury" feel, but it becomes compact a few inches below the surface and runs together badly. Care must be exercised not to work the soil when too wet since it puddles easily and becomes very cloddy. Originally, it supported large forests of hardwood timber of poplar, sugar, oak, beech and elm. Consequently it is low in humus content, the light color of the soil indicating this deficiency. The color of the soil can be changed materially by the incorporation of a liberal supply of organic matter, in the form of barnyard manure and vegetation.

The Knox silt loam is derived from loessial drift which is composed of the finer glacial material. It owes its deposition to wind and water, the former agent doubtless being the principal one. The wide topographic range in which the type is found is striking. On the crests of the highest hills which are protected from erosion, on the level areas, and in the older valleys the texture and appearanc of the soil are identical. In the southern part of the area, the surface is very rough and the mantle of loess is comparatively thin. On many of the prominent points the soil has been entirely carried away by erosion, leaving bare the residual sandstone beneath. The silty soil has insufficient clay to hold it together firmly and consequently it tends to wash badly. In the hilly sections, the greatest problem of the farmer is the one of erosion. Gullies are formed rapidly which generally reach to the bottom of the loessial drift, before they are checked. These washes are started at the slightest provocation and in a remarkably short time become so large as to be very difficult to manage. Hundreds of acres of the best upland soil in the county have been practically ruined for all time by this destructive process, which has been allowed to go on through neglect and carelessness. However, by careful cultivation and by keeping the slopes in growing crops or grass as much as possible, farmers are able to minimize the danger in this respect.

In the northern and western part of the area, the topography is more level and the general farming value of the soil is greatly increased. When properly handled it is well adapted for the raising of corn and wheat, producing often as high as 50 and 25 bushels respectively. However, the average yield does not exceed 30 bushels of corn and 12 bushels of wheat. The soil is rather easily exhausted, and at present much commercial fertilizer is used. This usually consists of bone meal, containing from ten to twelve per cent. of phosphorus and sometimes with the addition of one to two per cent. of potash. Very little nitrogen is applied in the form of fertilizer, although the nitrogen content of the soil has become very low. Since very little livestock is raised in the county, there is a correspondingly small amount of manure produced; so this source of nitrogen is likewise denied the soil.

Timothy does well on the Knox silt loam, this crop being one of the most extensive grown. Clover or other leguminous crops have a limited use, due chiefly to conditions of the soil unfavorable to their growth. Yet it is through the use of these crops that the failing nitrogen supply can be most economically maintained or increased. Until these conditions are corrected then, farmers will be seriously handicapped, since the growing of nitrogen gathering crops is among the first essentials of successful farming.

One of the difficulties of the Knox silt loam is the acid condition that prevails. Closely associated with this is the lack of thorough drainage. This does not include the entire area, as there are sections where neither condition is found. However, the texture of the soil is so fine that, with the heavy compact nature of the subsoil, natural drainage is poor even on the sloping areas. The soil is not only wet and cold by virtue of the above conditions, but the free circulation of the air through the soil, a most important requisite to the growing plant, is prevented as well.

The lack of drainage further promotes the accumulation of organic acids in the soil. It is safe to say that the greater part of the area of Knox silt loam, while probably not giving a strong acid reaction, would nevertheless be benefited materially by an application of ground limestone. Where there is an abundant growth of red sorrel and bracted plantain, a sparse growth of cultivated crops, a heavy sodden condition of the soil, and the failure of clover, the acidity of the soil is apparent. The amount of ground limestone necessary to correct this condition depends somewhat on the nature of the soil, but from two to four tons per acre every three or four years will usually produce excellent results.

Thorough tile drainage will do much to improve the aeration of the soil as well as afford an escape for the soil water. The tile should not be laid more than thirty inches below the surface or the laterals more than five rods apart. Cement tiles are being used quite extensively in some sections and where correctly made are proving quite satisfactory.

There is no denying the fact that the drainage and liming proposition would prove an expensive one and would necessarily need to be introduced slowly, with a view to make "one acre pay for another." With the accomplishment of these things and with a frequent turning under of heavy crops of cow peas or soy beans this soil could easily be made to double its present yield in a short time. The land is valued at from $5 to $20 per acre in the most broken regions and $40 to $60 per acre in the more level locations. The Knox silt loam responds generously to careful, scientific treatment, and in many cases the productivity of the soil has been increased one hundred per cent. in a remarkably short time by such treatment. It is especially adapted to the growing of fruit trees and many promising young orchards are found in the area.

The results of the mechanical analysis of the Knox silt loam are given in the following table:

Locality.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
Middle Sec. 15, Clay Tp.	Grey silt	.0	.0	.25	1.3	5.9	76.8	15.5
Subsoil	Red silty clay	.0	.0	.5	3.3	10.2	76.7	9.2
Middle Sec. 9, Franklin Twp.	Grey, sandstone soil	.2	.0	3.0	11.5	5.0	62.5	17.7
Subsoil	Slightly redder	.0	.0	3.95	2.6	2.1	71.1	19.7

Waverly Silt Loam.

The Waverly silt loam is a light grey to white colored soil with an average depth of five to eight inches. The subsoil is a heavy grey to white heavy silty loam mottled with light yellow to buff streaks. Numerous iron stains are also encountered in the subsoil and iron concretions are frequently found. The Waverly silt loam contains but little sand or gravel although in certain parts of the area the iron concretions interspersed through the soil are sufficiently numerous to give it a gravelly texture. The topographic features are marked by flat, low areas with poor drainage facilities. The soil in many places is "crawfishy," and presents a cold, wet, sterile appearance.

The largest areas of Waverly silt loam are found in the northeastern part of the county, comprising the so-called "Flats." In the "Flatwoods" district, in southeastern Washington Township, the soil is of this type. In the former area, the surface is underlaid at a depth of from 12 to 15 feet with a deep layer of fine sand. This sand carries an abundance of water and is a typical "quicksand." In digging wells in the region, this stratum gives considerable trouble if attempts are made to penetrate it. It doubtless marks the bed of the shallow lake which formerly spread out over this area. The subsequent filling in, with the finer materials from the surrounding uplands which was spread out over this bed of sand, accounts for the heavy mantle of soil above it. There are also small areas found along the smaller stream courses. In the spring, the soil remains wet and miry until late, making it impossible to plow until the season is well advanced. So soft and miry is it that stock finds great difficulty in walking across the fields. The tracks thus made often remain throughout the entire summer, for when once dry the surface is very hard and compact. When wet, the soil is a dull grey, but on drying it bleaches out to an ashy white. In the cultivated fields, the surface is loose and free from clods but becomes very compact below the surface.

The drainage facilities of the Waverly silt loam are very poor. The level topography, the close texture of the soil which often reaches over ninety per cent. of silt and clay, and the almost impervious subsoil, account for this poor drainage. So nearly impervious is the subsoil that water stands on the surface for long periods in small depressions, while directly beneath it the subsoil remains apparently dry.

The soil is made up of glacial material which has been reworked by water and deposited in the lower areas, forming wide, level plains. In the stream valleys, it is usually found in the second bottoms and is known as "white slash" land. Much of it is due to the erosion of the adjoining uplands, by which process the finer material is carried down and re-deposited in the valleys. Consequently, the resulting soil is naturally low in organic matter. This absence of humus, together with that of the iron oxides, which are usually found locked up in small brown concretions, results in the greyish color of the soil. The surface can be made much darker however by heavy applications of manure or other forms of vegetable matter.

The explanation for the presence of these concretions, locally known as "turkey gravel" or "buckshot," has received considerable attention both from farmers and geologists. They are invariably associated with a light colored soil and one that is poorly drained. It seems that the iron compounds in the soil possess a strong chemical affinity, not well understood, and that this affinity is promoted by a heavy unaerated soil that is saturated with water. The result of this action is the drawing together of the iron oxides towards a common center and the forming of the soft, brown pellets so common in wet soils. The ashy grey appearance of the soil is made so by this extraction of the coloring matter, which is principally the iron oxides. The remedy for these soils is thorough drainage. With the excess of water removed and the air given free-access to the upper soil particles, the tendency for these compounds to become concentrated into concretions is destroyed. It is further alleged by a former geologist* that after a few years of thorough drainage the concretions already formed will gradually dissolve and re-color the soil. The greater part of the Waverly silt loam has been affected in the above way, and similar smaller areas are found throughout the Knox silt loam. These latter areas range in size from mere spots, often occupying slightly elevated ridges or knolls, to several acres in extent.

Doubtless the lack of drainage is the most serious problem of the farmers in these areas. The installation of a complete system of artificial drainage is an extremely difficult matter, since the close texture of the soil prevents the tile from "drawing" more than two rods on each side. Hence, to drain the soil effectively, the laterals must not be more than four rods apart, with the tile not more than thirty inches below the surface. Cement tiles are

* Geological Report 1890.

being used quite extensively in the vicinity of Quincy. H. H. Mitchell and J. D. Truax, farmers in Harrison Township, have proven the practicability of making their own tiles. They own and operate a small cement tile machine and are able to turn out from 400 to 600 tiles per day at a cost of not over 12 cents per rod. The initial cost of the machine and equipment did not exceed $60. On a large farm, such an investment would assist greatly in solving the drainage problem.

The greater part of the Waverly silt loam is sour and an application of ground limestone at the rate of from two to five tons per acre is strongly to be recommended. If the soil is then livened up by incorporating into it as much organic matter as possible in the form of green manuring crops or barnyard manure, it would be in proper condition for successful farming. According to an estimate of J. B. Abbot, soil expert at the Indiana Experiment Station, it would require $30 per acre to improve this soil in the way described above. While this seems a staggering proposition at first sight, yet even though introduced slowly highly productive farms will result in a few years and a corresponding increase in land values.

At present there is no convenient place to secure ground limestone in the county, and if shipped in from distant points the freight expenses are excessive. With the farmers anxious to obtain the material and with an unlimited supply of natural limestone close at hand, an excellent opportunity is here offered for the building up of a new and important industry—that of operating stone crushing mills. The demand for the product, once created, would increase rapidly. Such a movement would do more to assist in building up the wealth of the county than almost any other.

Timothy is the most successful crop grown on this type although the other crops are raised as well. The average yields are 30 bushels of corn, 11 bushels of wheat, and 20 bushels of oats. Much of it is kept in permanent pasture for sheep and cattle, the land ranges in value from $25 to $50, depending on the location.

The following table gives the results of mechanical analysis of the Wavery silt loam:

Locality.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
Sec. 17, Washington Twp. In Flatwoods	White, silty soil	.0	.0	1.4	4.1	3.4	80.3	10.1
Subsoil	Stiff, mottled clay	.0	.3	6.5	23.4	15.5	42.5	11.0

Chemical Analysis of Waverly Silt Loam.

Collector, Edmonson.

Reaction to litmus	Neutral
Moisture in air-dried soil	1.57%
Total soil nitrogen	0.055%

Analysis of fine soil dried at 105° C.—

Volatile and organic	3.17%
Insoluble in 1.115 HCl	87.76%
Soluble silica (SiO_2)	0.18%
Ferric oxide (Fe_2O_3)	1.74%
Alumina (Al_2O_3)	4.84%
Phosphoric acid anhydride (P_2O_5)	0.14%
Sulphuric acid anhydride (SO_3)	0.03%
Calcium oxide (CaO)	0.42%
Magnesium oxide (MgO)	0.43%
Potassium oxide (K_2O)	0.17%
Sodium oxide (Na_2O)	0.23%
Total	99.11%

Wabash Silt Loam.

The Wabash silt loam is one of the chief soils of the White River valley. It is a loose, dark brown to almost black soil ranging in depth from 10 to 15 inches. It contains a small per cent. of sand with a high content of silt, giving it its characteristics properties. There is no definite line between the soil and subsoil, the texture changing but little to a depth of 36 inches where there is an appreciable increase in the coarser materials. The surface is loose and mellow and is very easily cultivated. The high content of organic matter, to which the soil owes its color, gives it an open, porous nature that prevents it from baking or cracking. The areas adjacent to the streams are subject to frequent overflow, although very little of it is covered by water for any length of time. The color of the soil becomes somewhat lighter as the distance from the stream is increased, due to the decreasing humus content.

The Wabash silt loam is an alluvial soil, having been transported and redeposited along the streams where it is now found. It is of glacial origin, and much of it has been derived from the surface of the glacial drift during the heavy rains. In fact the soil owes its natural productiveness to this deposit of fertile sediment from the fields, as well as to the large amounts of organic matter contained in it. The texture of the soil is not entirely uniform, the per cents of sand and silt varying in different places

Usually the parts remote from the stream show more fine sand than the areas bordering the stream. The surface is level and oftentimes low. Natural drainage in these sections is limited, and artificial drainage must be resorted to before the soil can be cultivated successfully.

The Wabash silt loam is especially adapted for the raising of corn, the yield ranging from 50 to 80 bushels per acre. It is not so well adapted for the production of the small grains, however, since the rank growth of these crops induces lodging. Very little manure or commercial fertilizers are used on this type. Due to its special adaptation for the production of corn and its supposed inexhaustible fertility, a regular system of crop rotation is seldom practiced. Instead, corn is often raised on the same soil year after year. Clover does well on this type and makes an abundant growth. This crop should be used more extensively as a green manuring crop for corn, since it is not adapted to the crops of a general rotation. Timothy makes too rank a growth for the best quality of hay and the further danger of overflow prohibits it from being grown extensively. The type is especially drought resistant and on the other hand crops do not drown out easily where artificial drainage is employed. The land is valued at $100 to $200 per acre.

The soil originally supported large forests of poplar, oak, beech and elm, but most of this has been cut away and the area is practically all under cultivation. The White River bottom comprises the greatest area of this type although it is also found in the smaller stream bottoms, where the erosion from the hills has not influenced the soil too greatly. The bed of the White River is shallow and its course is tortuous. As a consequence, the river is continually encroaching on the adjoining fields, especially at the sharp bends where the banks are being rapidly pushed back at the expense of the fields. Much damage is being done every year by this destructive process.

The following table gives the results of the mechanical analysis of the Wabash silt loam:

Locality.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
Sec. 28, Washington Twp.	Soil	0.1	0.4	0.2	6.2	14.8	63 1	14.8
Sec. 28, Washington Twp.	Subsoil	.0	.8	.1	3.4	12.4	68.3	15.0

KNOX SANDY LOAM.

The Knox sandy loam is found in small areas along the bluffs of the White River. Its texture is the coarsest of any soil found in Owen County. It is a dark grey, loose sandy loam, with the properties of a sand in places where the organic matter is low. The subsoil is not marked distinctly from the soil, the color gradually becoming lighter with depth until at 20 inches it is a light grey sand with but little humus. The soil is composed of medium to fine sand, and carries a considerable amount of organic matter, which, in places, where it is protected from the burning out effect of the sun, gives it a very dark appearance. However, where the surface is exposed to the action of the sun by cultivation, the soil presents a lighter color.

The Knox sandy loam occurs mostly as elevations along the bluffs of White River valley. These present the appearance of terraces in some sections, as is found on the eastern side of White River opposite the town of Freedom, or they may occur as a chain of low, rounded mounds or ridges which lie between the valley and the upland proper. Such an arrangement is found in southwestern Washington Township in Section 30.

The Knox sandy loam is derived from either of two sources. The sand is either the result of the disintegration of the residual sandstones in the regions farther northward and has been transported to its present position by the water; or the sand may be of glacial origin which was dropped by the Wisconsin ice-sheet, several miles to the north, and carried down to be redeposited where it is now found. The action of the wind doubtless assisted in the formation of the dune-like mounds.

The type ranks fairly well as a general agricultural soil. It is not able to resist long periods of dry weather, for the crops burn out easily. The soil is so open that natural drainage is often excessive. The type is well adapted for water-melons and garden truck. The areas found in this county are too small to be considered among the more important agricultural soils.

DOVER SILT LOAM.

The Dover silt loam is closely associated with the limestone regions of the county. It varies in color from a reddish-brown to a light brown silt loam with enough fine sand to give it a loose, open texture. The soil averages from 8 to 12 inches in depth although there is no sharp differentiation between the soil and subsoil. The subsoil verges into a heavy yellow or reddish-brown loam, usually somewhat lighter than the surface. The content of sand increases somewhat with depth, giving it, in the better drained areas, a loose granular structure. At a depth of 36 inches the subsoil becomes a light yellow, and is often mottled with streaks of grey or white. Often in the level areas the subsoil becomes a stiff, tenacious, reddish-brown, heavy loam with the properties of clay. Such phases, however, are usually found in the vicinity of its closely associated type, the Knox silt loam.

The Dover silt loam comprises one of the best agricultural soils in the county. It is a typical loess, derived from glacial debris, which, after its deposition, has been greatly influenced by the residual stratum of limestone which underlies it. It is the result of the weathering of this limestone and the mixing of the weathered material with the mantle of loess that differentiates it from the Knox silt loam and makes it a distinct type. The Dover silt loam is characterized by a rolling to hilly topography with long gradual slopes and wide valleys. The elevations are seldom so abrupt as to cause exposures on the hillsides and consequently, the surface, which is matted with an abundant growth of grass roots, is seldom broken. Thus, the danger of washing is reduced to a minimum in the uncultivated areas.

The type is underlaid almost entirely by the Mitchell limestone and the surface is pitted in many places with sinkholes, ranging from a few feet in diameter, to those covering an acre or more. Throughout the area, outcroppings of the limestone are found on the sharper slopes although they seldom interfere with the cultivation of the fields. The beds of the streams are usually composed of this stratum.

The Dover silt loam is especially adapted to the growing of bluegrass, by virtue of its abundant lime content, its open, porous surface and the excellent drainage. The grass grows luxuriantly and furnishes good pasture throughout the summer. A large part of the soil is kept in permanent pasture for sheep and cattle. This is especially true in Wayne Township. Here the farmers are making a practice of cutting the weeds in the woods pasture every summer and in other ways are caring for them. The soil is open and loose, and requires but little work to produce an excellent seed bed. Corn does well, especially when an application of barnyard manure is added. It produces from 30 to 65 bushels per acre, with an average of about 45 bushels. Wheat is grown rather extensively and averages about 15 bushels per acre. Commercial fertilizers are not used extensively, although there were many inquiries as to the fertilizer needs of this soil. Doubtless an application of a fertilizer rich in phosphorus would produce the best returns, provided clover or some other legume is grown regularly in the rotation. If not, nitrogen should be supplied in the fertilizer, although the latter method is not to be recommended since this element can be furnished much more cheaply through the legumes.

The Dover silt loam is the only upland soil in the county that shows no indications of sourness. The close proximity of the Mitchell limestone layer is responsible for the wholesome condition of this type. Clover does well, there being little trouble in getting a stand or an abundant growth during favorable seasons. It is also well adapted for alfalfa and this crop should be raised more extensively, as but little is being grown at present.

The principal area of this type is found north and west of Gosport, extending through Wayne and into the adjacent townships. Other areas are found in Clay and Washington townships. The timber growth on this soil is quite characteristic and furnishes a means of readily recognizing the type wherever encountered. The original forests were confined almost wholly to black and white walnut, sugar and poplar trees. Many fine specimens of walnut and sugar trees still are to be found, but the poplars have practically all been cut away.

The large number of sinkholes characteristic of this area has handicapped the farmers a great deal. Generally, bushes and young trees are allowed to grow up in these depressions which prevent them from becoming larger and hold the soil from washing in. However, some of the more enterprising farmers have practically eliminated them from their fields by choking the underground openings with stones and rubbish and filling in with dirt. A number of sinkholes on the farm of Mr. Holt Pickens, in Montgomery Township, was treated in this manner and the surface has been made practically level. The drainage of the area is to a large extent underground, the water escaping rapidly after the rains through the sinkholes into the subterranean channels.

The following table gives the results of the mechanical analysis of the Dover silt loam:

Locality.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
N. E. Sec. 30, Wayne Tp.	Reddish brown loose loam............	.0	.0	.55	11.6	10.4	66.8	10.0
Subsoil..................	Brown, compact, stiff............	.0	.0	10.1	25.9	14.2	29.9	19.3

Chemical Analysis of Dover Silt Loam.

Collector, Edmondson.

Reaction to litmus	Neutral
Moisture in air-dried soil	1.48%
Total soil nitrogen	0.087%

Analysis of fine soil dried at 105° C.—

Volatile and combustible	3.47%
Insoluble in 1.115 HCl	86.05%
Soluble silica (SiO_2)	0.16%
Ferric oxide (Fe_2O_3)	2.34%
Alumina (Al_2O_3)	6.37%
Phosphoric acid anhydride (P_2O_5)	0.33%
Sulphuric acid anhydride (SO_3)	0.07%
Calcium oxide (CaO)	0.30%
Magnesium oxide (MgO)	0.53%
Potassium oxide (K_2O)	0.21%
Sodium oxide (Na_2O)	0.29%
Total	100.12%

Wabash Fine Sandy Loam.

The Wabash fine sandy loam is an alluvial soil, the largest area being found in the Eel River bottom, with smaller areas in the valley of the White River and minor streams. It is a dark brown to black, mellow soil with a depth ranging from 12 to 15 inches. The surface has a comparatively small amount of sand, feeling to the touch much like a silt loam. However, the sand content increases rapidly with depth and at 30 inches often runs as high as fifty per cent. The subsoil grades into a very heavy, stiff, sandy clay which, on drying, is extremely hard. It is of a lighter color than the surface, being a dull drab with light yellow spots of clay or iron oxide.

The area of Wabash fine sandy loam in the extreme southwestern part of the county in Eel River bottom is low and inclined to be marshy, in the vicinity of the stream. The entire area is subject to overflow and great damage is done to the crops every year by these untimely floods. In seasonable years, however, this type is very productive, being especially adapted for the raising of corn. From 80 to 90 bushels per acre are commonly obtained. But during the wet seasons, crops suffer greatly and are often drowned out. Artificial drainage is being employed to some extent with excellent results. But even then the water drains out very slowly, since the fall is so slight. The main difficulty lies with the Eel River itself. The general slope of the region is very slight; the elevations of Johnstown, at the point where the river crosses the Owen County line, and Worthington, three miles farther south, are exactly the same. Consequently, the stream where it touches Owen County is very sluggish and the channel has become slowly filled up with accumulations of brush, trees and mud. What little impetus the current might have is practically destroyed by the meandering course which the stream takes. So when the floods are brought down from the more sloping regions above, the results are a general overflow, at this point. After the destruction of two successive crops in this way, farmers have refused to farm it longer, at such a risk of losing everything, and consequently hundreds of acres of rich soil are now lying idle. However, a project is being considered, of deepening and straightening the channel of Eel River for a distance of 23 miles along the county line. In this distance, the channel would be shortened to one-third its present length by eliminating the crooks. This would affect about 35,000 acres in the valley and the estimated cost would not exceed ten dollars per acre. The present price of the land in this region is from $20 to $30 per acre and if they succeeded in preventing the destructive floods and securing a good outlet, the value of the land would increase in a short time to $75 to $100.

In the valleys of the smaller streams, the drainage is usually good. Corn is the staple crop. Tomatoes are grown quite successfully in Franklin Township on this type.

The Wabash fine sandy loam is of glacial origin, having been carried down by the streams and redeposited. The subsoil varies considerably, sometimes changing to a bed of fine sand which shows evidence of water deposition. Where the valleys are narrow and erosion of the hills has been extensive, the identity of this type is lost in the deluge of silt and clay that is spread out over it. Many fields in these valleys, once very fertile, have been practically ruined by this fine material washed down from the bare, unproductive hills.

The mechanical analysis of the Wabash fine sandy loam is as follows:

Location.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
Sec. 36, Jefferson Twp...	Soil................	.0	.9	1.0	12.4	25.7	47.2	11.9
Sec. 36, Jefferson Twp...	Subsoil............	.0	.4	3.1	28.5	28.6	33.2	5.6

Peat.

The only bed of peat found in the county is located in Jackson Township, Section 12, on the farm of Mr. Robert Martin. It is a low-lying, swampy region, in the valley of Jordan Creek. A study of the region reveals evidences of the existence of a long, narrow lake, at one time in the history of this valley. A large number of springs open from the eastern slope and have kept the soil saturated with water. As a result, water-loving plants have grown up and decayed for ages until a deep bed of soft springy peat has been formed. There had been no attempt to utilize this area until the Martin brothers undertook the task of draining it. This proved a big proposition, but it was accomplished by means of a large number of tile drains, and excellent corn is being raised on it at present.

The layer of organic matter is from three to four feet thick, under which is found a deep layer of water-bearing sand.

Lying north of the peat bed is a small area of black muck. This is difficult to handle, and spots are found on which corn will not mature. Such spots are evidently very deficient in potash and this fertilizer should be added when the crop is planted.

For areas of Soil Types of Sullivan County, see map page 246.
For descriptions of these types, see Knox, Clay and Vigo Counties.

Soil Survey of Clay, Knox, Sullivan and Vigo Counties, Indiana.

By Chas. W. Shannon.

The four counties included in this survey are situated in the southwestern part of the State, and occupy an area of 1,709 square miles. All the counties to the south and east of this area have been worked by the Soil Survey, and the reports have been published, with the exception of Owen County, which was covered during the past season, and the report of the field work is published in another part of the present Annual Report. The Wabash River forms the western boundary of the area, with the exception of the northern part of the west line of Vigo. The counties on the north have not been surveyed.

PHYSIOGRAPHY AND GEOLOGY.

The area under consideration, in a general way, has for its northern boundary the southern line of the Wisconsin drift. The entire area is within the limits of the Illinois glacier, and most of the surface has received a deposit more or less of the loess-like material derived from the Iowan drift, and the extreme northern part has been influenced to some extent by the outwash from the Wisconsin. In many places the underlying geological formations have been the source of much of the soil making material. On the slopes, the hillsides and the cuts of the streams, the drift has been carried away and the soil is a true residual type. The surface formation of the area consists of some small areas of the Upper Mississippian (the Huron) and a considerable continuous strip of Mansfield sandstone (Millstone grit or basal member of the coal measure) along the eastern side of Clay County; the coal measure proper covers the whole of the remaining part of the area, with the exception of a narrow outcrop of Merom sandstone, along the bluffs of the Wabash in Sullivan and Knox counties.

There are no very rugged surface features over the area with the exception of the immediate stream bluffs. In general the surface is level and gently undulating. Rock exposures are numerous throughout the counties. The surface is in most places covered with a coating of drift material varying in thickness from a few inches to several feet. It has been estimated that in order to accomplish the work done by the ice sheets and to form the great thickness of drift material that the ice must have covered the region about Terre Haute to the depth of at least five or six hundred feet.

The Illinoian Drift.

The State was invaded by ice which had its center of dispersion in the elevated districts to the east and south of the Hudson Bay. From the region to the north of Lake Huron there was a movement to the west of south over the Lake Michigan Basin, Illinois and western Indiana. From a part of this sheet, the part known as the Illinoian lobe was formed. The deposit left by this invasion constitutes the surface (aside from the thin covering of loess) over the entire of southwestern Indiana and an area of almost equal size in the southeastren part—that is, it covers the entire area between the glacial boundary and the line of the Wisconsin drift. Many wells and drillings have shown that this drift is present also farther to the north underlying the Wisconsin. The thickness of this drift over the area of its exposure is in general about twenty-five feet deep except in filled valleys. In places, the ridges carry but a thin coating, while adjoining valleys may be filled one hundred feet or more. At the southern limit the coating of material is very thin in most places and while the boundary is not marked by a well defined ridge, the character of the soil and the natural vegetation mark approximately the limits of the drift.

In general, the material is of a yellowish brown color to a depth of 15 feet or more, beneath which the color is a gray or blue gray. There is every transition from the brown to the gray; it is therefore probable that the brown is an altered gray till, the oxidation of the iron having produced the color. In the filled valleys sand and gravel are often found and in the northern part of the area the drift becomes more variable. The underlying rock formations in most of the area appear to have contributed largely to the material of the till. Where the underlying rocks are of a friable nature the material has been reduced to sand or pebbly constituents. The till thus varies with the character of the underlying rocks. The locally formed pebbles and rock fragments are chiefly sandstone, but numerous foreign rocks and bowlders of large size are occasionally found near the limit of the drift. The region presents a fairly even topography. In places, knolls and ridges with undulating surfaces occur, but in no place do they become of great height.

Striæ are found in several places. They occur in Sullivan, Vigo, Clay, Greene, and Owen counties. The markings are chiefly upon sandstone exposures. In Clay County, on the northwest side of Eel River, on the James Campbell farm, there are very conspicuous glacial scorings on the surface of Mansfield sandstone exposures. Here a bare exposure of considerable extent in the head of the ravine has had the stone surface polished very smooth and finely grooved by the action of the ice-sheet. A part of this exposure has been blasted away for the purpose of securing stone for railroad ballast and road material, and on the remaining part the scorings have been somewhat obliterated because the surface was formerly used for a feeding ground. The markings are, however, very indistinct. In the pictures taken of this exposure some were taken just as the surface appears; in others the grooves were strewn with white sand in order to give more contrast in the photographs. Some of the photographs are included in this report. This exposure should be preserved. One mile east of Bowling Green, at the fork of the roads, is another exposure of sandstone with a flat surface upon which glacial striæ have been noted. At the present time the washed material from the higher ground has covered a large part of the exposure and on the part projecting into the roadway the lines have become very obscure, from the wheels of vehicles, etc.

The drainage of the area covered by the Illinoian invasion was in many respects greatly modified. In attempting to work out the history of an area whose drainage has been arrested by the invasion of an ice-sheet, the life resolves itself into four fundamental parts. First, what were the topographic characteristics of the area during the pre-glacial history. Second, what changes took place during the glacial history. Third, what has happened since the disappearance of the ice-sheet; its post-glacial history. Fourth, what was the effect produced on the unglaciated parts of this area. The drainage is discussed to some extent under the description of the rivers.

The Loess of the Iowan Drift.—Prior to the invasion by the Illinoian ice lobe there was a marked interval of deglaciation and a similar interval occurred at the close of the Illinoian period. These intervals were marked by leaching and oxidation of the drift, the accumulation of peat and soil, and the processes of erosion. The interglacial interval following the Illinoian invasion is known as the Sangamon Stage.

The surface of the Illinoian drift out side of the limits of the Wisconsin drift is covered with a fine grained, yellowish silt or loam, to which the term loess has been applied. Loess is a deposit which, like sand or gravel, may be laid down whenever conditions are favorable, but since the great bulk appears to have been deposited at a definite stage in the glacial period, the time of deposition may be referred to as the Loess Stage. This loess may be of different ages, but since the materials contained are such as occur in glacial drift it must have been derived from the drift. The source is supposed to be from the Iowan drift and the distribution due to the combined action of wind and water. The loess of Indiana varies from a fine silt of a loose, floury texture to compact masses held firmly by a calcareous cement. In some places small pebbles are found imbedded; also fossil remains of fresh water mollusks, and some insects and bones of mammals are found. The color varies from yellow to almost white, due probably to modified forms of the same material. The thickness varied from a thin coating to 25 feet or more. Where exposures of the loess material occur, the faces are vertical and compact, and any markings upon the face remain well preserved indefinitely. (See photograph of exposures along Wabash River north of Old Fort Knox, Knox County.) How far the material from the Iowan drift extends under the Wisconsin is not known.

Wisconsin Stage.—The ice-sheet of the Wisconsin Stage did not extend into this area except on the very northern boundary of Vigo County, and there are therefore no deposits of this stage covering the general surface of the region. Every stream, however, which led either directly outward from the ice margin, or received water from the tributaries which headed at the ice front carried large amounts of material from the glacier and deposited it to the south of the ice margin.

Across the northwest corner of Vigo County are accumulations of drift material which belong to the terminal moraine of the Wisconsin sheet. The surface material consists of intermingled beds of clay, sand and gravel. This area is more fully discussed under the soils of Vigo County.

The Recent Deposits.—The recent deposits of the area include those which have been deposited since the disappearance of the last ice-sheet. The time has been relatively short and a great amount of work has not been accomplished. The work done has been chiefly a reworking of the surface material, brought about by the action of surface and stream water. Loess, drift and residual have been carried down the slopes and thoroughly mixed. Many of the streams are still cutting in the glacial filling, and in many cases the cutting has not extended sufficiently deep to produce channels to accommodate the waters at the time of excessive floods, and the second bottoms are still overflowed at times and more or less of the fine silty material is spread over the surface, giving a new supply of fertile soil.

Small areas of swamp deposits occur within the area. These deposits consist of silt, muck and vegetable remains, and are found in the broad, shallow depressions in both the lower and upper flood plains, and in the areas of ponds which have become filled, to such an extent that they retain water only in the wet seasons. Artificial drainage is placing all of these areas in a condition for cultivation. Swamps of considerable size are found in the southwest part of the area about the cypress ponds, near the junction of the White and Wabash rivers. It will be only a few years until these ponds will all have been drained, and the last of the cypress growth will be destroyed. Most of the cypress has been cut out, but enough remains to say that the cypress is a native of this part of the State, and to give the swamp something of a southern aspect.

Abandoned stream channels of all stages exist from freshly cut bayous to channels almost filled. The filling of the channels is at first rapid, because of their connection with and close proximity to the rivers. According to a report in the Patoka Folio of the United States Geological Survey, filling of silt amounting to 6 inches in a season have been recorded. In addition, large quantities of drift wood are frequently washed in, and fallen trees add their remains to the accumulation. In the latter part of the filling the deposition is less rapid and consists mainly of silt and vegetable matter, being very much like the swamp deposits except in the shape of the area.

DRAINAGE.

The principal streams are the Wabash, White and Eel rivers, Busseron Creek, Turman's Creek, Sugar Creek, and Croy's Creek. These streams and their tributaries give a large acreage of alluvial soils, which are chiefly of fertile types, and capable of being well drained. The alluvial soils have been derived in part from the glacial drift, and in part from the formations through which the streams have cut their way. The principal streams afford a good water supply for all purposes and offer opportunities for good water power sites along their courses, and the Wabash and White rivers may be made navigable for many miles. The various streams are discussed under the counties through which they flow.

GENERAL.

The counties included in this area are of special importance from several standpoints. In addition to the many soil types of great fertility, these counties rank among the first in the production of coal, and the manufacture of clay products. The transportation facilities are good. There are good railroad lines, and each county has at least one interurban line, with others soon to be built, and the public roads are in general well improved. The Wabash River is navigable to some degree for small boats, and these are made use of locally for various purposes.

The cities of Terre Haute and Vincennes are important manufacturing and commercial centers. Brazil ranks third in population and industries. The next in order of their size are Sullivan, West Terre Haute, Bicknell and Shelburn, with several following close, but none with a population of two thousand.

The total population of the four counties is 192,000, giving an average for the entire area of 108 persons per square mile. Counting out the total city and town population, which is about 114,950, the rural population is 45 per square mile. The total farm area is about 1,024,000 acres, of which 835,150 acres are improved. Sullivan County has the highest percentage of improved land. The improved land sells at a price ranging from $50 to $200. Much of the land not so well improved is valued at $20 to $35 per acre.

CLIMATE.

The climate of the area presents no marked extremes in either temperature or precipitation. The conditions run about the same from year to year. The winters in general are not severe, nor is there excessive heat in the summer. The present winter has had the lowest temperature and also the greatest range in temperature of any for a number of years. There are many hot days in summer, but there is usually sufficient air movement to prevent an oppressive effect. The snowfall is light and does not remain on the ground for any length of time. The ground seldom remains frozen more than a few weeks at a time and a February thaw is always expected. The average growing season is between five and six months.

The climatic conditions as shown by the records at Princeton, Gibson County, will be of importance to the southern part of the area of this Survey. The record was furnished by Elisha Jones, who has acted as signal service reporter for twenty-eight years.

The coldest weather recorded at Princeton was on January 5, 1884, with 24° below zero. The highest temperature recorded was 120°. The greatest amount of snowfall in one year was five feet, seven inches during the winter of 1880-81.

The Patoka Hills north of Princeton, with an average elevation of about 640 feet, are well supplied with fruit trees, and they seldom fail to produce a crop because of weather conditions. The average time for the first wheat cutting in the county for twenty-six years was June 14th, and the earliest was June 2d. In the summer of 1910, it was June 20th. The greatest yearly rainfall in twenty-six years was 58 inches, the least yearly rainfall was 27 inches, and the greatest amount of rainfall reported for twenty-four hours was 10½ inches.

It will be noted from the following table that the average temperature for December, 1909, was much lower than for December, 1908.

	December, 1908.	December, 1909.	Year 1908.	Year 1909.
Highest temperature	67°	62°	98°	102°
Lowest temperature	14°	-4°	50°	-4°
Average temperature	35°	26°	56°	58°
Rainfall and melted snow	1.5″	3.7″	40.5″	39.5″
Snowfall	2″	6″	14″	.....

December, 1909, was the coldest December. The first snow was on the 7th. The first snow to cover the ground in 1908 was Christmas eve. December, 1911, was much colder than the same month for 1909, but the record is not reported.

The following table from the Weather Bureau records at Worthington, Greene County, which is just to the south of Clay County and just east of Sullivan, shows the temperature and rainfall and the dates of killing frosts:

Normal Monthly and Annual Temperature and Precipitation.

Month.	Temperature. °F.	Precipitation. Inches.
January	....	....
February	31.6	3.61
March	41.2	3.76
April	54.3	3.52
May	62.8	3.78
June	72.4	4.58
July	75.2	3.55
August	73.3	3.68
September	66.6	3.14
October	55.3	2.59
November	42.2	4.15
December	33.0	3.07

Dates of First and Last Killing Frost.

Year.	Last in Spring.	First in Fall.
1897	Apr. 10	Sept. 21
1898	Apr. 7	Oct. 15
1899	Apr. 16	Sept. 27
1900	May 10	Oct. 18
1901	Apr. 21	Sept. 18
1902	Apr. 15	Sept. 14
1903	May 4	Sept. 17
1904	Apr. 21	Oct. 23
1905	......	....
1906	......	Oct. 28
1907	Apr. 21	Nov. 3
1908	May 1	Oct. 3
1909	May 11	Oct. 12
1910	May 14	Oct. 23
1911	May 3	Oct. 24

The frost record at Worthington is not a correct indication of the range of temperature for the entire area surrounding. The station is located in an angle of the river valley where the air circulation is poor. A record for the adjacent uplands would probably show a somewhat longer growing period for fruits and vegetables.

CLAY COUNTY.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Clay County was named in honor of the statesman, Henry Clay, but the name proved to be very oppropriate because of the inexhaustible supply of clay and shale, which has placed the county first in the manufacture of clay products.

The county was organized in 1825, and contains 357 square miles. It is 30 miles long from north to south and from 10 to 16 miles wide. The general elevation ranges between 550 feet to 675 feet above tide. In 1817, Sullivan County was organized out of Knox and included all territory now contained within Vigo and Clay counties and parts of Greene and Owen. When Vigo and Owen were organized in 1818, the former included 132 square miles of the area afterward formed into Clay County. The county is divided into eleven townships: Lewis, Harrison, Perry, Sugar Ridge, Washington, Posey, Jackson, Cass, Van Buren, Dick Johnson and Brazil.

The greater part of the county in its primitive condition was heavily timbered. The earliest settlements in the county were necessarily made on the higher lands, chiefly on the bluffs and knolls along Eel River and other streams. In the early days, the lowlands and flats were too wet for cultivation, and not safe places for the settlements to be made. To David Thomas belongs the honor of having made the original settlement on the bluffs of Eel River, in the autumn of 1818, on what is now the James M. Campbell farm. In 1819, Samuel Rizley came from Knox County and settled at the same location, where on February 13, 1820, Eliza Rizley was born, the first white child born within the limits of the county. Many names among the pioneers might be mentioned with interest, but further concerning the historical retrospection must here be passed by. However, the pioneers of Clay County will not be forgotten. Their labors have been crowned with success, even more than could have been anticipated.

Brazil, the county seat, was founded in 1844, by Owen Thorpe, who had moved a house from the site of the original Harmony, to a point along the National Road three miles farther west. Thorpe was the first postmaster and named the town for Brazil, South America, which was at that time attracting the attention of the world, because of its action in certain insurrectionary movements. The growth of the town from 1845-50 was very slow in population, the government census showing for 1850 a total of 84 persons, and an historical account of that date mentions Brazil as "a small village in Clay County, on the National Road, 16 miles east of Terre Haute." But with the coming of the Vandalia Railroad, and the discovery and development of block coal, the town began to grow rapidly, and in 1857 the town showed a population of 393. In 1873, there was a population of 3,000, and at the present time there is a population of 10,000.

The conditions are very favorable for a great future growth of the city. There are six steam railroads with twenty-four passenger trains daily; one interurban line, with hourly service east and west; more than ten miles of brick street; fifty miles of stone and cement walks; municipal water works with fifteen miles of mains; fifteen miles of sewer; fifty factories and mills which together with the mines employ 2,000 men and 50 women, with a weekly payroll of $40,000. There are seven public schools, a parochial school, and about sixty teachers are employed. There are twelve churches, five banks, and three building and loan associations. Among the industries may be mentioned six bakeries, nine brick and tile mills, three carriage and wagon factories, two cigar factories, four lumber yards, flour and grist mills, five machine shops, overalls factory, fence factory and piano factory.

In addition to the above factories, two others built during the past year are of great importance—a concern of large capacity for the manufacture of tin cans and containers, located in the northwest part of the city, and a foods product plant situated near the piano factory on the east side of the city. The factory is for the canning of tomatoes, corn, and other products, the making of catsup, and various other products. The establishment of such factories should be a great benefit to the city and the surrounding country. Hundreds of acres which have been yielding but small returns can be made to produce excellent yields of special crops.

The Commercial Club has brought much new business into the city and county during the past few years and now offers free sites and financial aid to manufacturing industries desiring to locate in this region. The availability of good steam coal at a low price makes the location attractive.

The clay industries located about the city, none more than two miles distant, give employment to 1,100 men. A population of at least 5,000 thus gains its support from this industry. Adding to this those who are engaged in the mining business, the dependence of the town upon the natural resources is readily seen. The output of the factories, clay plants and mines are marketed in every State of the Union, but chiefly within a radius of 200 miles. The great development of business has come about in less than twenty years. Prior to that time, with the exception of the Weaver Clay Company, the trade was only local and in comparison with the coal business was insignificant.

The city has now an excellent water supply from a series of eight or ten deep wells. Various tests and chemical analyses of the water have shown it good. A striking test of the adequacy of the supply was furnished in the summers of 1908 and 1911, when many cities suffered water famines. In Brazil the supply showed no signs of failing and no restrictions were placed upon the liberal use of the water for all purposes. Many private wells also furnished abundant supplies for various uses, and are used to a considerable degree for drinking water, but from a sanitary standpoint the water from the city supply is much safer to use.

A number of substantial and modern buildings have been erected within the past few years, both in the business and residence districts. The city has an assessed valuation of about $4,000,000. A splendid federal building is now being constructed, which will add greatly to the city's advancement.

Much dissatisfaction over the county over the location of the county seat (at Bowling Green) caused hard feelings, and on January 25, 1879, after a new court house had been erected at Brazil the records were removed by wagons to the new court house, which building has served until the present year. An attractive new edifice is now being built on the same site.

Knightsville, with a population of 1,080, is two miles east of Brazil, just to the south of the National Road. The Vandalia Railroad passes through the town, and a station on the Terre Haute, Indianapolis and Eastern interurban line is situated about a half mile to the north of the town. There are two schools employing five teachers; about twenty-five stores, including all classes, and the amount of business transacted is good for the size of the town and its nearness to a larger center. About 400 of the residents are employed in mines and factories outside of the town.

Harmony, with a population of 1,500, is on the National Road, three miles east of Brazil. The original town plot was laid out in 1839, but this was afterward vacated. About 1864 a new plot was laid out by Isaac Marks. The early growth and development was due largely to location of the Planet Iron Furnace, about a mile northeast of the town. This furnace gave employment to 50 or 60 men, but was in operation only five or six years.

The Vandalia Railroad and the interurban line both pass through the town. There are several stores, some of which are well stocked and carry on a considerable amount of business. It is a good residence town, and is well situated to grow as such. It is the largest unincorporated town in the county, and is said to be the largest town of the name in the United States.

Carbon, with a population of 493, is located six miles north of Brazil and is on the main east and west line of the Big Four Railroad and on the Midland line which comes in from Brazil on the south and gives connection with several points to the north and east. The Big Four line is double tracked from Indianapolis to Terre Haute, and has a heavy traffic on both freight and passenger service. The Midland is an old line doing freight business, with some mixed trains for passenger service.

There are about fifteen stores, one lumber yard, one public school, three churches, one state bank, one brick and tile mill, and one clay plant with a capacity sufficient to give employment to 150 to 200 men, but the plant is not in operation. The town owes its origin to the mining industry, but the mines in the immediate vicinity have been pretty well worked out. The town was founded in 1870 by the Carbon Block Coal Company. The surface of the surrounding country is fairly well improved and the soils will admit of successful cultivation. The best agricultural possibilities have not been reached, but there is a great opportunity for development, and the town would furnish an excellent location for grain mills, canning factories and similar industries.

Cardonia is a little village situated about half way between Carbon and Brazil. It has a population of about 200.

Benwood, one mile east of Cardonia, exists now only in name. In former years a little village sprang up when the mines in that region were in operation.

Marysville is the name applied to the part of the town of Lena lying on the south side of the railroad. The stores and the postoffice are in Parke County. The railroad station is on the county line. The population is about 200. It is four miles east of Carbon.

Perth, with a population of 250, is a mining town on the Big Four Railroad, three miles west of Carbon. There are a few stores, a good public school, and a new railway station. The dwelling houses as a rule are not substantially built.

Prattsville, or Lodi, in Dick Johnson Township, is now nothing more than a place name.

Staunton, four miles southwest of Brazil, has a population of 750. The past few years have made some changes in the town. Several new buildings have been erected and during the past year a new school building was built, and a three years high school is maintained. The town is on the old line of the Vandalia Railroad, and is a little more than a mile south of Staunton stop on the interurban line. There are now no factories in Staunton, but there are chances for development in the various raw materials of the surrounding country.

Cloverland is a small village of about 200 people, six miles west of Brazil on the National Road and the interurban line. There is one general store, a postoffice and a number of good residences.

Turner, or Newberg, is a little village on the old line of the Vandalia, about midway between Brazil and Staunton.

Cory is a small town of 300 people in the southwestern part of the county on the line of the Evansville and Terre Haute Railroad. The principal industries are a sawmill and a lumber yard, a flour mill and a broom factory. The town is surrounded by an excellent farming region, and is an important marketing and trading center for the surrounding country.

Coalmont, in the southwest corner of the county, was founded by John R. Walsh in 1900, and was so named after its location in the coal belt and in an area of higher elevation than the surrounding points. The town now has a population of 650; several good mines are near and it is probable that the town will continue to grow.

Howesville is a small village in the extreme southern part of the county, seven miles southwest of Clay City. It is on the new line of the Monon and is well situated to make a good growth.

Clay City is in Harrison Township, eighteen miles south of Brazil. It is the principal town of the southern part of the county. It was first known as "Markland" or "The Y," but when the postoffice was established was named Clay City. It owes its origin to the fact that a twenty-six mile line of railroad built out from Terre Haute had its terminus at this point instead of extending to the old town of Middlebury. The town was founded in 1873. It is on the E. & I. Railroad and the new line of the C., I. & L. Five rural mail routes go out from the town. The chief industries are two grain elevators and feed mills, lumber yards, machine shops, sawmill, two tinshops, a canning factory, a pottery, two brick and tile plants, the largest of which is not in operation at present. An attempt has been made during the past season to secure a creamery here, and it is reasonably sure that it will be established. There are about twenty-five stores of various kinds. A large new school building was erected during the past year. The town is in good condition for a substantial growth if enterprises can be secured to make use of the materials at hand.

Middlebury, about a mile south of Clay City, is one of the early towns of the county. It is situated on an elevated tract of land, about one hundred feet higher than the town of Clay City. The town has a population of about 350.

Saline City, six miles north of Clay City, is located at the junction point of the main line of the E. & I. Railroad with the Brazil Branch. The town was laid out in 1872. It marks the site of encampment of two companies of Indiana militia sent out to protect the canal property at the time the canal reservoir of Birch Creek was being constructed. (See account of Reservoir War in another part of this report.) There are several stores, two or three of which are very good general stores. The town affords a good trading center for the surrounding country. Many excellent farms are found in the region.

Just on the south side of Eel River, about midway between Clay City and Saline City, is the station known as the Eel River Station. There is only a switch, a scale house, a stock pen and a small store. The station is, however, of great importance to a large area of the adjoining county. All grains and other farm products are bought, weighed and loaded on cars for shipment. Grain companies and stock buyers buy the products and do the shipping for themselves. It is proposed to build a grain elevator here before another shipping season. A noted camping place is nearby on the banks of the river. The fertile, rich bottoms give high yields of corn and the adjoining uplands are especially adapted for wheat.

Ashboro, a little village and postoffice, is on the Brazil Branch of the E. & I., ten miles south of Brazil. The town was named from Ashboro, North Carolina, and not from the location of certain ash trees as the name might indicate, and as is the general impression. The population is about 300. The town is located about the center of the county. Two or three good general stores furnish supplies for the vicinity. A sawmill is practically the only other industry. Many of the residences about the edge of the town are on farms of considerable size and great fertility. Some good timber is still found in the vicinity. Just to the south edge of the town is the fruit farm of Isaac Sharp. Much of the fruit raised is shipped to Brazil and other points.

Center Point is located in the central part of the county, eleven miles southeast of Brazil, on a branch of the Vandalia Railroad. It has a population of about 425. Four rural routes go out of the town. The principal industries are brick and tile factory, flour and grist mill, a sawmill and a canning factory. It is a good residence town and is well situated to furnish desirable home locations.

Asherville, a small village, is situated on the Center Point Division of the Vandalia, six miles southeast of Brazil. It affords a good trading center for the surrounding country.

Stearleyville, now a place name only, was formerly a postoffice. Whittington, four miles southeast of Brazil, was also a postoffice location. Pontiac and Bee Ridge are only locality names. Eagles is a stop name along the interurban line east of Harmony.

Prairie City is a town plot and station on the E. & I. Railroad, six miles south of Brazil, has a population of only 64 people. It was named from its location in the Wheeler or Clay Prairie.

Bowling Green, the oldest town within the county, was laid out in 1825. It was the first county seat of Clay County and held this distinction until 1879. The first court house and jail were built in 1827 of hewn logs. A second court house was erected but was burned in 1851; another was built and first occupied in 1853. This building was destroyed by fire in 1910. The county seat has been located at Brazil since 1879. Bowling Green has a public school employing three teachers, three churches, a flour and grist mill, a furniture factory and a sawmill.

There is no railroad through the town. A few years ago a line was in the course of construction, passing near the town, but failed of completion after much work had been done. The nearest railroad accommodation is Center Point. A hack line operates between the two towns.

Poland, the only town in Cass Township, is six miles north of Bowling Green and a half mile from the Owen County line. It is located in a good agricultural region. This part of the county was settled chiefly by Germans, and their thrift has shown upon the development and improvement of the farms. A large German church is situated one mile south of the town.

General.

The growth of the county may be readily seen from the following concerning the population and industries: The population in 1836 was 1,616; in 1840, 5,567; in 1850, 7,000; and in 1910, 32,535. An old historical report of 1850 gives the following information: "There are seven stores, four lawyers, twelve physicians, twelve preachers, four grist and sawmills and the usual proportion of the different mechanical trades. The surplus articles for exportation are wheat, hogs, cattle and horses." The total farm area is 212,036 acres, of which 165,553 acres are improved. The value of the total taxable property of the county is $14,866,000, of which the farm land and improvements amount to $6,267,675. Land sells on the average for about $50 per acre for farming purposes, but commands much higher prices when underlain with coal deposits. The price for the best of the land is from $300 to $500 per acre.

The chief crops grown in the county are wheat, corn, oats, and rye. The county produces annually about 800,000 bushels of corn, an average of about 25 bushels per acre; wheat 245,000 bushels with an average yield of 12 to 15 bushels, with an occasional yield of 30 to 40 bushels per acre; oats 226,700 bushels, ranging in yield from 10 to 25 bushels per acre; some small patches of buckwheat are grown and produce on the average of 10 bushels per acre; about 100 acres of rye are grown annually and give a yield of about 10 bushels per acre; timothy about 36,000 tons, a yield of from one to 1½ tons per acre. The county ranks among the ten leading counties in the State both in acreage and production of timothy hay; about 5,000 acres of clover are grown, giving a yield of about a ton and a quarter per acre. Some seed is hulled, but the production is very low; the average yield for the county is about 700 bushels, which is less than one bushel per acre for the amount thrashed. Alfalfa, about 50 acres, yielding on the average about three or four tons per acre, with some exceptional yields of six and eight tons per acre, when the soils were limed and the best care taken in the harvesting.

From 450 to 500 acres of potatoes are grown and yield from 50 to 60 bushels per acre. Tomato growing promises to become of considerable importance. A large acreage was planted during the past season, but it is difficult to estimate the yield for a good season since the season of 1911 was so very dry that the crop could not mature. For a few years past, about 250 acres have been grown and yielded from two to three tons per acre.

Peas grow well, and an increasing acreage is being grown each year; about 460 bushels of onions are grown, giving about 75 bushels per acre. All small fruits are grown to some extent. About

8,000 bushels of berries of various kinds are grown annually, giving a yield of about 125 bushels per acre. Small areas about Brazil, Cloverland, Ashboro and Clay City are devoted to truck farming and the growing of small fruit. The soils are well adapted to this purpose, but so far the interest taken in the production of such crops has not produced yields by any means sufficient to supply the county's demands.

Clay County has not reached its highest development.

Coal mining has been the principal industry of the county. At present the county does not stand at the head of the list in the production of any of the farm products, and in some of the grain crops it ranks but seventieth among the 92 counties. Some Indiana soil has produced 150 bushels of corn per acre; some in Clay County has produced 80 to 100 bushels, but the average crop is only 25 bushels. There is great opportunity for growth and development along this line.

Dairying offers to be a paying enterprise in this county. In the north central part of the county a considerable number of cattle are kept which furnish milk supplies for Brazil and Terre Haute. An attempt is being made at present to establish a creamery at Clay City. The locality is a very favorable one for this industry.

The land about Clay City is specially adapted for cattle raising and dairying. There are at present very few farmers in the locality who keep more than two or three cows, a few have six to eight, and a number have one or none. One of the principal needs in the keeping of cows is a good supply of summer feed. All about Clay City and chiefly to the east and south are hundreds of acres of land which are practically without use, and could readily be made to yield good returns as pasture land.

The yield of the grain crops per acre is low on the majority of the farms, and the chief reason is that the soils have been depleted by continual cropping.

All produce raised is marketed from the farms and all organic matter and available plant foods are destroyed. If enough cows were kept on each farm to eat the crops produced, the material taken from the soil would be restored through the manure.

In times when a large amount of humus was being restored to the soil through the application of barnyard manure, there was no need for commercial fertilizers, but grain crops began to fail in their production. The cause of this diminution of course was the incompleteness of the returns of the soil ingredients taken off by the crops, when they were exported to the cities or other regions. Such a condition led to the discovery of mineral fertilizer. The only possible substitute for stable manure is found in green manuring with leguminous plants conjointly with the use of mineral fertilizers. If such crops are grown on the farms to keep up the soils, a double value may thus be secured by pasturing and feeding cattle on the crops. The use of commercial fertilizers alone leads to the depletion of humus substances which renders the proper tilth of the seed bed impossible and causes a compacting of the surface soil which no tillage can remedy. While manure is valuable because of the chemical composition it is well understood that its efficiency is largely due to the important physical effects it produces in the soils. The manure also acts readily upon the bacterial activity of the soil. It renders the soil ingredients more available and imparts to the soil the loose condition required in a good seed bed.

The establishment of a creamery in Clay City will be one of the best things which could be done to assist in the proper agricultural development of the surrounding country and bring about the fertilization of all the land.

Transportation facilities.—In general, the railway facilities of the county are good. Some parts of the county are, however, somewhat handicapped by lack of railway transportation. The C., C., C. & St. L., or Big Four, Railroad crosses the northern part of the county, with a double track line; the Pennsylvania Road (the Vandalia) crosses from east to west through Brazil, is also double tracked. These lines run almost straight east to west across the county. The Vandalia has branch lines, the old line passing to the southwest from Brazil through Turner, Staunton, and back to Terre Haute. The Center Point Branch from the main line extends south to Asherville and Center Point. Several other branches and switches lead out to the various mines and clay plants. The Central Indiana (Midland) now operated by the Big Four and Pennsylvania Lines, extends from Brazil north through Carbon and connects with points north and east.

The C., E. & I. runs north from Brazil and extends through the northwest part of the county. This road joins the main division at Momence, Illinois. A main branch of the E. & I. or E. & T. H. extends from Terre Haute through the southwest part of the county, passing through Cory to Saline City, where it forms the junction with the Brazil branch, and extending south through Clay City, then turning to the south and east to Worthington and then in a southwestern direction through Washington to Evansville. The C., I. & L. (Monon) comes into Clay City from the east and turns south through Howesville into the Linton coal field; this division connects with the main line at Wallace Junction. The Southern Indiana extends across the southwest corner of the county, through Coalmont, with a branch extending off to the southwest into Sullivan County. The Indianapolis division of the line as planned was partly constructed from Black Hawk, Vigo County, to Eel River near Bowling Green in 1904-05, but operations ceased and have never been renewed. The T. H., I. & E. traction line extends across the county almost paralleling the Vandalia Railroad. It gives hourly service between Indianapolis and Terre Haute, with additional cars between Terre Haute and Brazil. The railroads give good connection with Indianapolis, St. Louis, Evansville, Chicago and many other good commercial centers. A north and south interurban line through the county would be a great benefit; such a line would encourage dairying, truck-farming and fruit growing.

The county has 800 miles of public roads, with 250 miles improved, of which 160 miles are improved with crushed stone and about 50 miles with broken stone with a top dressing of gravel and the remainder with gravel alone. The roads are, as a rule, in good condition, and the farmers are well satisfied with their investments in improved roads. Some parts of the county are abundantly supplied with good road material, while other parts have no available road metal.

Agricultural Societies.—The farmers of the county attempted to organize an agricultural society as early as 1853. In the "Eel River Proceeding" of August 27th, the first issue of the paper, the following editorial appeared concerning the organization of such a society: "There is considerable talk among the farmers of the county at the present in regard to the organization of an agricultural society. We hope they may persevere until they accomplish their object. The farmers will find it much to their advantage and should not cease working on the matter until a society is organized. They have a newspaper in the county now to attend to the publishing department, and there is no excuse for any further delay."

In the meeting which followed it was decided to hold the first fair at Bowling Green. The movement met with success and the fair was held the next year at the same place. The following year the fair was held at Center Point. The fair was held at this place for five years; then in 1862 new grounds were secured at Bowling Green, but with the public attention being absorbed by the Civil

War the fair was abandoned for several years. In 1869, the county was in a joint organization with Owen, Monroe, Morgan, Greene, Putnam, Lawrence and Hendricks counties and the fair was held at Gosport. Township fairs were held at various times and places during the years 1857-1860.

In 1878 the Clay County Fair Association was organized. In 1882 the "Clay City Industrial Fair" held a three days' exhibition near Clay City. Following this the "Harrison Township Agricultural Society" was formed. This organization was established at Brazil, but the organization passed out of existence a number of years ago and the grounds have been plotted in city lots.

A farmers' institute has been maintained for the past twenty-five years and meetings are held at various places in the county. In 1908 the society was organized as the "Clay County Farmers' Institute Association." The meetings are usually well attended. Good speakers on various agricultural questions are secured for the meetings. The general discussions which take place in the meetings are of much importance. The exchange of methods among farmers themselves should be an important phase of these meetings. There are some of the best farmers, however, who do not take interest in the meetings, for the reason that they do not feel that the meetings are of any special value to them, but these are the very ones who should be encouraged to give their methods to others. Another class not much interested is the poor farmer who does not have faith in new and up-to-date methods for the reason that he has not seen the thing demonstrated and is not of a progressive nature to seek for a better plan. The institutes are therefore chiefly attended by the wide-awake, and medium well-to-do farmer.

The Boys' Corn Club has created considerable interest during the past few years. The Woman's Auxiliary was organized at Clay City in 1907.

Physiography and Geology.

Topography.—The surface is principally level or slightly undulating. The rougher portions are found along the principal streams, chiefly Otter Creek and its tributaries in the northwestern part and across the central northern; Croy's Creek in the southeast, and along the immediate border between the bottoms and uplands along Eel River. The elevations range from 550 feet to 700 feet on a few points.

Although the present surface is fairly uniform, the drill prospecting and coal mining show that the old preglacial surface has been pretty thoroughly dissected, and if the present surface could be removed, deeply eroded channels with intervening ridges would be characteristic of the topography. These channels are of special concern to the mining industry. The amount of coal underlying a tract of land is uncertain, and much drilling and prospective investigation within the mines is necessary to determine the value of coal properties. "Some of these hidden channels have been revealed by mining operations or the drill. Thus near Carbon, Section five (13 N., 6 W.) three old channels exist, running southwest, one passing a short distance east of the Litchfield shaft, the other two, some 100 feet or so broad, crossing the property of Eureka No. 2 shaft, cutting out the upper coal. South of Carbon drillings are reported to have revealed a broad channel crossing Section 7 (13 N., 6 W.) and running south on the top of the hill west of Otter Creek, then still south to the west of Brazil, then turning and passing south to Turner, Section 11 (12 N., 7 W.) and going west into Vigo County. In like manner these old valleys have been met in all parts of the county."*

At the Leachman Gravel Pit in the southeast quarter of Section 12 (13 N., 7 W.) the deposit seems to be a preglacial channel. To the east and west, coal is found at the same level as the gravel and sand. Well drillings and mine shafts show the deposit to be at least 100 acres in extent, with a thickness of 10 to 50 feet. The pit is opened along the bed of a small stream, where the gravel is covered with only from three to five feet of soil and clay, but outside the valley the covering is from 15 to 30 feet thick.

Geological Formations.—The surface formations of the county consist of the Huron, the Mansfield and the Coal Measures.

The Huron comprises an area in the eastern part of about eight square miles along the valley of Eel River and Croy's Creek, and to the east where the Mansfield sandstone has been eroded away. The Huron formation consists of a series of shales, sandstones and thin bedded limestone. None of this formation is well enough developed to be of any economic importance in the county. The shales have contributed somewhat to the soils of the hillsides and the stream bottoms of the area.

The Mansfield sandstone is a massive, coarse to medium grained sandstone containing, usually, considerable iron. It is the surface over an area of about 50 square miles. Its greatest thickness is about 75 feet. At the base is a rather persistent layer of black,

* G. H. Ashley, Report State Geologist, 1898, p. 520.

coaly shale. The streams through this area follow very closely the outcrop of this formation and are cutting down the dip, so that in many places vertical or overhanging cliffs are produced. The finest scenery within the county is developed along the exposures of the stone. At several points it is of sufficient purity to be a source of glass sand and a number of investigations and analyses have been made for the purpose of interesting persons in the development of this industry. Near Bowling Green are some fine examples of glacial scoring upon the surface of the Mansfield. The weathering of this formation has been the source of much of the sand content of the alluvial soils of the county.

The coal measures proper consist of a series of sandstones, shales, coal, underclays and thin bedded limestones. These are the economic rock of the county. The shales, underclays and coal have been the natural resources which have developed Clay County. The limestones are good for road metal and railway ballast.

The following sections will show the nature and thickness of the soils and the various members of the geological formation.

Section at the Simpson Mine and Clay Factory, Two Miles West of Carbon.

	Feet.	Inches.
Soil and surface clay	2	0
Yellow surface clay	4	0
Gray to yellow, shaly sandstone	17	0
Coal IV	3	10
Under clay	6	8
Blue to gray shale	28	0
Coal III	3	2
Under clay merging into sandstone	7	0
Total depth	71	8

Open Pit on the John A. Wells Farm, One-half Mile Southwest of Carbon.

	Feet.	Inches.
Soil	1	6
Yellow clay	5	0
Blue clay and sand, "Joint clay"	4	0
Blue gray shale	4	4
Coal IV	4	1
Under clay	6	2
Total depth	25	1

This pit gives an excellent view showing the contact between the different materials; the overlying soil is a typical, fine grained drift clay, free from impurities.

Section at the Shaft of the American Sewer Pipe Company.

	Feet.	Inches.
Soil, yellow clay	12	0
Bowlder clay	7	0
Gray clay shale	33	0
Coal	2	3
Under clay	3	2
Blue clay shale	19	0
Shale, dark bituminous, fossiliferous	1	6
Coal	3	6
Under clay	5	4
Total	86	9

Section at Open Pit of the Chicago Sewer Pipe Company, South of Brazil.

	Feet.	Inches.
Surface soil and clay (stripped)	1	6
Reddish yellow drift clay	8	0
Decomposed shale and reddish clay mixed.	5	0
Drab to blue clayey shale	10	0
Coal V	0	4
Under clay	5	6
Total	30	4

Section on the Wm. T. Jenkins' Farm, Three-quarters of a Mile South of Center Point.

	Feet.	Inches.
Soil and yellow clay	9	0
Gray sandy shale and sandstone	4	6
Blue clayey shale	14	6
Coal IV	3	0
Under clay	3+	0
Total	34+	0

Section of Open Pit of the Clay City Brick and Clay Company, Three-fourths Mile Southeast of Clay City.

	Feet.	Inches.
Soil and yellow surface clay	15	0
Blue clayey shale	16	0
Coal V	2	10
Under clay	8	0
Total	41	10

Drainage.—The drainage of the county belongs to two systems. The north and south forks of Otter Creek drain the northwestern part of the county and flow into the Wabash River. The rest of the county is drained by Eel River and its tributaries. Eel River joins White River at Worthington. The angle at which the junction is formed is a great hindrance to the successful flow of the waters from the Eel River system. The waters are discharged almost directly up the channel of White River, and consequently the flow is checked, and also when high waters come down the White River the waters are backed up into the Eel River channel often causing disastrous overflows in the valley of the latter stream. An attempt will be made to straighten the channel at this point and thus aid in the drainage of the Eel River flats, both in Greene and Clay counties. An old dam at the mouth of the river is also a source of serious trouble to the outlet. This point is boosted for its water-power facilities, but the clearing away of all obstacles in order to secure better drainage of the farm lands will be of much more value than all the income to be derived from water power.

It is unfortunate that the name Eel River has been applied to two streams within the State. The river here being considered should not be confused with the Eel River which enters the Wabash at Logansport.

Eel River has a length of about 100 miles. The east fork known as Mill Creek, which rises in Hendricks County, crosses the corner of Morgan, and traverses the limestone region of Owen County, is about 40 miles in length; and the west fork, Walnut Creek, which has its source in southern central Boone County, flows across the corner of Hendricks into Putnam, where it crosses over the edge of the Wisconsin drift, is 50 miles or more in length. Below the junction of these forks, the stream has a length of about 45 miles, not including the minor windings of the channel. The distance of flow through Clay County is about 36 miles. The stream follows a very meandering course, and has a sand choked channel. The material is derived in part from the glacial drift, but largely from the heavy sandstone formations exposed along the course and especially in the tributaries. The following description of the Eel River area from the "History of Clay County" by William Travis gives a good account of the attempts to work out safeguards against flood waters, and to establish a satisfactory drainage system. The description also includes the tributaries of Eel River which flow entirely or in part within the county.

"From the point at which Eel River crosses the line into this county in Township 12 north, range 5 west, it flows in a direction west of south until it strikes the rocky bluff at Bellaire, a distance of ten miles on the straight line where it is deflected, then flows in a direction a little south of west until it strikes the foot of Old Hill, another distance of about ten miles on the straight line, where it is again deflected, from which point it flows uninterruptedly in a southeastern direction, a distance of 13 miles to the extreme southeast corner of the county. The entire length of the stream from the source of Walnut to the mouth at Point Commerce, Greene County, including its meanderings, cannot be accurately estimated, but may be approximated at 300 miles. An air line from the source in Boone County to the confluence with White River will measure about 100 miles. Counting from the source of Mill Creek the distance is less. In its tortuous trend, it practically crosses the county twice. At a point just below Bellaire it approaches within half a mile of the Owen County line at Old Hill, within two miles of the Vigo County line, and as it flows out of the county it touches within half a mile of the Greene County line. It divides the county into two very irregular and unequal sections, two-sevenths of the territory lying on the east and five-sevenths on the west side of the stream. In other words, the area on the east is to that on the west as 1 to 2.5. In its circuit from the Rhodes Bluff to the point of its covering the Owen County line, a course of 90 miles, it forms a remarkable triangular-shaped bend presenting numerous equally remarkable horseshoe crooks all along its course. The distance direct between these two points, which are substantially on the same meridian, is but 12 miles.

"Eel River has but comparatively little fall in its course through the county and is therefore a sluggish stream. Assuming the elevation of the source of the stream in Boone County to be 950 feet above sea level and that of the mouth of the river at 533 feet, approximately the entire course of the stream at 300 miles, the fall would be 417 feet, or practically 17 inches to the mile. From the sluggishness of the stream three things are easily deducible; (1) That it affords facilities for navigation. If there be any doubt that Eel River is ranked among the navigable streams of the State in the estimation of the pioneer legislator, it may be removed by the citation of the fact that in 1829 the General Assembly passed an act empowering the board of justice for Clay County to remove obstructions from the channel of the stream as far up as Croy's Mill for purposes of navigation. (2) That its water privileges for manufacturing purposes are but meager. There have been flouring mills and sawmills operated along its course, but at times, in both the wet and dry seasons of the year the stage of the water is such as to render them inoperative. (3) That it readily overflows and inundates the lowlands bordering upon it, which is both an advantage and a disadvantage. While it contributes to the fertility and productiveness of the soil it is detrimental to health and to the crops. The river bottom proper, which varies in width from a half mile to three miles, has been inundated frequently to a depth varying from a few inches to five or six feet. Naturally this overflow accumulates a great deal of drift which tends to the channel as the water recedes.

"For thirty years after the organization of the county, Eel River was crossed either by ford or ferry. Usually during the summer and fall months the stream could be safely forded at all main road crossings. To this there was an exception, which was the crossing of the Greencastle-Carlisle road at Brunswick on the lower course of the stream.

"The first ferry on Eel River was established by David Thomas, a very early pioneer, near Bowling Green, before the date of the organization of the county and operated with but temportary suspension for practically a half century—up to the time of the completion of the present bridge at the crossing immediately west of the town of Bowilng Green about 1870, and did a traffic far beyond that of any other ferry in the county, which was a source of profit to the proprietor. Succeeding David Thomas, this ferry was operated by his son, James P. Thomas, and family, until the time of its abandonment. A ferry was established also at the original old bridge crossing, at Bowling Green, by Elkin and Campbell, in the latter part of 1808.

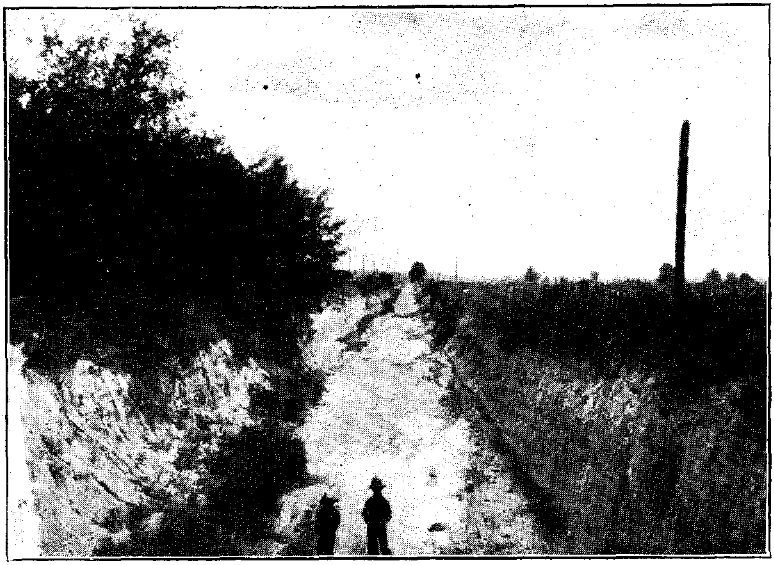
"Parker's Ferry at the road crossing directly west of the town of Poland, at the former Nicholas Cromwell place, was established by William B. Parker very soon after he came to the county in 1835 and was operated at seasons of the year when the stage of water in the stream made it necessary, up to the time of the construction of the bridge crossing, a short distance up the stream in 1872.

"At the Feeder Dam a ferry was operated for a number of years by William T. T. McKee, who located there in business at the time of the opening of the canal, in 1850, which was afterward conducted by Levi Huffman and still later by Jessie A. Allee up to the time of the building of the original bridge at this point, which was completed in 1879. Down the river between the dam and the Old Hill were the Harris Ferry at the mouth of Birch Creek, operated at the time of the Civil War by David Harris, and the Wilkins Ferry a mile above the mouth of Splunge Creek, conducted by John Luther and later by David Lee. First below the Old Hill was the ferry at the Perry Holston place.

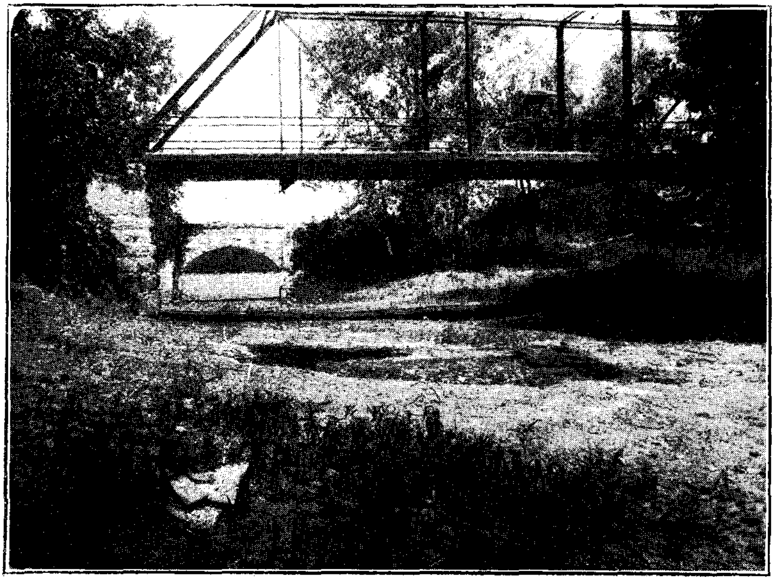
"Eel River basin, that scope of territory drained by this stream, covers an area of probably 1,000 square miles, including practically all of Clay County, with part of Owen, Putnam, Boone, Hendricks and Morgan counties. Tributary to that part of Eel River lying within the borders of this county, including its lower and middle courses, are as many as thirty smaller streams, of which the larger number are affluents from the west side. On either side are three principal branches, Jordan, Six Mile and Big Creek on the east; Croys Creek, Birch Creek, Splunge Creek on the west.

"Jordan has three distinct sources, rising in Jackson, Jennings and Morgan townships, Owen County. The main source is near Cataract. The three branches flow together one mile north of Jordan Village and a half mile east of the county line, the main stream then flowing westward into Eel River at Bowling Green. The surface drained by this stream is uneven and rugged, at places precipitous and hilly, affording sufficient current for motor purposes and the operations of mills of minimum capacity. There have been on this water course as many as four flour mills for the production of breadstuffs and feed.

"Big Creek rises at a different point in the northern and eastern parts of Harrison Township. The basin of this stream blends with that of Eel River, as do the waters of the two streams, so that the shallow confines of the creek are soon overflowed and the proportions of the stream expanded over large areas. So superficial is the bed of this stream at places that it almost loses its identity, its water diffusing promiscuously over the bottoms. However, that section of it known as "the lake," something more than a mile in extent, lying two and one-half miles northwest of Clay City, is a marked exception, of which the well defined banks, depth of channel and volume of water would seem to indicate that it might have been at some time part of a section of a much more pretentious water course. At ordinary water stage, Big Creek forces its way into Eel River through two channels. The natural one flows from the lake to the southwest, entering the river below the old "Eldorado" mill seat; the artificial one known as "the ditch," starting at a point a mile or more north of the Kossuth Road, about five and one-half miles in length, and flowing into the river a little distance above Brunswick. This channel was cut by the State in 1854 to drain the swamp lands when the channel of this stream



View of Guirl Ditch through Pucketts Prairie, Clay County.



Bridge across Splunge Creek at Old Hill. The stone wall and flood-gate up stream from the bridge were constructed to keep back the flood waters from Eel River. The creek bottom is solid sandstone at this point.

was also cleared of obstruction to what is yet known as the Cromwell Place, near the old rose patch.

"Croys Creek rises on the border of Putnam County, three miles northwest of Lena, flowing in a southwestern course across the corner of Parke County line between Lena and Calcutta, thence southeasterly through Van Buren Township, emptying into Eel River immediately above Carpenters Creek. A west side branch of this stream rises near Benwood, runs southeast and makes the junction with the main creek in the northeast corner of Jackson Township. The valley of this creek, like that of the Jordan, is very narrow, bordered at many places by short and rugged hills, the rocky bluffs approaching each other so closely as to leave but gorges for the passage of the stream.

"Birch Creek drains the central part of the county and is the largest tributory of Eel River. It has three or more distinct sources, all of which lie within the county. The east branch of this stream rises near Knightsville, the middle branch near Brazil, and the west branch at several points near Newburg. From the confluence of these three branches, near the iron bridge at the Zenor cemetery in Jackson Township, Birch Creek flows west of south into the river, just below the old aqueduct and directly opposite the former Daniel Harris place. The length of this water course is about 18 miles.

"This stream was named from the profusion of birch timber along its banks. The middle branch of it is known also as "Pogue's Run of Brazil," in allusion to Pogue's Run flowing through the city of Indianapolis, which because of the repeated annoyance and damage by overflows was improved by confining the course and flow of the stream within a walled channel. This stream is to be henceforth controlled and retained by similar improvements.

"Aside from Eel River, Birch Creek is the historic stream of the county, having contributed as a feeder to the Wabash and Erie Canal and having been also the scene of the Reservoir War, on the banks of which was encamped in June, 1855, the army of occupation.

"Splunge Creek rises in Vigo County, flowing eastward in the main across the old reservoir grounds, crossing the line into Clay County a mile or more west of the foot of the Old Hill, at which point it empties into Eel River.

"That part of the county drained by Otter Creek, including all of Dick Johnson Township and parts of Van Buren, Brazil and Posey townships, about one-tenth of the area of the county, does not belong to the basin of Eel River, but tributory to the Wabash. The main creek rises in Jackson Township, Parke County, crosses the Dick Johnson Township line three-fourths of a mile west of the northwest corner of Van Buren and flows across the township into Vigo County. In the southwest corner of Nevins Township, Vigo County, Otter Creek proper is formed and flows thence into the Wabash.

"A quarter of a century ago, the notion prevailed on the part of many of the interested landholders, shared largely by the public, that the practical, effectual, permanent and therefore economical way of averting the overflow and inundation of the large area of the valuable lands in the big bend of the river was to change the course of the stream by cutting a channel through from Rhodes Bluff thereabout to a point below New Brunswick. With this object in view an informal survey and profile of the lands subject to overflow and sought to be reclaimed, conducted by Elias Cooprider, was made in the fore part of 1884, showing an area of 40 sections, something more than 25,000 acres, lying between Rhodes Bluff and the county line above Johnston. Upon the basis of estimate, it was shown also that there could be produced one-half million bushels of corn annually, worth approximately $200,000, on these reclaimed lands. In the month of January following, petitions were put into circulation asking the Legislature to make an appropriation of $40,000 to aid in the excavation of the proposed channel and the straightening of the stream, the cost of which was estimated at $60,000, setting forth that such improvements would reclaim lands, the taxable valuation of which would add $750,000 to the duplicate. The General Assembly, however, did not favorably consider and act upon the memorial. Without the assistance from the State by way of appropriations, the cost of such an undertaking was considered too big and was therefore practically abandoned. But at the session of the General Assembly in 1889, an act was passed providing for the incorporation of associations and the issuing of bonds of drainage, and the prevention of overflows by the cutting of ditches, construction of levees, etc. The cost of such improvements to be proportionately assessed against the land thereby benefited.

"But it was not until ten years later that any concerted action was taken by the disinterested landholders, when within the period of practically six years bonds were issued by the county aggregating more than $100,000 for such improvements. May 18, 1899, for the excavation of the Lafferty Ditch, 20 bonds of $810 each, or

$16,200, were issued; June 1, 1900, for Connelly Ditch, 73 bonds of $500, or $36,500; September 15, 1902, on account of the Lewis Township Improvement Company, 44 bonds of $500, or $22,000; May 16, 1903, for the Old Hill levee, 30 bonds of $100 each, or $3,000; October 7, 1904, for the Guirl Ditch, 40 bonds of $500 each, one of $338.11, and one for $338.16, or $2,676.27; January 16, 1900, on account of the Eel River Improvement Company, 50 bonds of $500 each, or $25,000.

"In times of protracted and heavy rainfalls, Eel River bottom has been frequently covered with floods which have swept the valley from hill to hill. The amount of damage sustained in the loss of property from this cause is dependent largely on the season, but on the aggregate it is incalculable. No season is exempt from these visitations. If the floods come in the summer time, the greatest damage is to the crops. If in winter time, to stock. There are now but few living who were here at the memorable flood of 1847, so that it is impracticable to attempt to give any account in detail of the destruction caused by it. Mention has already been made of the accumulation of drift traceable thereto and of the undermining and washing away of the Anquilla flouring mill.

"The flood, which came the middle of May, 1854, was unprecedented in the suddenness of its rising, reaching the high water mark within an incredibly short time, then receding as quickly, the like of which had never before been witnessed, from the effect of which the farmers of the flooded area did not recover that year. The freshet of July, 1866, immediately succeeding the wheat harvest, was signally destructive of the crops then standing in the shock, which were floated about and lodged promiscuously against fences, trees, and other obstacles at places in heaps by the roadsides.

"The flood tide of 1875 exceeded that of any previous or after time in the history of the county as known to civilization. Following the incessant rainfall of the last days of July, the crest of the flood on the first day of August, Sunday, rose above all known high water marks. Families living in the flooded districts who had not gone to the uplands in anticipation of the worst, who lived in two-story houses were driven to the upper floor and tenants of one-story buildings to the attic and even to the roof for safety. Relief parties in boats ministered to the wants of the imprisoned and distressed, rescuing those whose lives were in peril. Stock which had not been driven to the hills or collected upon a few knolls not covered with the waters was lost, only an occasional straggler showing up after the passing of the flood. The track of the Terre Haute and Southern Railroad between the river and the bluffs of Big Creek was covered with a depth of from three to four feet, boats passing over it in the rowing back and forth. The flood rose to the level of the floor of the wagon road at Bowling Green from 15 to 18 feet above low water mark at that point. Thousands of acres of corn were destroyed. On the higher lands along the course of the stream were hundreds of people on Sunday to witness the scenes attending the swirlings of the flood.

"In the spring and summer of 1882 there were repeated freshets from heavy rains falling at intervals. Corn planting was late and after a large per cent. of the acreage had been once plowed there came another overflow which drowned out the growth, necessitating the replanting of the same acreage, which was not finished until the last days of June. Many farmers abandoned their intended planting. The harvest time of this year was exceedingly wet. Very heavy showers deluged the country, bottom and upland on the 27th and 28th of June, so that the use of machines in the grain fields had to be abandoned, as horses mired down and had to be helped out, farmers resorting to the cradle and rake in caring for the crop.

"The flood of February, 1883, did not lack much of coming up to that of August, 1875. The experience of the population of the river district was but repetitions of those of former years, intensified by low temperature and hard freezing. Schools were closed and all communication cut off from the outside territory. There was much suffering and loss of stock from drowning and being frozen up in the ice, standing in several feet of water, from which relief came only by chopping them out. The distress of the icebound inhabitants was relieved by aid committees from Clay City and other points. The Clay City Independent of February 9th said: 'Notwithstanding the elevation of the tracks of the Terre Haute and Southeastern Railroad across Big Creek bottom, it has been again submerged for considerable distance to the depth of one and a half or two feet. At one place the grade was completely washed out, leaving the track hang as a connection by way of suspension. We had no mail on Monday, no trains crossed until Thursday, hence we had no freight arrivals during the interval between Saturday and Thursday. Cabins in the low bottoms have been filled up to the square and some wholly inundated. In many instances, on second bottom dwellings have been filled to the windows in the lower story, the occupants being driven upstairs. Owing to the cold weather and the ice, stock has suffered greatly. The present indications are that more stock will be lost by this freshet than any one known in this section. The river is reported completely clogged with ice from the bend below the railroad bridge down to Old Hill.'

"Scarcely a year goes by without one or more such rises in Eel River. The conditions and sequences attending them from time to time, including all those of more recent years, are very much the same. At times the actual loss of property and life is comparatively meager. In cases of sickness, human suffering has been aggravated and prolonged from want of medical attention and relief and the burial of the dead delayed from the obstacles interposed. In extreme cases, the corpse and necessary train of attendants have been moved out by canoes and skiffs. Very young and helpless stock, calves, pigs, etc., have been temporarily housed and cared for in the family quarters, in kitchen or parlor until the subsidence of the water. Horses and other stock have been stifled and drowned in their stalls from the sudden rising of the flood tides by night, or in the absence of any one to release them. Small game and vermin inhabiting the bottom lands, driven from their retreats and haunts congregate on the few elevations or exposed points, especially the levees, where they may be taken with but little effort. Scores of rabbits at such times are found pacing to and fro upon the thrown up embankments of the stream, awaiting their fate at the hands of whomsoever may come along.

"As a result in effect from these frequent and sudden rises and flow of the currents there have been many changes in the banks and the corresponding location of the channels by erosion or the washing out of earth at given points, and its deposit elsewhere. In other words, the acreage of land on the immediate banks of the stream have been cut down or reduced by attrition on the one side and enlarged by corresponding accretion on the opposite side. As an example of such change wrought by time and flood, the south bank of the river at the Luther Place, at a point immediately in front of the present residence of ex-County Commissioner Jacob Luther, is now 65 rods removed and north of where it was at the time of the Government survey of lands in 1816. And just below this point, where the railroad company diverted the flow of the stream by cutting an excavation for the straightening of the channel as a precaution to the protection of the bridge, there is now an area of made land, covering the bed of the former semicircular trend of the stream and the nook about which it coursed its way, the force of the swelling tide striking the south end of the bridge. At the angle or bend of the stream a half mile above the Rhodes Bluff at the mouth of Six Miles, a part of the ground on which stood the town of Bellaire is now swept by the flow of the stream. It may be truthfully said that grounds are now being cultivated or pastured along the course of Eel River which at a former time were so utilized on the opposite side.

"The old roadway leading around the bend of the stream east side, a little distance below the site of Feeder Dam bridge, was so repeatedly encroached upon and endangered as to force back the line of travel upon the adjoining lands, the county paying the owners of the premises in the course of years, as by the statute provided, for a considerable acreage so appropriated to the public use. As matter is indestructible and the law of compensation in Nature universally operative, this area of dirt set free by attrition at this point, to the loss of the landholders or the county, was lodged elsewhere by accretion to the gain of some one else.

"No steam craft is known to have ever plied on Eel River. However, it is said that the small boats which used to be operated on White River between Point Commerce and Spencer for light local traffic half a century ago were frequently moved up the mouth of Eel River to the mills operated there. In the extreme south part of the county, near Howesville, is a body of water known as Muir's Lake, which is believed to be a section of the old river bed, Eel River having at some time changed its channel and flowed through this part of the bottom or valley. Other sections of the original channel which are not filled with water are easily traceable. This lake is about one and a half miles in length, extending in the main eastward, and was so named because of William Muir's lands bordering upon it and the family residence standing near it. This body of water is narrow and correspondingly deep at places. The bed of it at places is said to be rock, and at other places coal. The supports of the original bridge at the crossing near the Muir residence are known to have stood upon a solid body of coal. In the early history of the county, D. A. Hill used to take out coal on the banks of this channel for home consumption. It is frequently visited by picnic and fishing parties."

SOILS.

The soils of the county are divided into two general groups, the upland and the bottom land. These groups comprise six distinct types. Of these, the upland type (Knox silt loam) which is derived from the drift material and the loess of glacial origin is the most extensive. The type is a silt loam varying in color from light ash gray through all shades of yellow and brown. It is chiefly a productive soil. The other types of the upland group are of very limited area. The bottom soils include those of the Eel River flats and the lowlands of the tributaries, and the low lying tract known as the "Old Reservoir" region. The bottom lands are confined almost entirely to the southern half of the county. The soils have a wide range of adaptability. All of the ordinary crops are grown, many special crops, truck farming and fruit growing, and each finds a soil specially suited for its needs.

There are many local variations in the soil types, but these are of small extent and are not mapped separately. Where special peculiarities or adaptations occur, mention is made of same in the written report. It is not possible or advisable to make a large number of chemical analyses of soil. Some few complete analyses are given and many partial analyses were made to determine certain qualities. Some analyses are also given of samples which have been collected from adjoining areas surveyed and these will show the uniformity of the types of the different areas. About five hundred samples of soil were taken over the county for various examinations and tests.

The soil types are determined by mechanical analyses. The most important thing to be considered in the determination of a type is the texture, which deals with the size of the particle; the structure, which deals with the arrangement; the organic matter content, origin, color, depth, drainage, topography, native vegetation, and natural productiveness—all factors that influence the relation of soil to crops must be taken into consideration.

The grouping known as the soil class is based on texture. All soils are made up of particles of different sizes and by means of mechanical analyses the particles are separated into different grades and the various percentage relationships determine the class of soil. Seven separations are made which are designated as fine gravel, coarse sand, medium sand, fine sand, very fine sand, silt, and clay. The class may be designated as a clay, clay loam, sand, sandy loam, sandy clay loam, gravelly loam, or a stony clay.

A set of soil classes may be so related through source of material, method of formation, topographical position and coloration that the different types constitute merely a gradation in the texture of an otherwise uniform material. Soils of different classes thus related constitute a series. Soils may, however, be very similar in origin and texture but may occupy so entirely different topographic positions that their relation to crop production is entirely changed, and this fact would be recognized by another serial name. Many of the soil types in any area have been formed by the same general processes and necessarily grade into one another in respect to all characteristics. It will be observed through this report that wherever possible the term used for the name of the various types are correlated with those used by the United States Bureau of Soils in their classification. There will be found in all areas surveyed soils of local origin and of exceptional characteristics, which will necessarily be given local names, but such soils encountered will be placed as much as possible under the general types, but described as to their importance, peculiar qualities, and their behavior under cultivation.

The maps of each county are constructed on a scale of two inches to the mile and in the process of printing are reduced to a scale of one inch per mile. On a scale of one inch to the mile, a square one-eighth of an inch on each side represents ten acres, and smaller areas cannot be well represented. In many cases terraces are mapped with the valleys. Various markings are used to designate the different soils. On the map all lines such as roads and boundaries are necessarily exaggerated, since a mark one hundredth of an inch wide on the paper will represent a width of nearly fifty-three feet on the ground. In many cases the boundary of a soil type can only be mapped approximately because of gradual gradations or from errors in the base map.

The soil maps are as fairly accurate as can be constructed from the base maps available, and other data which may be found. It is always necessary to be continually checking up all errors which are encountered in the field, but often these errors cannot be remedied unless a plane table outfit be used and a traverse base map constructed in the field. The soil maps should show all township and section lines, roads, both earth and improved, towns, railroads, churches and schools. It is not necessary to attempt to construct a topographic map, but areas rising to considerable distance above the surrounding country and distinct bluffs or the occurrence of a hill in a level tract, such as cut-off hills and lost ridges should be indicated by some special markings.

The following table gives the names of the various soil types and the area occupied by each:

Knox silt loam	212
Wabash silt loam	90
Modi silt loam	36
Wabash clay loam	12
Middlebury sand	3
Sioux sandy loam Sandy clay loam	4
Total	357

Knox Silt Loam.

The Knox silt loam is the same as the Miami silt loam described in former reports. It is the most extensive type in the county. It is the common "yellow clay" seen exposed in ravines and along public roads and railway cuts. This soil is derived from the drift and loess material. In many places the soil is greatly modified by the residual materials which enter into its composition. Where the underlying rocks have entered into the making of the soil, the sand content is usually higher than in the true silt loam.

The topography of the area occupied by this type is in general almost level to slightly hilly. The hills are low and rounded, with gently sloping sides, and intervening valleys are broad and flat. The only abrupt hills occur along the immediate border of some of the streams. The rolling topography furnishes good natural drainage. With proper care there is little injury resulting from erosion, but when the soils are neglected it suffers greatly from erosion and large areas of the subsoil are exposed along the steeper slopes.

Great care is necessary to keep the soil of this type in a high state of productiveness, and a good rotation of crops is necessary to insure the best results. The soil is naturally a productive soil, although the organic content is low. By continual cropping the organic matter is soon removed and the soils become depleted.

The soil is a silt loam averaging from 6 to 10 inches in depth and varying in color from a light ashy gray to brown, according to the amount of organic matter present. Much of the surface in a well tilled field is a loose, floury dust, and the clods which occur are light and porous. The soil should not be plowed when wet, or clods of great size and hardness will be formed, which are difficult to pulverize. On old land this is especially true when the organic matter is deficient. The light and dark colored areas are easily cultivated and are the most productive, but in places where the color approaches whiteness the successful cultivation is more difficult and the crop yields are not as satisfactory. Such areas usually have poor drainage conditions. Over the surface will be found little iron pebbles. In some places they are very abundant. They will be most readily observed in wheat fields, where the surface has been washed and beaten down to a smooth, compact condition. These are in some places so abundant as to almost cover the surface. It has been found by examination that these pebbles contain a great deal of the plant food which has been taken up from the soil. Lime concretions are also found. Drainage will stop the formation of these pebbles, and the application of lime and manure will render much of the material contained in the concretions available for the growing plant. Soils from such areas give a strong acid reaction and this sour condition must be overcome before the best yields can be secured.

The soil is retentive of moisture but the surface does not become baked because of the silty texture. In the northern half of the county the subsoil contains much more sand and fine gravel than in the southern part.

Corn, wheat, oats, timothy and clover are the principal crops grown. Much of the rougher land is well adapted to pasture, but only a small number of stock are raised on these lands. Considerable tracts of the area are yet timbered, some with the original growth and some with small second growth. In order of acreage, corn is the leading crop. The yield per acre is from 25 to 75 bushels. The white varieties are grown almost exclusively, having replaced the yellow varieties within the past few years. The farmers believe that the white varieties are much better producers. Some, however, value the yellow varieties the higher. Most of the corn is drilled; some few prefer to check. Considerable fertilizer is being used on the corn, but usually in too limited quantities to produce good results. Usually at least two crops are grown in succession.

Timothy holds second place in acreage, about 22,000 acres being grown on this type of soil, and producing from one to three tons per acre. The crop for the year 1911 was, however, very short, the yield being from one-half ton to one and one-half tons. The hay grown is of good quality. When the meadow is allowed to stand many years in succession, other varieties of grass spring up and spoil the grade of the hay. Most of the hay is baled before being marketed. Usually the hay is stacked in the field and baled later, but some are now having the hay baled in the field as soon as properly dried. This is a labor-saving plan, but balers cannot always be secured. Others have allowed timothy to stand until the seed is fairly well matured, then cutting and throwing up into small stacks for a few days, then thrashing for the seed and baling the hay after the seed is removed. This gives good profit, as much of this hay finds its way into the market as first-class hay and the seed is also sold at good profit. There is some doubt if the seed from timothy cut so early is properly matured so as to give the best results.

Wheat holds third place in importance. This soil is a good wheat soil. The average yield is from 10 to 15 bushels per acre, with some yielding as much as 30 to 40 bushels. Most of the wheat is fertilized. A marked contrast is shown between unfertilized and fertilized. The time for sowing wheat is from September 10th to October 1st. Thrashing is usually begun by the first of July and often by June 25th.

Oats are grown to a considerable degree in some parts of the area, but not to as great a degree as the conditions would warrant. The method of sowing is not very satisfactory in many cases. Some plow the ground and harrow it down in good condition before seeding and then harrow again; others sow in the corn ground of the previous year without even scratching the surface before or after sowing. Good crops may be secured from corn ground by using the disc and then seeding with the drill, or if the ground be loose the drill alone may be used. The average yield of oats is from 20 to 30 bushels per acre; few pieces make as high as 40 bushels. Some attention should be paid to the seed and the method of sowing.

In addition to the grain from the oats and wheat crops, the straw is of much value to the farmer as feed and as a means of restoring organic matter to the soil. Much of the straw is sold from the farm, usually at a price which is a loss to the farmer if he considers the building up of his soil.

Clover of several varieties is grown. The average yield is from three-fourths of a ton to two tons per acre. Some seed is threshed. In most cases timothy and clover are sown together where it is expected to allow the field to stand for meadow. When grown for pasture and fertilizer, clover is sown separate. On some of the rental farms, clover has not been grown for twenty-five years. Clover hay often brings from $10 to $15 per ton, but it is a loss to the farmer to sell it even at that price. It should be fed on the farm as hay or pasture, or turned under as green manure.

Some rye is grown, but farmers disagree as to the value of rye as a soil builder. Some use rye every year, pasturing it in the fall and turning it under in the spring. One farmer states that a spot on which a rye straw stack stood failed to produce corn for fifteen years afterward. Another says one planting of rye kills the ground for two years.

The Knox silt loam is specially adapted to the growing of tomatoes, and the building of canning factories should make the crop become of much value in the county. For the main crop of tomatoes, a fairly heavy soil is desirable, and one which holds moisture well but has good drainage. There is little danger that the soil be made too rich. On the soil for the tomato crop, from 600 to 1,200 pounds of fertilizer should be used to the acre. The fertilizer used should be specially for the crop and should contain nitrogen 4%, actual potash 6%, and available phosphoric acid 7%.

Truck farming can be made a profitable industry on this type of soil. In several places it is being well demonstrated. The fruit and truck tracts about Clay City, Ashboro, Cloverland, and Brazil show good results from this soil. Apples, pears, peaches, raspberries, blackberries, strawberries, currants, gooseberries are the principal things grown in the fruit line. There is a great opportunity for the production of special crops in many parts of the county. The supply is now largely shipped from other localities and at much higher prices than home production would cost. Strawberries bring about $2.25 per crate, currants $2.75 per crate. Blackberries and raspberries average $2.00 per crate for the early and from $1.00 to $2.00 for the last of the crop.

Practically all the fertilizer used in this county is on the Knox silt loam. The most of the brands used run in the 2–8–2 quality for corn, with about 125 pounds per acre. On wheat, some use a brand containing 14 per cent. phosphoric acid, with about 125 to 150 pounds per acre. It is plain that 200 of the brand is too heavy for wet seasons. On this soil a good fertilizer to use would be about 2 per cent. nitrogen, 7 per cent. potash, and 6 per cent. available phosphoric acid, with an application of from 400 to 1,000 per acre. A sod of clover top-dressed with stable manure affords a good basis for corn, and a crop of cowpeas or soy beans is almost as good. The cowpeas and soy beans have not been grown in the county to any extent and should be given a thorough test. When planted on land which has not had clover or peas or other leguminous crops, a plan which will insure good returns is a heavy application of stable manure, reinforced by phosphoric acid and potash fertilizer. A moderate crop of corn of 50 bushels per acre actually takes from the soil 67 pounds of nitrogen, 80 pounds of potash, and 31 pounds of phosphoric acid.

Winter wheat grows best on a rather compact, well drained clay loam. In wheat growing, a proper rotation of crops is very important, and it cannot be expected to derive good results from the use of fertilizer alone without rotation. If the wheat can be made to follow a crop of clover or cowpeas, little or no fertilizer is necessary. A proper fertilizer to use should contain about 2 per cent. nitrogen, 6 per cent. potash, and 8 per cent. available phosphoric acid. From 150 to 500 pounds should be used per acre. Many farmers claim that some varieties of wheat are failing to produce good results, but the trouble would appear to be not so much in the running out of the wheat as in the "wearing out" of the soil. Hundreds of test on red and white, smooth and bearded varieties show no constant differences in their yields and in milling values.

The upland soil should produce a better yield of oats. The oats like the other grains need a liberal supply of phosphoric acid, potash and sufficient nitrogen to secure a medium growth of straw. On this soil 100 to 500 pounds of a 3-5-8 brand should give good results. The oats are usually bothered with smut. This may be largely overcome by placing the seed oats for fifteen minutes in water, which has been heated to 132½° F. and not vary more than two degrees from that temperature.

In clover production, the nitrogen may be disregarded, but the potash and phosphoric acid are important. The plants when well established draw sufficient nitrogen from the air. A crop of two tons per acre removes from the soil 96 pounds of potash and 28 pounds of phosphoric acid. A top dressing of lime is also very important for the clover crop.

The large majority of tests made on the soil samples of this upland type show the soil to be acid or sour. Lime is needed on such soils. The lime hastens the decay of the plant remains in the soil and this aids in the availability of the plant food. It makes sour soil sweet and also improves the physical character of heavy soils. The lime may be applied in the form of commercial lime, waste lime, lime plaster, ground raw limestone or any other form. In the use of raw limestone from two to 20 tons should be applied according to the nature of the soil and the crop grown. Good results have been obtained from such applications.

RESULTS OF MECHANICAL ANALYSES OF THE KNOX SILT LOAM.

No.	LOCALITY.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
21a	½ Mile West of Lena County Line........	Surface 12 in...	.15	.15	1.50	4.55	7.0	75.0	18+
21b	½ mile west of Lena on county line.......	Subsoil 12 in. to 48 in.......	.15	.15	1.05	10.15	11.0	64.0	13.50
22a	2¾ miles west of Lena.	Surface 18 in....	.0	.01	.20	1.05	1.60	86.0	15.20
24a	1 mile north of Eagles.	Surface 12 in...	1.64	.30	1.05	3.25	5.60	75.50	14+
56a	1 mile south of Eagles.	Surface 8 in....	.0	.0	.10	.63	4.50	78.0	16.
63a	1 mile north of west of Staunton...........	Surface 6 in...	.35	.05	1.15	11.0	15.0	60.	12.45
134	Center Sec. 30 Clay City..............	Surface 12 in...	.10	.10	.40	3.05	4.10	77.10	14.0
136	The George Kaiser Clay Plant, Clay City..............	Surface 12 in...	.10	.15	.40	.50	6.0	80.0	14.75
136a	The George Kaiser Clay Plant, Clay City..............	Subsoil 12 in. to 84 in.......	.10	.0	.40	2.80	4.50	92	+
77	¼ mile north of Cory.	Surface 12 in...	.10	.80	.50	1.30	6.25	76.10	13.75
	¼ mile east of Longnacker S. H........	Surface 12 in...	.0	.20	.10	.30	9.0	68.15	21.40
	¼ mile east of Longnacker S. H........	Subsoil 12 in to 30 in..........	.20	.50	.50	.60	3.30	70.25	22.0
121	Owen-Clay Co. line S. Bowling Green...	Surface 18 in...	.40	.50	1.50	5.50	6.50	84	+
114	Center Sec. 3 S. Poland..............	Surface 12 in...	.20	.30	1.20	3.80	4.25	90	+
	2 miles S. W. Nails Mill..............	Surface 12 in...	.40	.50	.50	1.50	5.15	91	+

Analysis of Surface 12-inch Sample Taken One and One-half Miles Northeast of Harmony.

Collector, Shannon.

	No. 5 Clay
Description	"Surface 12"
Reaction to litmus..	Neutral
Moisture at 105°C. from air dried soil....................	0.97%
Total soil nitrogen..	0.054%

Analysis of fine earth dried at 105° C.—

Volatile and organic matter....................	2.75%
Insoluble in 1.115 HCl	90.14%
Soluble silica $(S:O_2)$..........................	0.18%
Ferric oxide (Fe_2O_3)..........................	1.10%
Alumina (Al_2O_3)..............................	4.78%
Phosphoric acid anhydride (P_2O_5)..............	0.09%
Sulphuric acid Anhydride (SO_3)................	0.08%
Calcium oxide (CaO)............................	0.52%
Magnesium oxide (MgO)..........................	0.43%
Potassium oxide (K_2O)..........................	0.14%
Sodium oxide (Na_2O)..........................	0.23%
Total	100.43%

The following analysis is from a mixed sample made up from several locations over the county where this type of soil is best developed. No. 1 is sample of the surface soil, No. 2 of the subsoil, and No. 3 and 4 is a mixed sample of surface and subsoil made up from parts of samples from different parts of the county:

Collector, Shannon.

Description	No. 1 Clay Surface.	No. 2 Clay Subsoil.	No. 4 Clay Subsoil. No. 3 Clay Surface } Mixed
Reaction to litmus	Neutral	Neutral	Neutral
Moisture at 105° C. from air dried soil	1.53%	2.27%	1.58%
Total soil nitrogen	0.040%	0.052%	0.075%

Analysis of fine earth dried at 105° C—			
Volatile and organic matter	2.98%	3.71%	3.60%
Insoluble in 1.115 HCl	87.28%	83.15%	85.92%
Soluble silica ($S:O_2$)	0.21%	0.22%	0.20%
Ferric oxide (Fe_2O_3)	1.86%	2.99%	2.05%
Alumina (Al_2O_3)	6.21%	7.89%	6.95%
Phosph. acid anhydride (P_2O_5)	0.13%	0.14%	0.10%
Sulphuric acid anhydride (SO_3)	0.13%	0.14%	0.12%
Calcium oxide (CaO)	0.59%	0.66%	0.56%
Magnesium oxide MgO)	0.53%	0.82%	0.50%
Potassium oxide (K_2O)	0.20%	0.29%	0.23%
Sodium oxide (Na_2O)	0.41%	0.67%	0.38%
Total	100.53%	100.68%	100.61%

The following tables of analyses are given to show the uniformity of the type over large areas:

MECHANICAL ANALYSES OF COMMON LOESS.

LOCALITY.	Description.	Organic Matter, Per Cent.	Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Clay and Silt, Per Cent.
Mixed Samples—								
No. 45	Surface	1.50	.0	.50	.75	.95	4.10	92+
No. 46	Subsoil	.60	.50	.75	.60	1.05	4.85	91+
Clay Pit South Side Princeton	Surface	2.10	.10	.20	.50	.75	6.00	90
	Subsoil	.50	.25	.50	.80	1.10	7.50	89

Chemical Analysis of Surface of Loess.

Collector, Shannon.
Laboratory number, 45.

Reaction to litmus	V. F. Acid
Moisture at 105° C	2.41
Total soil nitrogen	.125
Carbon dioxide	.....
Analysis of fine earth dried at 105° C—	
Volatile and organic matter	3.655
Insoluble in (1.115 sp. gr.) HCl	88.395
Soluble silica	.031
Ferric oxide (FE_2O_3)	3.211
Alumina (Al_2O_3)	3.911
Phosphoric acid (P_2O_5)	.156
Calcium oxide (CaO)	.279
Magnesium oxide anhydride (MgO)	.398
Sulphuric acid anhydride (SO_3)	.036
Potassium oxide (K_2O)	.245
Sodium oxide (Na_2O)	.254
Total	100.051

Chemical Analysis of Subsoil of Loess.

Collector, Shannon.
Laboratory number, 46.

Reaction to litmus	Acid
Moisture at 105° C	3.54
Total soil nitrogen	.074
Carbon dioxide	....
Analysis of fine earth dried at 105° C—	
Volatile and organic matter	3.398
Insoluble in (1.115 sp. gr.) HCl	84.721
Soluble silica	.073
Ferric oxide (FE_2O_3)	4.641
Alumina (Al_2O_3)	5.283
Phosphoric acid (P_2O_5)	.145
Calcium oxide (CaO)	.231
Magnesium oxide anhydride (MgO)	.477
Sulphuric acid anhydride (SO_3)	.029
Potassium oxide (K_2O)	.372
Sodium oxide (Na_2O)	.192
Total	99.562

Modi Silt Loam.

This soil over the area is a modified form of the Knox Silt loam. In previous reports on the soil survey of Indiana counties it has been included in the regular upland type, the Miami Silt loam, or as used in this report, the Knox Silt loam. In the area of this survey it was readily observed that in the upland soils there was a difference in fertility, state of tilth and productiveness. These areas of the better condition have thus been mapped as the modified silt loam. The topography is as a rule more even than that under the Knox Silt loam, drainage is better, and the general condition is improved. In most places no distinct line can be drawn between the two classes of soils, but it was found advisable to map them separately so far as possible. The general condition as to origin, texture, etc., will be found under the description of the Knox Silt loam.

Low Land Types.

Wabash Loam and Silt Loam.—These types are the soils found in the Eel River bottom and the tributary streams. The soils are mapped together. The soil varies through all grades from loam and silt loam to fine sandy loams. The areas are not well defined, and so far as the mechanical character is concerned the productiveness is the same.

The Wabash loam consists of a light brown to yellowish brown loam about 10 inches deep, containing usually a high percentage of fine sand and in some places some gravel. The darker color is found when the silty content is highest and the lighter color when the sand is more abundant. There is but a small amount of coarse sand and a comparatively small amount of clay. The soil is a soft, fine-grained alluvium, and does not become compact enough to form clods. The amount of organic matter varies. The soil is easily cultivated and produces good crops, especially of corn. This is the principal type found along the tributaries. In most places along the smaller streams there is an increased amount of sand and also of rock fragments which have come in from the upland and weathering bluff. The soil owes its origin to the wash from the uplands; the sand being derived from the disintegrating Mansfield sandstone and the shaly formations along the north and east tributaries.

The subsoil is usually a heavy brownish yellow loam, from 2 to 4 feet deep, overlying a sandy or gravelly loam.

The Wabash silt loam varies from the Wabash loam in the more silty nature and the higher clay content. The soil is about 12 inches in depth, underlain by a heavy silt loam. The soil to a depth of two feet or more is dark brown to black color. In some places the sand content of the finer grades is from 15 to 20 per cent., underlain by a more sandy type. The soft, fine-grained quality of the soil due to the silt and very fine sand gives a loose, open, mellow structure, and any clods found are readily pulverized.

Along the smaller streams, practically all the bottom land is in cultivation and gives good yields of corn, wheat, oats, meadow and truck growing. The greater part of the area is in the Eel River bottom. The valley is from one-half to more than three miles in width. The area is subject to overflow. The most of the material now brought down by the floods is the light yellow silt from the cultivated uplands. In the earlier days of the agricultural development of the county the sediment left after each inundation was much darker in color and doubtless consisted of the humus bearing material from the virgin soils then in process of clearing.

Levees have been constructed along the river and the damage from floods is not so great as formerly. The bottoms from Poland past Bowling Green to about Nail's Mill are in a good state of cultivation and produce excellent crops. Below this point the crops have been repeatedly destroyed by floods until no one feels safe in taking up the cultivation of the land. Natural drainage conditions are bad and good artificial drainage cannot be accomplished until something is done to give a better action to the river. The soil in the lower part is just as good as that in the upper part, except where the stagnant waters have leached the plant foods. The plans concerning the drainage of the lowlands of the county are discussed in another part of this report.

In the better parts of the Eel River bottoms the land is valued at $100 to $200 per acre, but there is little that is for sale even at $200 per acre. Corn yields on the average 50 to 75 bushels. At Eel River station on the Jake Luther farm, a field across east from the station yielded in 1910, 98 bushels of corn per acre, and the prospects were even better this season, July first. It is said that this field had at one time been in corn continuously for fifty years and that the last year it produced 45 bushels per acre. The crop plan the past several years has been corn two years, then sow to wheat in the fall and clover in the spring, then the second spring back to corn. Two years ago the wheat yielded 20 bushels per acre and after the wheat was harvested the crop of clover was cut and 107 bushels of seed thrashed from the 75 acres.

In the summer of 1911 a tract of seven acres, one mile southeast of the station produced 225 bushels, a yield of 32 1-7 bushels per acre. To the southwest of the station on the Weber farm, 75 acres of stalk ground wheat averaged 24.5 bushels. Other pieces as compared with these were estimated at 40 bushels.

Timothy makes a very rank growth on the bottom and is usually of good quality; in wet seasons it is rather coarse. In 1911, the yield was two tons plus per acre, while the upland hay averaged less than one ton per acre. The corn is usually cultivated four or five times, or as long as it can be plowed. It is usually four to eight feet high and tasseling by July first. Clover is often sown in wheat and then turned under in fall for another crop of wheat. In the better grades of the soil a second season stand of clover is too much for the wheat, causing it to grow so rank that it cannot stand until mature.

Much of the land in the bottom is rented and the average yield of crops is thus somewhat cut down. Terms of rent for corn are one-half in the crib, when tenant furnishes everything; in other cases the land owner receives one-third when tenant furnishes all. In wheat, tenant furnishes half, pays half the thrashing and receives half the wheat, or furnishes all, pays all the thrashing and takes two-thirds of the grain.

Throughout parts of the area, sheds are common along the road where tenants keep their horses and tools in working seasons. Wells are also very plentiful. Water is obtained at a depth of from 10 to 30 feet. Some of the tenants move out to shacks or live in tents during the crop season, when leave until the crop is mature.

Many of the landowners have their farms part in the bottom and part in the upland. The best of the hill land is valued at from $50 to $75 per acre. The fertilizer used on the upland is chiefly of the 2–8–2 formula, mixed with bone to insure a stand of timothy. The average yield of wheat on the bottom is 15 to 25 bushels; on the adjoining upland average 15 bushels.

The river bottoms were originnaly timbered. On the second bottoms, black walnut, beech, burr oak, sugar and sycamore were the prevailing types, with some poplar, white oak and buckeye. One sycamore between Eel River station and Old Hill, said to have been so large that when it fell a man could walk in the hollow trunk for 60 feet, and that farmers laid poles up against the sides for shelter for stock, and the hogs slept in the hollow tree. Sassafras and persimmon are very rare on the bottoms. On the first bottom, sweet gum, hickory, white oak and ash are common; cotton wood, black and peach leaved willows, and river maple grow abundantly in the lower bottoms and along bayous. Steel weed, smartweed and horse weed grow rank and dense.

In the valley of Jordan Creek is found some good soils of the regular types, but much of the area is not under cultivation. In the Birch Creek bottom the soils have been pretty thoroughly leached. The surface four to eight inches is usually very white and somewhat compact but pulverizes easily. The crops grown are chiefly in small patches because of poor drainage conditions. Water lilies, swamp grass and reeds are common in the sloughs and bayous.

The fertility of the river bottoms is evidenced by the large cribs, barns, and many good farm residences, the good methods and machinery used and the general thrift of the people. Good drainage conditions would bring about the improvement of a large area and bring much wealth into the county. The contrast is very marked between the different parts of the area, due to the present drainage conditions. During the year 1911 hundreds of acres of good soil were lying idle in the south part of the river bottoms. For the two years past crops put in were destroyed by flood, and the farmers became so discouraged with the conditions that they will not run the risk of putting in the crops. This part of the area should be made just as productive and well improved as the parts farther to the north.

The drainage commission has prepared a full report on the drainage conditions, and this, along with a petition from the landowners, has been filed, and reported on favorably. A new channel is being located, and the cost of the enterprise will be approximately a quarter of a million dollars. At least 25,000 acres of land will be directly benefited. It is expected that the contract will be let for the work during the winter of 1912-13.

The mechanical analyses of the lowland soils are as follows:

RESULTS OF MECHANICAL ANALYSES OF WABASH LOAM.

No.	Description.	Locality.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
126 A	Surface 10 in...	River Bottom Eel River Station......	.0	.3	1.1	29.4	30.2	32.7	6.0
113	Surface 12 in...	S. W. ¼ Sec. 30 N. W. Bowling Green..	.0	.5	2 0	26.5	30.5	32.5	7.5

Results of Mechanical Analyses of Wabash Silt Loam.

No.	Description.	Locality.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
126	Surface 10 in...	River Bottom Eel River Station.......	.0	0.1	0.2	12.4	23.6	50.8	12.7
149Y	Surface 10 in...	River Bottom N. E. Howesville.........	.0	1.6	0.9	6.7	10.4	61.6	18.7

Wabash Clay Loam.

This soil comprised an area of more than 3,000 acres in the southwest corner of Perry Township. The area is known as the Old Rerservoir Region. It lies on the west side of the bend of Eel River, and extends from about one-half mile south of the old Wabash and Erie Canal in Sections 5 and 6 to as far south as Old Hill. In elevation it lies below the 540-foot contour line. Part of the area falls to an elevation of about 520. The low water mark at Old Hill is 525 feet. From this it will be seen that the drainage is a very difficult proposition. In the days of the construction of the canal a levee was thrown up across the valley from about the location of the Junction school to Old Hill. This flooded an area of about 4,000 acres, of which one-fourth was covered with timber, soon in a state of decay. This fact was very objectionable to the people of the vicinity, because of its supposed malarial effects. With the building of the Feeder Dam and Birch Creek reservoirs the opposition was increased to such an extent that the canal company was forced to place the matter before the Legislature and it was necessary for the works to be protected by the State Militia.

The old embankment has been practically all destroyed and at present this part of the course shows, where the old line of the canal existed, only a ditch-like depression almost filled in places and the remains of the old levee on the west side. A public road now runs along the east margin of the old canal.

The following account from Wm. Travis' History of Clay County concerning the construction of the Old Canal will explain the origin of the reservoirs of the county:

"In the year 1827, the Congress of the United States made a grant of lands for the construction of the Wabash and Erie Canal with Toledo and Evansville as terminals. In 1830 and 1831 the Legislature of the State authorized the commencement of its construction and work was actually begun in 1832 on that section lying between Toledo and Lafayette. That part of this thoroughfare lying between the Wabash River at Terre Haute and White River at Worthington was known as Cross Cut. This section crossed Clay County intersecting Perry, Lewis and Harrison Townships. Its course through the country was northwest to southeast, nearly 20 miles in extent. The construction of this canal was a part of the system of internal improvements undertaken by the State. As a summit divide between the White and Wabash rivers lies in this county, in part, both ends of the Cross Cut had to be fed from the waters of Eel River and its tributaries. This necessitated the construction of the Feeder Dam and Splunge Creek reservoirs. The building of the former was commenced in 1837 and completed within two years. At the same time the construction of the side cut for conducting the water from the dam to the main canal was in progress. As the line of this canal lay across Birch Creek, an aqueduct across the stream was built in 1838. No work had yet been done by the State on the lower section of the Cross Cut between the Junction and White River. Owing to the depressing effects of the financial panic of 1837 the State was unable to meet its obligations incurred in the progress of its internal improvements and work on the Wabash and Erie Canal ceased in 1839.

"In 1845, the people along the line of the proposed canal began a general agitation of the necessity for its resumption and completion and petitioned the Legislature accordingly. In answer, on the nineteenth day of January, 1846, an elaborate bill was passed which was supplemented by another in 1847 and operations were resumed the same year. Much of the work which had been previously done by the State was going rapidly into decay. The canal was completed to Terre Haute in the fall of 1849, the first boat arriving on the 25th day of October. Meanwhile the work was progressing in Clay County on the Cross Cut, the Side Cut and the Feeders. Eel River dam and the Birch Creek aqueduct were rebulit. Splunge Creek reservoir was made by throwing up an embankment across the valley from the foot of Old Hill two miles north of the junction of the Side Cut with the main canal. This work was completed in 1849 or early in 1850 and the reservoir filled with water in the fall of the latter year. The Side Cut, leading from the dam to the reservoir, a distance of seven miles, was completed and the water let into it in the spring of 1850. On the first day of May, the water from Eel River first reached Terre Haute through the Cross Cut. As soon as the canal was sufficiently filled to admit of navigation, communication was established between Terre Haute and Bowling Green as slack water on Eel River ex tended as far up as the Thomas Ferry.

"The opening of the canal stimulated business enterprises and commercial activity. At Bowling Green, the head of slack water navigation, the firm of Fuller, Milton and Kennedy, composed of Jesse Fuller, John M. Milton and Joseph Kennedy, built a warehouse just below the bridge, which was afterward converted into a brewery, and also built the canal boat "Belle of Bowling Green," which first went out in August, 1860, in command of John W. Eret, loaded with grain and bound for Lafayette. From this time on the 'Belle' continued to make regular trips to Lafayette and Toledo taking out grain and produce and bringing back to Bowling Green such freights as the local trade demands. After passing from the Side Cut into Eel River, boats were pulled or towed to Bowling Green. As a motive power to facilitate this work, the firm heretofore named constructed a rude tow boat, which bore the euphonious name 'Bull of the Woods.' In 1851, a company was organized to build a small steamer to propel canal boats up from the dam, of which Oliver Cromwell, Sr., was the leading spirit. But from delay of execution the project was abandoned. Some years later, after the dissolution of the firm of Fuller, Milton and Kennedy 'The Ohio,' owned and operated by John W. Eret and John M. Milton, made regular trips up to the spring of 1861, when it went out for the last time, taking a mixed load of produce. This was the last boat ever seen at Bowling Green.

"After the opening of navigation, A. H. L. Baker, who had real estate interests at the bend of the river, three miles south of Bowling Green at the mouth of Six Mile, conceived the idea of building up an important commercial center and resort at this place. Though his plans were much more visionary than substantial, he proved his faith by his works in the building of a large warehouse and a commodious hotel, having a large number of rooms and numerous outlooks, a house of greater proportions and pretensions than any hotel building now in the county. This building, however, was never completed and used as originally desiged. The town which was laid out at this point in 1852 was named Bellaire from the circumstance that Mr. Baker had lived for a time at Bellaire, Hartford County, Maryland. He too engaged in canaling and owned and operated the boat known as Eight O's. The Julia Dean, which was owned and run by James M. Mushett, did business regularly at Bellaire and made occasional trips to

Bowling Green. Mr. Baker was succeeded in business by Lewis Row, who bought and shipped a great deal of grain. In 1857, Nicholas Goshorn and Son located at this point, built a second warehouse, did shipping for several years and continued merchandising up to 1865. Though this town had several stores and a post-office and shops for several years there are now no marks remaining on the site to indicate that it ever existed. At the dam, private investment and improvement began at a much earlier date. The town of Anquilla, at first known as New Amsterdam, was laid out in 1838. As early as 1842 or 1843 the Wines Brothers, Terre Haute, built a large sawmill and flouring mill, and also engaged in general merchandising. The mill was run for several years, up to 1850 probably, when the machinery was removed because of the instability of the foundation from the encroachment of the water. The Wines Brothers were succeeded in the mercantile business by Thomas Harris, and W. F. T. McKee built a sawmill near the site of the former one which he operated up to the time of the abandonment of the canal. Shipping lumber to many distant parts of the country, selling the best quality of poplar and walnut lumber at fifty cents a hundred. There was also a post-office at this point for a period of twelve or fifteen years. This town too has been vacated and the passerby does not now see that a manufacturing business nor a canal feeder ever existed here. Besides Eel River and Splunge Creek, Birch Creek was made to contribute to the water supplies of the Wabash and Erie Canal by the construction of Birch Creek reservoir, in the central part of the county, to which a branch or side cut was made from that confining this body of water, was thrown across the valley from east to west between elevated grounds on either side and was a half mile in length, now the wagon road west from the railroad station. A part of Saline City and a section of the track of the Terre Haute and Southeastern Railroad are now on the site of this feeder. This reservoir was built as late at 1853. The total extent of water transportation in the county, including the side cuts and Eel River slack water, was about 40 miles. From the best information which we have been able to command the Cross Cut was used for a period of ten years, the first boat having passed through from Terre Haute to Worthington in the spring of 1851 loaded with salt, and the last one from Worthington to Terre Haute in the spring of 1861 loaded with flour belonging to Augustus Stark and bound for Lafayette and Toledo."

The area of Splunge Creek was always flooded during the wet season by the overflow of Eel River, and from 1,200 to 1,500 acres were under water except in the drier seasons. The higher portions of the ground were overgrown with a most luxurious growth of wild grass or weeds from two to six feet high, and with the coming of the flood this material was washed down to decay.

The reservoir region was first visited on April 22, 1911; at this time about five sections were under water and it was stated by people of the vicinity that the waters were not so high as they had been for the past three years. Only a very small percentage of the area is ever under cultivation. Much of the ground has a growth of black willow, swamp grasses, horse weed and giant smartweed. Marsh hawks inhabit and nest in this region in abundance. Mudhens, bittern, etc., are plentiful and the area furnishes a stopping place for wild duck and geese in their migrations. Many hunters go to this area, but the inaccessible means of getting over the ponded parts makes hunting rather difficult.

Embankments have been thrown up in various places to attempt to save parts of the area from the water, without success. Splunge Creek passes through the area and several open ditches have been cut, but the outlet is so poor that these ditches cannot perform their work. Several plans for better drainage have been proposed. If the present plan to change the mouth of Eel River is carried out, the water may be successfully carried from the area into Eel River at Old Hill; or if the Connelly Ditch should be cut through to the river and allowed to carry the flood water, the conditions would be helped. A flood gate has been placed at the mouth of Splunge Creek at Old Hill to prevent the flood waters from backing up into the creek and adding to the flood of the area, but this has not proved satisfactory.

Another proposition is to construct a ditch around the border of the area to catch and carry away all the water coming in from the higher land surrounding, and then if necessary use windmills to pump the water from the lowest parts of the area, over into the ditches, where it would be carried away. Under present conditions this would necessitate the cutting off of the mouth of Splunge Creek to prevent the flood water from encroaching by being backed up from the river. There is a tremendous piece of work here for some one who will find a scheme by which the area may be drained. A cost of $10 to $20 an acre for a successful piece of work would be a paying investment to the individual owners and a source of great increase to the county.

In addition to the surface of the area lying below the 540 contour line the area up to the 560 line is frequently too wet for cultivation. On the opposite side of the river a tract of 10–15 square miles is often flooded. In the upper part of the valley about Bowling Green there has been no severe flood since 1875.

On July 12–15 the reservoir region was again visited for investigation by the Survey. All the water was confined to the creek and ditch channels and these were very low and in some places entirely dry. The season was an exceptionally dry one and some parts of the area might have been put under cultivation but for the uncertainty of the crops having a chance to mature. The ground was dried out very hard and cracked about three to four inches below the surface. This layer of soil seemed to represent very recent deposition and the layer separated radily from the underlying soil.

The soil varies in color from ashy gray to white. It is a silty clay loam from six to 24 inches deep. The subsoil is a gray to white plastic to very tenacious silty clay. The surface is very level except for small mounds from one to five feet high. The soil although having a hard appearance is not difficult to pulverize. When a fresh surface of the soil is exposed it weathers into cubical fragments, which continue breaking up until they are very fine. The soil is chiefly the reworked silt loam of the upland type. Many pebbles of a concretionary nature consisting of iron, lime, etc., occur over the surface and in the soil. These pebbles are formed by the leaching out of materials from the soils by stagnant waters.

Very little can be said as to the yields of various crops because of the small amount of farming done within the area. But every indication is that the soils are of a productive type and under proper conditions would give excellent yields.

The areas which were included in the Birch Creek and Feeder Dam reservoirs have soils very similar in character and appearance to those of the Splunge Creek region. But these areas are for the most part well drained and give good crop production. The soils are of a light color, much leached and streaked, but careful cultivation is placing these soils among the best of the county. These areas are classed with the silt loam type. Those of the lowlands and flats with the Wabish silt loam and those of the slightly higher elevation with the Knox silt loam.

MECHANICAL ANALYSES OF WABASH CLAY LOAM.

No.	Description.	LOCALITY.	Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt and Clay, Per Cent.
15	Surface 12 in....	Splunge Creek Reservoir.....	.0	.05	.20	1.25	4.0	93.50
128	Surface 12 in....	S. Saline City Old Reservoir.	0.5	.10	.20	2.0	3.8	94+

Approximate Chemical Analyses for Wabash Clay Loam.

White Soil—Surface 12 inches.

Reaction to litmus............................	Acid
Total soil nitrogen............................	.090
Volatile and organic matter....................	2.819
Insoluble in HCl............................	92.000
Soluble silica	.085
Ferric oxide (Fe_2O_3).........................	1.415
Alumina (Al_2O_3)..............................	2.447
Phosphoric acid anhydride (P_2O_5)..............	.090
Calcium oxide (CaO).........................	.508
Magnesium oxide (MgO).....................	.440
Sulphuric acid anhydride (SO_3)................	.052
Potassium oxide (K_2O).......................	.213
Sodium oxide (Na_2O).........................	.305
Total	99.924

MIDDLEBURY SAND.

The town of Middlebury or Martz is situated on a sandhill, the summit of which is about 100 feet above the general level of Clay City. This sand soil is not an extensive type. It caps the hill over an area of about 80 to 100 acres and extends out to considerable distance with arms to the northwest and to the south. Similar sand also occurs along the bluff of Eel River on the north side at New Brunswick and extending in limited areas to the east and west.

The sand is a medium fine to coarse sand of brown to gray or yellow color. It is usually quite uniform in texture. The subsoil is somewhat compact and grades from yellow to brown in color. Where the soil is under cultivation it is chiefly in truck and fruit, raised for family supplies. Some parts about Middlebury are in field cultivation, as is also the area about New Brunswick. Wheat and oats grow well. Some melons are grown and the soil seems well adapted to this crop. Hay produces well. Some tomatoes are put out for the canning factory at Clay City. This crop grows and produces well. At New Brunswick the sand is on the average about four feet thick. The entire area of Middlebury sand should prove of great value for truck crops and melons and should be devoted to this work.

SUMMARY.

Clay County should become one of the most prosperous agricultural communities. The large majority of the landowners and farmers are progressive people. Many good, substantial farm improvements are being made, good houses, well built barns, and shelter for stock and machinery.

The climate is favorable for all agricultural pursuits common to this part of the country. There are no great extremes in weather conditions. The rainfall is fairly evenly distributed, and the period between killing frosts is about twenty-four weeks.

The greater part of the county was originally timbered. On the lowlands the principal growths were the oaks, ash, hickory, black gum and sweet gum. On the margins of the streams were the sycamores and cottonwoods and on the uplands black walnut, burr, white, red and black oak, hickory, beech, sugar maple and poplar. The undergrowth consisted chiefly of redbud, sassafras, dogwood, pawpaw, blackhaw, hazel, sumac, etc. The timber afforded the material for the principal industries of the early days. Some of these industries were lumbering, chair manufacturing, poplar shingles, hoop-poles, grain cradles, barrels, tubs, buckets, fanning mills, measures, pump stocks and cordwood.

A small sawmill at Ashboro saws lumber for local use and also furnishes a large supply of mine props, consisting chiefly of oak, hickory, birch, beech and elm.

Tile drainage is receiving considerable attention and farmers are well repaid for their work and expense. In general, a tile from eight to 14 inches in diameter is used for the mains and smaller, down to four inch, used for the arms. In best drained areas, 4-inch tile have been put in at every 40 feet, but most generally the tributary arms are about 100 feet apart.

Seepage water and springs occur all along the lines between the upland and bottom land and makes drainage difficult in small areas. This is, however, a good source of water for stock. A large number of ponds in the silt clays of the upland also furnish water supplies. The wells in the county are from 25 to 100 feet deep and the water is as a rule good for drinking and domestic purposes.

It is estimated that 75 per cent. of land in Indiana is rented under various conditions. This lowers the standard and thrift which should be shown among the farming population. Under the ordinary methods of renting, the farms are run down and the tenant takes from the farm all that is raised, all that it is possible to get from the ground. When a tenant has use of the same ground for a number of years the conditions are much better. If the landowner and tenant go into partnership in the farm management, good results are usually obtained. A large percentage of land in Clay County is farmed by tenants. The terms of renting vary somewhat in different parts of the county. In some cases the tenants furnish everything and crib the corn and take one-half; in other cases the tenants receive two-thirds. In wheat, when the tenant furnishes half the seed and pays half the thrashing, he receives one-half the wheat; if he furnishes all and pays all thrashing bills, he receives two-thirds of the wheat. Some tenants are hired by the month to manage the farm. Tenant furnishes part or all of horses and machinery, receives use of garden plot and a share of fruit and receives from $50 to $75 per month, according to amount of material furnished. Some land is rented for cash at from $5 to $10 per acre.

Farm labor, single-handed by the month is at the rate of about $1 per day. Harvesting season prices are from $1.50 to $2.50 per day. It is becoming very difficult to secure good farm help.

Hay harvest usually begins about July 10th. Good methods and up-to-date machinery are used in caring for the hay. Thrashing is usually well under way by July 4th. The greater part of the corn crop is husked from the standing corn, but the use of shredded fodder is greatly on the increase.

Large areas of the more rugged parts of the land should be devoted to grazing, and dairying would become a paying occupation. More creameries are needed in the county and inducements will be offered for their establishment.

In the vicinity of Seeleyville, Cloverland and south, most of the farmers run small dairies in connection with their farm work. The interurban line furnishes good transportation for the industry. The farmer receives about 18 cents per gallon for the milk and pays about one and a half cents for transportation. The price received, however, is based on the percentage of butter fat.

When cattle are kept for dairying purposes, most farms are kept up in good condition since all crops raised are fed on the farm and turned back to the soil. Many farmers use cream separators and are well pleased with their use and would not be without them even when only two or three cows are kept. Herford, Short Horn, Jersey and Holstein cattle are raised chiefly. A few men raise a considerable number of cattle, hogs and sheep and ship their own stock to Chicago and Indianapolis markets. Taking the county as a whole, stock raising receives comparatively little attention. While some live stock is kept on each farm operated by the owner, the greater part of all the crops produced is sold at the local markets.

The young clover was practically a failure over the entire county in the spring of 1911. This was probably due to two causes; on account of the very dry spring much of the seed did not germinate, and that which did make some growth was burned by the excessive drought. It was also true that much of the seed was inferior. In the fall of 1910 much of the clover was late in maturing and was bitten by the early heavy frosts and much of the seed thrashed from late fields was immature. In many cases farmers who spent as much as $50 to $100 for clover seed met with utter failure of a new stand. Good seed is the important thing in successful clover growing. Every farmer who is not thoroughly familiar with the appearance of good clover seed should have his seed tested. The seed should be tested as to the quality of the seed and also for impurities. Six to ten dollars a bushel is a high price to pay for imperfect and impure seed. It is better to buy good seed at a high price than inferior grades at a low price.

A large acreage of timothy meadow is grown in regions about Cory, Ashboro, Center Point and Saline City. The yield is from one and a half to three tons per acre. Much of the hay is baled before being sold from the farm. Timothy grows well in both upland and bottoms, but is rather coarse in lowlands.

Alsike clover mixed with one-fifth timothy gives good results for pasture in the Birch Creek bottoms. Alfalfa has been grown to a small extent on the adjoining uplands. The alsike clover is specially adapted to wet, clayey soils and will stand overflows better than the red varieties. When stiff, clayey spots occur in a field, a mixture of alsike and red varieties will usually insure a good stand. The alsike clover comes in and makes a full stand on the wet places. It is the thin spots which cut down the average yield for the field.

There are still some good pieces of timber in the region about

Ashboro and between Staunton and Cory and to the west. The principal tree growth of these areas are the oaks. In the northern part of the county the tree growth is almost wholly beech. River birch, black willow, sycamore, red maple, river maple, Carolina poplar, elm and some oak make up the growth along Birch Creek.

In the Birch Creek bottom south of the station at Ashboro, ground ivy or myrtle covers the ground with such a dense growth that all grasses and weeds are crowded out.

In a number of places, rows of black walnut, red maple and catalpa trees have been planted along roadsides and about farm yards, which add much to the attractiveness of the place and show an interest in the growing and care of trees. The shading along the road is also a great saving to the roadway. Black locust is native to the county and grows abundantly along roadsides and on rough lands. Numerous plantings have been made and in most cases do well. The borers, however, have caused much trouble in the growing of locust trees. The borers also infest some of the maple trees and cause the young trees to fall. There is no remedy for locust trees which are infested with borers and no practical way to prevent infestation. The adult is a brown bettle marked with yellow, another species of the same, bores in hickory.

In past years it has been a common practice to plant juniper or red cedar trees along apple orchards, and but few have realized the injury to the apple crop from the rust of the cedar apple. Several places were observed where the cedar trees were either in the orchard or around the edge as wind breaks, and the trees were loaded with the fungus apple. Such trees should be destroyed. If wind breaks are desired some other sort of a tree should be used.

Several farmers have put out groves of catalpa, usually of about 1,000 trees, planted on an acre or more of ground. The trees grow well and where they have not been injured by the catalpa sphinx are in good condition. J. C. Moss at Ashboro has an excellent grove six years of age which has never been troubled by insects. He also notes that but few insects of any kind are found in catalpa groves, even flies are scarce, and such groves would afford good retreats for picnickers and places for quiet rest in the shade. Mr. Keller's grove south of Staunton and Mr. Van Vacky's grove south of Seeleyville are of trees three to four years old and have never been troubld by insects. To the northwest of Cory are several groves, the largest of which are on the farms of E. B. Collins, Wm. Miller and H. E. Miller. These are all the third season trees but have been badly defoliated by the sphinx two years in succession. Last year the leaves put out and were killed by frost, and when the new leaves were later put out they were destroyed by the worms. In 1911 the trees had been completely defoliated by June 20th and the new leaves were beginning to put out and would probably be visited by another brood. The trees average in height from four to eight feet. In most cases the proper pruning of the trees is neglected. Agents recommend too many trees to the acre.

On small trees it is practical to control the insects by spraying with any arsenical solution, or gathering the larvae by hand when they are small, at which time they are inclined to feed in colonies. Large trees are also infested and when they grow singly as was observed in several places where the catalpa was used for lawn shade. For a few trees of large size, spraying may be done, but it is impractical in large groves. Cultivation of the soil about the trees when the moth is passing the pupa stage in the ground may be a means of holding the pest in check.

Much osage orange has formerly been grown for hedge fences throughout the county and in most cases the plants were not properly pruned and many have grown to tree size and much of the new growth has escaped into the fields and roadways. Many of the farmers are now cutting out the hedges, or rather grubbing out in order to remove the whole plant to stop further growth. It was found that the hedge plants used much of the moisture from the soil and that when they were planted about fields the crop for ten to twenty feet was cut short by lack of moisture and by shading. Some osage orange fences which have had proper pruning are very attractive. No new plantings are now put out. Where it is desired to have a border about lawns and gardens, various varieties of the privet are used. It makes a very pretty growth but is not very hardy.

Poole wheat grows well but does not give as good yields as when first introduced. The Fulse variety has almost played out on many of the soils but some farmers still obtain good yields and hold to it as the best variety. The farmers in general believe that it would be well to try a new variety. The yield of wheat per acre varies from 10 to 15 bushels with occasional yields of 30 to 40 bushels.

Some commercial fertilizer is used throughout the county, usually without any reference to crop or soil, the same kind being applied for wheat, corn and potatoes. Various brands are used and most of the farmers are realizing some profit from the use of commercial fertilizer.

Considerable rye is used as fertilizer. It is usually sown in corn in the fall and then pastured in the early winter, then allowed to make a good growth in the spring, then again pastured and later plowed under. Corn is thus grown upon the same ground year after year. This is not as advisable as rotation, for more than two years, and many farmers doubt the value of rye as a green fertilizer.

Tomatoes are grown for canning factories at Center Point, Clay City, Brazil and Terre Haute. In the vicinity of Cory, about 200 acres are grown for the Terre Haute Canning Company. The yield is from three to seven tons per acre and the grower receives $7.00 to $7.50 per ton delivered. The tomatoes are hauled to Terre Haute by wagons. The upland soils are well adapted to tomato growing and this should prove to be a paying industry. An effort should be made to have the factories run the entire year, canning corn, peas, tomatoes, beets, sweet potatoes, beans, pumpkin and hominy. In the central part of the county those growing tomatoes for the Brazil plant are paid $7.00 per ton delivered at their nearest railroad station.

Just as the coal and clay industries have been and are at present the great enterprises of the county, so agriculture must be advanced to meet the demands and growth of the county. The soil conditions of the county should be carefully studied and continued investigation made as to their needs. The diversity of crops which can be grown, the natural productiveness of the land, the transportation facilities, the nearness to good markets and the development of the natural resources, coal and clay, all tend to make the area of this survey one of the most prosperous sections of the State.

KNOX COUNTY.

History of Settlement and Agricultural Development.

Knox County is the oldest county in the State. It has been called the "Mother of Indiana Counties." Its organization dates back to a period before the territorial government and finds a place among the earliest acts of the Government formed from the territory northwest of the Ohio River. Its original boundaries extended from the Ohio River to the lakes, including the State of Michigan, and from the Wabash River to near the middle of the State.

The original Knox County was established in 1790. In 1798 Wayne County was formed with Detroit as the county seat and comprising a greater part of Michigan and northern Indiana. By an act of Congress passed in 1800, the territory embraced in these States was divided into two territories with Vincennes the seat of one and William Henry Harrison as its Governor. In 1802 Clarke and Randolph counties were formed and in 1805 Dearborn County was added. Late the same year Michigan was made a separate territory and a part of Illinois which was included in Knox County was made a distinct territory in 1809. At this date there were only four counties in Indiana Territory, Knox, Clarke, Dearborn, Harrison. In 1810 Jefferson and Franklin counties were established, and in 1813 Gibson and Warrick were organized. Sullivan was added in 1817, and Greene in 1820, thus reducing Knox to its present size. The county was named in honor of General Knox, Secretary of War.

Vincennes, the county seat, is one of the oldest and possibly the oldest settlements in the State of Indiana. It is situated on the banks of the Wabash 57 miles south of Terre Haute. It was at this point that the French Jesuit missionaries from Canada said mass before astonished savages in the year 1702. This act may be regarded as the very beginning of French civilization in Indiana, although missionaries had visited the territory during the fifteen years preceding, and Robert D. LaSalle passed through it on the old Wabash and Maumee route and erected some stockades in 1680. There was, however, no permanent mission founded within the limits of the State until 1702. This was one year after the establishment of Detroit by La Molle Cadillac, and the French records show that the missionaries came from that part. Three years later, in 1775, the date when the French fort at Ft. Wayne was erected, a French trading post and stockade were established at Vincennes. Thus Ft. Wayne and Vincennes are on an equality as to antiquity. There was not any considerable settlement about Post Vincennes until 1745. There are no authoritative records concerning the settlement for a number of years, down to 1749, other than the Government records at Quebec. Vincennes was the seat of government for the Indiana Territory until the removal of the capitol to Corydon in 1813. The place was first known as a Piankeshau village by the name of Chippe Coke, or Brushwood. It was also called Post Vincennes, or Au. Post Vinsenne, and finally Vincennes. The latter name was adopted as early as 1749, in honor of F. M. De Vincennes, a gallant French officer who was killed in battle with the Chickasaws in 1836. In 1850 the town had a population of 2,000.

The following paragraph, quoted from the reports of the Bureau of Statistics for 1909 and 1910, shows the present condition of Vincennes.

"Vincennes, city, population 1910, 14,895, increase of 4,646 over 1900; county seat, on B. & O. S. W.; E. & T. H.; C., C., C. & St. L. and the Vandalia Railroad; 9 rural routes; Adams, U S. and American Express, Western Union and Postal Telegraph, Bell and Independent telephone; 3 daily and four weekly newspapers; 3 miles of sewer; 7 public schools employing 82 teachers, 3 parochial schools, college, 15 churches, 20 lodges, 3 national banks, State bank, trust and savings bank, 5 building and loan associations, business men's association and commercial club; agricultural and implement factory, 6 bakeries, brewery, 2 brick and tile mills, canning factory, 2 cigar factories, two distilleries, 3 flour and grist mills, furniture factory, 3 planing mills, 2 saw mills, sewer pipe factory, 3 glass factories, 2 paper mills and rolling mill; 20 physicians, 15 dentists, 3 veterinary surgeons and 25 lawyers, 2 department, 5 dry goods, 6 shoe, 11 drug, 58 grocery, and 9 hardware stores; 3 laundries, hospital, 12 hotels; estimated number of employes in manufacturing plants, 3,000; estimated weekly payroll, $65,000; 72 saloons.

In commercial bodies, Vincennes has a board of trade and a merchants' and manufacturers' association. The output of factories includes brass, iron, sewer pipe, bar iron, paper, straw-board, milling products, beer, whisky, egg cases boxes, barrels, automobiles, fire apparatus, stoves and ranges, furniture, iron bridges, agricultural implements, brick and concrete blocks. The raw materials available are clay, sand, timber, coal and oil. The Board of Trade will give financial aid to new industries and has more than 200 acres of land which will be given for factory sites. Vincennes is a good location for any kind of factory, as the shipping facilities are excellent and fuel can be obtained at a very low rate."

Bicknell is located 15 miles northeast of Vincennes on the I. & V. Railroad and was incorporated as a town in 1907. It was originally laid out in 1869 by John Bicknell, for whom it was named. In 1900 the population was 510; at the present time it is a little over 4,000. The rapid growth of the town is due to the recent development of the coal industry. There are six large mines in operation. The thickness of the veins being worked is from five to eight feet. Other veins of good thickness also occur in the same field. The mines are all well equipped. There are good opportunities for factories which would utilize the clays and shales from the mines. The other industries of the town are a flour and grist mill, planing mill, lumber yard, and about 50 stores of various kinds, and most of them are good in the line. Two rural routes go out from the town. The number employed in manufacturing plants and mines is about 900, with a weekly payroll of $16,500.

The town has made a very rapid and substantial growth. The development and progress of the town is very well assured. The coal field has an inexhaustible supply, good clay and shale is abundant, water resources are good, and the agricultural region surrounding is such that when properly developed would support a very large population. The merchants' associatoin is anxious to secure new enterprises and assistance will be given to any industry seeking such a location.

Sandborn is in the northeast corner of the county, 25 miles from Vincennes, on the Vandalia Railroad. It has two rural routes. The population is about 500. The principal industries are flour and grist mill, a sawmill, lumber supplies, blacksmith shop and grain elevator. There are two banks, two general stores, one drug store, jewelry, books and stationery, millinery, two hardware stores, and a harness shop. The town is a good shipping point for grain and stock. The soil of the immediate vicinity is a sand and sandy loam. It is fertile and produces good crops. The town would be a good location for a canning factory, and any industry seeking location here will be assisted by the town.

Edwardsport, the oldest town in Vigo Township, is located in the northeastern side of the county, on a bluff along White River; has a population of 675. The town was incorporated in 1869. It was a very active place until the growth of Bicknell began. It is on the I. & V. Railroad. The town is surrounded by a very rich agricultural region, which is for the most part well improved. It is a good trading center and shipping point.

Westphalia is a German settlement, four miles northeast of Edwardsport. The population is about 85.

Freelandsville, in the northern central part of the county, is the only town in Widner Township. The population is about 600. The industries are a milling company, tile and brick plant, lumber and planing mill, also manufacturing lawn and porch swings and settees, a saw will and several good stores. The population is largely German. The town receives produce and business from a large area of the northern part of the county.

Oaktown has a population of 608. It lies 15 miles north of Vincennes and is on the E. & T. H. Railroad; has three rural routes, weekly newspaper, public school employing 9 teachers, 3 churches, State bank, flour and grist mill, 2 concrete block factories, 1 department, 2 dry goods, 3 grocery, 3 drug and 2 hardware stores, harness shop, building material, 2 livery stables, garage, hotel, 3 restaurants 2 barber shops, theater, 2 meat markets, 2 blacksmith shops, and repair shop. The town is situated in the center of a good agricultural region. It is a good residence town and is making a considerable growth as a home town.

Wheatland is 12 miles east of Vincennes, on the B. & O. Railroad. It has 415 inhabitants and, as its name suggests, is in the heart of a rich wheat growing area.

Bruceville has 366 inhabitants, is on the I. & V. Railroad, and is called "Boston of Knox County." It was here that the first wool carding mill in Knox County was built in 1820. An oil mill for extracting fluids from castor beans, a distillery and an ox-tread mill were then in operation. It is a good little village and receives considerable trade from the northern part of the county. An excellent new school building has just been completed.

Monroe City has a population of 630, is 12 miles southeast of Vincennes, has a rural route, public school with 6 teachers, 3 churches and a State bank, 8 physicians and a veterinary, 4 groceries, 3 general stores and a drug store, bakery and two sawmills. It is in a good agricultural region.

Other towns worthy of mention are Fritchton, Purcells, Emison, and Busseron.

Grants, Donations and Surveys.—A large part of Knox County was divided by the general government into militia donations, locations and surveys. These surveys were made between 1794 and 1802. The land was given for military service, claims against the

Government and as grants for settlements. The remainder of the county was later laid out in sections by the rectangular system of survey in 1801 and later. In the portion of the county divided into surveys and donations, the dividing lines run in most cases northeast and southwest and northwest and southeast, though in some cases they are irregular. The description of the land divides is given fully under Sullivan County. Some additional information is here given to show the manner in which the title to lands was secured and the desire of the early settlers to secure the land.

Laws were passed by Congress for disposing of lands in the western territory and for prohibiting settlement of unappropriated lands by reckless speculators. Land speculation on the border of the Ohio and Wabash Rivers was exciting considerable attention and large land companies were organized for the purpose of monopolizing the trade. Tracts of millions of acres were sold at one time by Congress, and so far as the Indian titles could be disposed of, the work of settling and improving the land began.

Governor St. Clair intrusted the secretary of the territory, Winthrop Sargent, with the execution of the resolutions of Congress regarding the lands and settlers on the Wabash. He directed that officer to proceed to Vincennes, lay out a county there, establish the militia, and appoint the necessary civil and military officers. Mr. Sargent at once proceeded to Vincennes, where he organized the Camp of Knox, appointed the necessary civil and military officers, and notified the inhabitants to present their claims to lands. In establishing these claims the settlers found great difficulty, and regarding it the secretary in his report to the President remarked:

"Although the lands and lots which were awarded to the inhabitants appeared from very good oral testimony to belong to those persons to whom they were awarded, either by original grant, purchase, or inheritance, yet there was scarcely one case in twenty where the title was complete, owing to the desultory manner in which public business had been transacted and some other unfortunate causes. The original concessions by the French and British commandants were generally made upon a small scrap of paper which it has been customary to lodge in the notary's office, who has seldom kept any book of record, but committed the most important land concerns to loose sheets, which in process of time have come into possession of persons that have fraudulently destroyed them, or, unacquainted with their consequences, innocently lost or trifled them away; for by the French usage they are considered as family inheritances and often descend to women and children. In one instance, and during the government of Mr. St. Augehere, the royal notary run off with all the public papers in his possession as by certificate produced to me. And I am very sorry further to observe that in the office of Mr. LaGrand, which continued from the year 1777 to 1787, and where should have been the vouchers for important land transactions, the records have been so falsified and there has been such gross fraud in forgery as to eradicate all evidence and information which I might have otherwise acquired from his papers.''

Winthrop Sargent informs us that there are about 150 French families at Vincennes in 1790. The heads of these families had all been at some time vested with certain titles to a portion of the soil, and while the secretary was busily engaged endeavoring to straighten out these claims he received a petition signed by 80 Americans praying for the confirmation of the grants of lands ceded by the courts which had been organized by Colonel John Todd, under the authority of Virginia, to which reference has already been made. This case was met in the action of Congress on March 3, 1791, empowering the Governor of a territory in cases where land had been actually improved and cultivated under a supposed grant for the same to confirm to persons who had made such improvements. The land supposed to have been granted not, however, exceeding the quantity of 400 acres to any one person.

Transportation Facilities.—The railway facilities of the county are very good. The B. & O. S. W. crosses from east to west near the center; the E. & T. H. from north to south through the western part; the I. & V. and the Cairo Division of the Big Four crosses from northeast to southwest. All converge at Vincennes and give good facilities for the location of a manufacturing center of importance. An interurban line from Vincennes to Washington is under construction. Both White River and the Wabash have been used for the transportation of products by rafts, flatboats, small steamers. It is probable that streams, and especially the Wabash, may in the future be made navigable. In the early days the stage lines from Evansville to Vincennes and Terre Haute carried many passengers.

The county has 580 miles of public road, with more than 300 miles improved. The improvement has been chiefly with gravel. The average original cost of the gravel road per mile is about $1,800, for the stone road about $2,000. The first improved roads were built in 1900. Along the Wabash there are several gravel pits opened in the vicinity of Emison, and to the south of Vincennes is considerable terrace gravel, but in the White River valley gravel is very scarce. Stone suitable for road metal is very scarce and cannot be produced as cheaply as other stone can be imported.

Agricultural Societies.—In 1809 Knox County boasted of its agricultural societies, the object of which was "To encourage domestic products." However, the society did not hold but one meeting. In 1826 a similar institution was formed and kept going for several years, until the Legislature made provision for the commissioners to aid such organization. A third organization was formed under the new ruling, which had existence from 1836 to 1856. Although appropriations were made during the first three years of the organization, there is no record of any fair being held before 1855. However, this one is referred to as "the fifth annual fair." It was held at the court house. In 1856 the sixth fair was held near Vincennes. Two hundred dollars were paid out for premiums, but there yet remained over $4,000 in the treasury, over which much dissatisfaction arose as to who should be its custodian. This finally led to the disorganization of the concern. In 1858 James D. Williams formed another agricultural and mechanical society, which held its initial meeting October 28, 29, and 30 of that year, as a district fair, at which Gibson, Warrick, Pike, Sullivan and Lawrence County, Illinois, all had exhibits. Louisville, Kentucky, and Evansville, Indiana, each had displays among a thousand or more entries. This fair was a great success, but after the next year it passed out of existence and was not revived until 1871, when the present Knox County Agricultural and Mechanical Society was organized. The society added to its possessions from year to year and now controls an immense tract of valuable land bordering on the northwest limits of the city.

General.

The population of Knox County was 6,557 in 1830. By 1850 it had almost doubled, and by 1910 it had reached 39,183. The county has an area of 510 square miles. The total farm area is 305,966 acres, with 249,603 acres improved. The average selling price is from $75 to $100 per acre. It ranks third in acreage of corn and wheat, first in acreage of peas, watermelons and cantaloupes. In number of mules sold it stands second in the State.

Knox County produces annually about 900,000 bushels of wheat, which averages from 15 to 18 bushels per acre; corn yields about 2,900,000 bushels each year, with from 30 to 40 bushels per acre;

yield of oats is about 175,000 bushels, averaging from 20 to 40 bushels per acre; rye is grown on about 340 acres, yielding from 7 to 12 bushels per acre; timothy is raised on about 12,000 acres, making more than a ton per acre; alfalfa produces from three to eight tons per acre, but is not grown on but about 550 acres; prairie grass is grown on from 100 to 200 acres, yielding about one and one-fourth tons per acre; clover yields from one to one and a half tons per acre on an acreage of about 7,000 acres. Potatoes yield from 75 to 80 bushels per acre, with more than 300 acres each year; onions are grown for market on about 25 acres, averaging from 60 to 70 bushels per acre; tomatoes yield from 2 to 10 tons per acre, and are grown on from 150 to 200 acres each year. The acreage of peas is about 4,000 acres; watermelons, 2,000; cantaloupes, 250 to 300 acres; berries are raised on from 10 to 20 acres, yielding from 25 to 35 bushels per acre; tobacco yields about 100 pounds per acre, but only five or six acres are put out annually. Quite a number of horses, cattle, hogs and sheep, but more specially mules, are sold each year. Poultry raising is not engaged in extensively.

"Nature, science and wealth have combined to make industrial farming in the community a calling out of which the producer not only gets big production, but which enables him to follow his vocation with profit and pleasure. The wonderful possibilities of scientific agriculture in this region cannot be exaggerated. The unprecedented crop yields are so enormous as to seem incredible to one not acquainted with the topography of the country, the climatic influences of river vapors on vegetation and the adaptability of the soil for their advantageous assimilation. One reason why farms in this section are so attractive and productive is because they are nearly all owned by the men who till them. Diversified farming is quite extensively carried on, and as a producer of cereals, all kinds of grain and every known variety of vegetable and fruit, the soil of Knox County is exceptionally fine. Especially in the production of corn, oats, wheat, clover, rye, timothy, potatoes, tomatoes, apples, peaches, pears, plums, grapes, strawberries, etc., is this true. Alfalfa, the staple crop of Kansas, Washington, Oklahoma and Texas, can be raised in many sections of the county where the ground has been properly fertilized, almost as well as in any of the States named, as has been demonstrated by William H. Brevoort, one of the largest land owners in the county, by practical experiments on several of his farms just below the city limits. Live stock farming, too, can be and is profitably carried on here to a large extent.

The natural water courses running through and the smaller streams traversing or lying within the confines of the farming districts and the excellent quality of grass for grazing purposes which grows abundantly far into the winter months and remains green and nutritious almost the year round are advantages which make the business at once inviting, pleasurable and profitable. Cattle, sheep, hogs and poultry are raised in unlimited quantities in Knox County, and for all of them there is always a ready home market. Some of the finest bred stock to be found in the county is raised in the pastures and on the fields adjacent to Vincennes.

"And when it comes to melons, the growers of this luscious fruit have the pumpkin growers decidedly outclassed. The industry of melon growing in Knox County has attained gigantic proportions. The quantity of the watermelons and cantaloupes produced in this county, all of which are of superior quality, is so great that when the crops are gathered the shippers frequently find it difficult to secure cars sufficient for their transportation. The Rocky Ford melons of this vicinity are prime favorites with the epicures of New York City, and the swell clubs and cafes of the eastern metropolis have acquired the habit of underlining on their menu cards 'Knox County nutmegs,' for which they receive handsome prices. The north and east are large consumers of the melons grown in this locality, and the railway stations at Vincennes, Decker, Purcell, Oaktown, Emison, Bicknell, Edwardsport and Wheatland are scenes of unusual activity when the melon season is on. The profits which accrue from the cultivation of melons are said to be enormous, amounting in the aggregate to more money in proportion to the time and labor expended and the extent of acreage cultivated than can be realized from the yield of any other product. And the industry, it might be said, is still in its infancy.

"Knox County has almost as many varieties of soil as the products thereof. The highlands are abundantly rich and mellow, adapted to the culture of any crop, and conform admirably to every kind of farm uses. The vast expanse of bottom lands which skirt the Wabash, White and Duchee rivers is especially adapted to corn, wheat and hay, which yield large crops during seasons of severest draught when vegetation in other localities withers and dies from lack of moisture. There is really nothing which grows to sustain life of man or beast that cannot be raised in abundance in this section with less labor and less cost than the same can be produced elsewhere. The unexcelled railway facilities which enable the farmer to get to any market he desires without having to see a middleman, the excellent system of gravel roads that penetrates the very heart of the farming country, maintained in fine condition the year round, are advantages which are not to be given secondary consideration in summing up the various conveniences of living 'down on the farm.' The rural free delivery of the mail to all sections and the service of two complete telephone systems, one of which is the product of home capital and enterprise, are other essentials not to be lightly considered in contemplating the advantages enjoyed by the farming community.

"The unrivaled agricultural resources of the county of which Vincennes is the seat of government have not only sustained but have built up the thriving city. Some of the wealthiest citizens, in fact many are or have been, owners of farms from which they derived their wealth. These men have kept pace with every advance step made in the direction of progressive agriculture. While none of them are farmers in the literal sense, nearly all own farms and personally look after the cultivation of them, for the reason that the industry of farming in this locality especially is considered a science as well as a profession, besides an interesting study, an interesting vocation, and has been to them the royal road to wealth. The major part of all farming land in the county (with the exception of localities where mounds and hills occur) is generally level or gently rolling with sufficient slope to afford first-class drainage, and so smooth that it will admit the passage of automobiles over its surface with comparative ease. It has few waste places to be made green, for the reason that nearly every acre of it is in cultivation or covered with a growth of valuable forest trees. Farm life here is made pleasant as well as profitable by congenial surroundings which unite a people in bonds of mutual interest and make a community of happy homes. The progress of the farming communities in this section has kept pace with the progress of the world. The farmers hereabout know what constitutes scientific farming and evidently possessed this knowledge before the study of agriculture was taught as a science in the advanced institutions of learning, for fortunes large and small have long since been gathered by them from the fruits of the soil. And yet there are no wild speculations here growing out of the sale of desirable farms like there are in other localities where undesirable farms are sold, in the so-called virile and growing West where land values as well as the land itself are fictitious. The best farms are bought and sold here for the best prices and the purchasers hail principally from the West, while not a few are from the East or

North. The unsurpassed fertility of soil, a climate adapted to the highest crop production and comfortable for human habitation, social, religious and educational advantages such as are afforded by up-to-date schools and churches; the number of good sized towns in proximity to the farms; and the splendid markets furnished by Vincennes for everything raised on a farm; a pleasing rural landscape, the beauties of which never become monotonous, but are always pleasing and refreshing, are a few of the manifold features having magnetic power to bring to this locality people who are seeking agricultural districts for agreeable homes and a comfortable competence. Good farms can be had as low as $30 and as high as $300 per acre.

"In proportion to the area of territory she occupies, Knox County raises a greater quantity of wheat and corn than any other county in the State, the average yield of the acres in actual cultivation being greater than that of any other county. It is not a very uncommon thing in favorable seasons to gather 85, 95 and even 110 bushels of corn from one acre of ground. On a farm two seasons ago, a sixty-acre farm within two miles of Vincennes totaled over 100 bushels of corn per acre. Conditions of soil and climate are very favorable to wheat raising, and from 45 to 53 bushels of this cereal to the acre is not considered as an extraordinary yield when the harvest days have been preceded by a season of winter weather conducive to the health and growth of the tender plant. Other crops fare as well and yield as abundantly here as hay, corn and wheat. The atmospheric conditions of the locality and the chemical formations in the soil arising from the alluvial deposits of the streams and from other causes characteristic of this region are responsible for the wonderful productiveness of the soil.

"Notwithstanding the ground in nearly all the farming districts has been worked more or less for years there are evidences of unanalyzed agents in the air and the earth which impart to uncultivated land elements of fertility and productiveness equal to that possessed by virgin soils in the less favored localities. Hence all products yield here abundantly, and the time and cost of fertilizing the land are materially lessened on account of these favorable conditions.

"The soil of Knox County is adapted to horticulture as well as agriculture. An impressive illustration of this can be had in a visit to the beautiful nursery farm of either Mr. Simpson or Mr. Reed, which adjoin each other and are located about three and a half miles southeast of the city, where flowers, trees and shrubs, natives of almost every clime under the sun grow profusely and are attractive features of two of the handsomest country homes anyone having a taste for beauties of landscape gardening or artistic architecture could wish for. The adaptability of the soil for flower culture has been demonstrated by W. A. Reiman, florist, who grows every year from 300,000 to 500,000 effusions of white, crimson and pink peonies from an open field of 12½ acres in one of the rich agricultural localities of the country. This wilderness of floral beauty is located about four miles northeast of Vincennes, and all lovers of nature as developed in flowers who have never seen them can form no adequate conception of its rarity and loveliness."

Physiography and Geology.

Topography.—Knox County is bounded on three sides by rivers, on the west by the Wabash and on the south and east by White River. The outline of the county is very irregular. The surface is generally level or gently undulating and in a few places becomes quite hilly. Lying between the two rivers, the slopes are short and gentle, so that no large streams occur. The county is practically all covered with the Pleistocene deposits. In the valleys the thickness runs up to 100 feet and in some of the old valleys which have not been changed, may exceed that. On the uplands the surface will not exceed 50 feet and in many places is not more than 5 to 10 feet.

The upper or barren Coal Measures form the surface rocks of the greater part of the county. The lower or productive Coal Measures underlie the whole county, but the veins of coal are so deep that they are at present being worked only in the eastern part. The upper Coal Measures are made up of alternating sandstones and shales with occasionally thin beds of "rash" coals of no economic value. The total thickness of these formations is more than 300 feet. The workable veins of coal in the county vary from three feet to more than seven. The coals underlying Knox County are from No. V to No. IX. Coal V is just at river level at Edwardsport. It is above river level at the mouth of the west fork of White River and on White River above Edwardsport. At Appraw Ford, Coal VII is down to the level of low water of White River, indicating a broad syncline from east to west in the center of the county on the eastern edge. At the northeast corner of the county the coals below No. V outcrop, so that Voal V is rising in that part of the county. Coal VI outcrops in the eastern half of R. 8 W. and VII a little distance west. The coals always have a westward dip.

Round-top hills rising on the eastern border of the Wabash Valley near Smith's Station north of Old Fort Knox, Knox County.

Wabash River, as viewed from the site of Old Fort Knox, Knox County, Ind.

At Vincennes, Coal VI is only 35 feet above sea level, or at a depth of about 400 feet, and the other coals will be found at a correspondingly greater depth. Some of the best equipped mines in the State are in this county, and the production of coal is rapidly on the increase. Present estimates would show the amount of workable coal yet remaining in the county to be more than 2,000,000,000 tons.

Drainage.—The divide between White and Wabash River extends through the center of the county, the western half being drained in the Wabash by Busseron and Marie creeks and Deshee River and smaller tributaries. The eastern half drains into the west fork of White River through Black Water, Indian and Pond creeks. The two forks of White River unite at the southeastern corner of the county and White River and the Wabash unite at the southwestern corner of the county. Several old streams and bayous occur in the river bottoms, forming marshes. Most of these marshes have been reclaimed by artificial drainage. In the southwest corner of the county, several ditches have been constructed, generally with good results. In the vicinity of Decker, about 4,000 acres have been reclaimed by the completion of the Plass Ditch in 1907. The ditch runs through six miles of what was the least valuable land in Knox County. About 25,000 acres near the swamp was also increased in value by this ditch. It cost the owners of the land affected about $60,000. The value to Knox County will result in at least $200,000. In addition to the drainage of the large tract of land, the ditch robbed the Wabash River of one of its main tributaries, the Deshee River. Before the ditch was constructed, the river emptied into the Wabash a few miles above Mt. Carmel, Illinois. Now the stream empties into White River, using the ditch for its channel for six miles of its course. Before the completion of the ditch, the Deshee River was the only outlet for these swamp lands, but the river failed to do its work and the swamp spread out over a wide area.

The Wabash River has been leveed along a considerable part of its course and the bottoms are fairly well protected. In the White River bottom, much tile drainage is being put in and the soil is in excellent condition.

Geological Section.—The following sections will show the thickness of the soil and the character of the geological formations.

Section East of Vincennes on Upper Prairie Survey No. 10.

	Feet.	Inches.
Surface soil, Vincennes plain	3	0
Merom rock, sandstone	45	0
Coal	0	3
Sandstone	2	6
Soft clay shale	14	8
Coal	0	2
Clay shale	15	0
Sandstone	10	0
Soft stone	0	10
Hard limestone	10	5
Black shale	5	0
Soft stone	18	0
Sandstone	50	5
Sandstone, soft	10	3
Coal	0	8
Fire clay	2	10
Total	189	0

Section of Bore at Oaktown.

	Feet.	Inches.
Surface	30	0
Sandstone	17	4
Coal	0	4
Fire clay	2	6
Limestone	3	4
Fire clay	10	6
Shale and iron ore	13	10
Black shale and coal	6	0
Clay shale	7	8
Limestone	10	0
Clay shale	3	7
Fire clay	5	0
Sandstone	6	6
Gray shale	2	0
Limestone	12	0
Gray limestone	4	0
Sandstone and gravel	4	2
Sandstone	2	4
Limestone	1	5
Gray limestone	7	0
Limestone	1	5
Shale and iron ore	6	7
Limestone	1	8
Clay shale	9	8
Iron ore	1	2
Clay shale	1	8
Blue limestone	6	0

	Feet.	Inches.
Clay and shale	8	6
Gray limestone	12	8
Gray shale	5	6
Limestone	9	0
Gray shale	23	0
Total	236	4

Section One and One-fourth Miles North of Edwardsport, N. E. Quarter Section 36 (5 N., 8 W.).

	Feet.	Inches.
Soil and drift clay	12	0
Blue sandy shale	10	0
Coal VII	3	2
Under clay	3	4
Blue clayey shale	39	0
Dark bituminous shale	3	0
Coal VI	5	3
Under clay	2	0
Total	77	9

Section of Old Mine Shaft Near Monroe City, Donation 228.

	Feet.	Inches.
Surface clay	12	0
Quicksand	7	0
Blue clay	55	0
"Concrete rock"	4	0
Coal	4	0
Bone coal	1	0
Fire clay	1	0
Sandstone	50	0
Coal	1	2
Total	135	2

SOILS.

The soils of the county present a great variety of types. The two great divisions are the uplands and the river bottoms. The county is one of the most fertile in the State. The broad valleys of the streams form the large portion of the surface and greatly increase the average thickness of the soil. The flood plains of the river are from one to more than three miles wide. Extensive terraces also occur. The bottom clays are chiefly clays and clay loams, grading in places into fine sandy loam. The sandhills and sand plains or terraces are extensive and very fertile. These sandy soils have placed Knox County in the lead in the production of melons in the State. The main type of the upland soil is the Knox silt loam, formed from the drift and loess of glacial origin. The following table gives the names of the various soil types and the area occupied by each:

	Sq. Mi.
Knox silt loam	200
Wabash silt loam	113
Sioux sandy loam	65
Knox sand	45
Sandy clay loam	34
Mode silt loam	30
Clyde sand	7
Clyde clay	5
Knox sandy loam	3
Muck and peat	3
Fargo clay	2
Marl loess	2
Wabash clay loam	1
Total	510

Knox Silt Loam.

The Knox silt loam and the modified Knox silt loam are the chief soils of the uplands. These soils have been fully described in the reports on the counties given in the preceding pages, to which the reader is referred.

In Knox County the upland soils are in general more fertile and better adapted to agricultural conditions than the same soils in the other counties to the north. They contain a higher percentage of fine silt, and in the western part, along the bluffs of the river, are pure loess soils. Exposures along the bluffs show the characteristic features of loess material, and the surface of cultivated fields show the loose, floury texture. The great central area of the county consists of the Knox silt loam.

The topography of the area of these types is gently rolling to hilly. In general, the hills are low and rounded, with gently sloping sides. In the true Knox silt loam areas the drainage is good, but in the areas of the modified silt loam the drainage is rather poor, or has been in times past. The former type is the light gray to yellow soil; the latter is from light to white in color. The texture, size of grain, etc., is practically the same in both soils, the separation being made on color and drainage conditions. The soil overlies beds of sandstone and shale which outcrop in many places along the river valleys and the stream beds. These rocks, however, have not entered into the composition of the soils except in a very limited way in some localities.

These soils are adapted to all of the general farm crops and to many special crops. Wheat and oats both give good yields, the wheat yielding on the average from 12 to 20 bushels per acre, and a large acreage is grown. Corn grows well but does not give as good yields as on the Sioux sandy loam. In the summer of 1911, however, the upland silt loam types gave much better yields than the prairies because of the excessive dry weather, the close compact nature of these soils being more retentive of moisture than those with the gravelly subsoil. Considerable fertilizer is used and with good results. A large acreage of clover, timothy and other grains are grown and give good yields.

In most places the soils show faintly acid to strong acid reaction, and attention should be given to this fact. Lime is used on a few farms and the results obtained have been very satisfactory.

Many small dairy herds are kept, and on these farms the soils are in excellent condition. Some alfalfa is grown. Apples, peaches, plums and other fruits are successfully grown. Truck farming is carried on to some extent and all the special crops give good yields.

In some parts it is necessary to exercise considerable care to prevent washing. This can be prevented by not breaking the surface too near the edge of the hills and gullies, and by using means to check the growth of washes which have been started. The margins of the hills and ravines are excellent places for the planting of forest trees, both for the value of the tree growth and the protection afforded the soil by the roots.

The folowing table shows the result of mechanical analyses of the silt loam soils:

Locality.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
Boyd Farm S. ¼ N. ½ Don. 46	Surface	0.5	0.5	0.4	1.5	4.0	82.5	11.8
N. ½ Don. 47	Subsoil 8 in. -20 in.	0.2	0.4	0.5	0.5	8.2	80.5	10.
N. ½ Don. 47	Subsoil 20 in.-72 in.	0.5	0.8	0.5	0.5	6.2	78.5	13.
Emison Farm: S. W. Bruceville	Surface 8 in.	4.0	1.5	0.7	0.5	6.0	70.8	16+
Alton Farm N. W. Bruceville	Surface 8 in.	0.5	0.8	1.2	0.8	7.5	81.4	8+
Near Monroe City	Surface 12 in.	0.4	1.0	0.6	1.5	6.5	78.5	11+

Note.—In the first three samples given in the table the surface was taken in wheat field. The soil was a typical loose, brown, fertile soil. The subsoil 8″-20″ was taken in a vertical exposure, was uniform brown in color, and contained a small amount of fine grit. The corn in adjacent field yielded about 65 bushels per acre. The subsoil 20″-72″ was a stiff, compact loess clay, uniform brown in color. In some places the subsoil is mottled with white. The sample taken on Emison farm was in corn field and contained many irony pebbles known as "hen gravel," due to former poor drainage conditions. The field is well kept up by manure and clover. The sample from the Alton farm was taken in a wheat stubble field. The farm has been rented for a number of years and not much humus is left in the soil. In places some gravel is found on the surface, but in general the soil is not in bad condition for a soil so destitute of organic content. This soil can easily be brought to a good state of tilth and crop production. The sample near Monroe City was taken in a wheat field which had made a good yield in the present season. The soil was in a good state of tilth and of good uniform color.

Chemical Analyses of Knox Silt Loam.

The folowing analyses were made for a mixed sample of the typical silt loam taken at several locations.

Collector, Shannon.
Chemist, Blanchard.

Description	Surface 8 in.
Reaction to litmus	Neutral
Moisture at 105° C. from air-dried soil	1.62%
Total soil nitrogen	0.150%

Analysis of fine earth dried at 105° C.—

Volatile and organic matter	5.19%
Insoluble in 1.115 HCl	84.99%
Soluble silica ($S:O_2$)	0.11%
Ferric oxide (Fe_2O_3)	2.00%
Alumina (Al_2O_3)	5.41%
Phosphoric acid anhydride (P_2O_5)	0.19%
Sulphuric acid anhydride (SO_3)	0.07%
Calcium oxide (CaO)	1.27%
Magnesium oxide (MgO)	0.80%
Potassium oxide (K_2O)	0.23%
Sodium oxide (Na_2O)	0.29%
Total	100.55%

Collector, Shannon.
Chemist, Blanchard.

Description	Subsoil
Reaction to litmus	Neutral
Moisture at 105° C. from air-dried soil	1.79%
Total soil nitrogen	0.104%

Analysis of fine earth dried at 105° C.—

Volatile and organic matter	4.10%
Insoluble in 1.115 HCl	84.86%
Soluble silica (SiO_2)	0.10%
Ferric oxide (Fe_2O_3)	2.66%
Alumina (Al_2O_3)	6.23%
Phosphoric acid anhydride (P_2O_5)	0.19%
Sulphuric acid anhydride (SO_3)	0.05%
Calcium oxide (CaO)	0.90%
Magnesium oxide (MgO)	0.81%
Potassium oxide (K_2O)	0.23%
Sodium oxide (Na_2O)	0.47%
Total	100.60%

Wabash Silt Loam.

The soils of the White River valley vary in character from silt loam and clay loam to fine sandy loam. The silt loam is the prevailing type. It contains from 15 to 20% of the finer grades of sand. It is of a light brown to dark brown color; it is of great depth and there is usually no marked line between the soil and subsoil. The subsoil in general is heavier and of a lighter color, at varying depths the subsoil grades into a fine sand or a sandy loam.

The type is strictly an alluvial soil of recent origin. The area is at times flooded, but as a rule only the lower parts are subject to overflow. In the earlier days of the agricultural development of the area the sediment left was much darker in color than at present, doubtless due to the greater quantity of organic matter contained in the virgin upland soils. In the areas where the type becomes more truly a fine sandy loam the color is somewhat lighter than in the silt loam. The greater the sand content the lighter the color. There is very little coarse sand. The upper part of the subsoil contains considerable fine material, but this decreases with depth, and at about three feet a fine sand of loose incoherent nature is often found.

The soils of the river bottom are very easily cultivated. They are not difficult to plow and will remain in good tilth during the entire season. The bottoms were originally timbered. The principal timber growth consisted of walnut, sycamore, elm, ash, white oak, black oak, burr oak, chinquapin, sugar, red and river maple, hackberry, dogwood, redbud and wild cherry. At the present time scarcely any timber of size remains and in most places the land has been cleared down to the river's edge. In places a fringe of small growth has been left along the immediate banks. This is a very essential thing to the preservation of the soil. When the tree growth has been entirely removed slumping is always taking place along the river banks and large tracts of soil are destroyed every year.

Corn is the principal crop. The yield is from 40 to 75 bushels. In considerable parts of the area the farmers estimate that on the average from 15 to 30% of the crop is destroyed by flood, either early in the season by causing a poor stand, or by overflow before the crop is gathered. The corn yields made, however, are always fair to good. The white varieties of corn are grown almost exclusively. Cribs of large size are built over the area, and the corn is cribbed at times of gathering and marketed as controlled by slack times in farm work, condition of the roads, and the fluctuation of prices, much of the corn being kept in store until after the following wheat harvest. Timothy is grown to a considerable extent and makes good yields, but the meadow will not stand in the bottoms more than two years. They are also damaged by flood waters, carrying in large amounts of old weeds, corn stalks, etc., which injure the quality of the hay and the weed seed being distributed everywhere causes injurious weeds to spring up, choking out the timothy.

Clover does well and a large acreage is grown. The moisture retained in the soil is sufficient to give good yields even in the dry seasons. A large percentage of the acreage furnishes both hay and seed. The first crop is cut early and allows the seed crop plenty of time for maturing. In the summer of 1911, large fields of excellent crops of clover for seed were grown, while on the uplands the entire clover crop was almost an utter failure because of the drought.

Cowpeas are grown to some extent, but make such a rank growth that they are too coarse for feed and do not mature the peas. The crop is turned under for green manure.

Wheat does well and usually gives good yields. Several pieces on the area in 1911 made 30 bushels per acre, and some 40 bushels.

The average yield is from 15 to 20 bushels. Straw grows very heavy and often kills out clover sown in the wheat. A large acreage of ground is being plowed for the wheat crop of 1912. Fulse and Poole varieties are grown chiefly, and it is said that Fulse gives the best yield. Some oats are grown, but usually grows so rank that they fall before maturing and make the crop uncertain. Trumpet creepers and morning glories are very troublesome in the corn fields.

Knox Sandy Loam.

The soil occurs in the region about Sandborn. It is a sandy loam about 6 to 12 inches in depth. The color varies from gray to reddish brown or dark brown. It is composed of medium to fine sand containing a small percentage of silt and clay. The surface is characterized by low knobs and ridges, the result of wind deposition, and are to some extent still influenced by the shifting by the wind. The subsoil is a medium to coarse sand or sandy loam of a yellowish brown color. The clay content varies greatly. In general there is sufficient silt and clay in the subsoil to give a firm, stiff texture. In places the material is a loose, light gray sand, which is usually dry and coarser than the material above.

On the edges of the area near to the upland the soil grades gradually into the Knox silt loam. It is probable that the sand was derived from sediment land down along the streams and drifted to the present position by the wind. Some of the low and coarse areas may be due to water deposition, but the variable depth, the topography and distribution would indicate wind action as the chief agency in the formation. In the cultivated fields the surface bleaches to a dull gray or slightly reddish gray, but on the better improved parts the dark color is well kept up by the use of clover and peas to add organic matter to the soil. Although rather loose and incoherent, the soil retains moisture very well. The usual farm crops are grown and give fairly good yields, but is usually valued lower than the best parts of the upland silt loam and the soils of the bottoms. The soil is easily cultivated.

Corn produces well, and wheat gives good yields, but it is essential to keep up the requirements of the soil by frequent changes to clover or similar crops. It would be an excellent soil for truck gardening, and is especially adapted to melons, tomatoes, and small fruits. A canning factory established at Sandborn would be of much importance to the area covered by this type of soil.

Mechanical analyses show the following results:

Locality.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt and Clay Per Cent.
½ mile north of Sandborn......	Surface 12 in......	0.6	3.5	8.5	30.5	10.5	45+
1 mile South of Sandborn.......	Surface 12 in......	0.5	4.0	10.5	25.4	10+	50

Wabash Clay Loam.

Several small areas of this type occur over the county, the largest of which is to the northeast of Sandborn. In general, the areas are small and have not been mapped separately from other similar types. The soil consists of a light colored silty clay loam. The surface varies from a very light gray to a dull yellowish gray. The areas are in low lying situations difficult to drain. When wet, the soil is plastic, and upon drying has a tendency to break into cubical fragments. Usually the organic content is low, but in some places sufficient to give a dark color to the soil for a few inches in depth. On plowed fields the surface when dry has a very uniform light color.

The subsoil is a stiff silty clay, containing but a very small percentage of sand. The color varies from yellowish to almost white. Iron concretions are not so abundant as is usually the case in soils of like situation and similar color.

When well drained the soil is very productive and is easily cultivated. Corn is the principal crop; some wheat, oats and meadow are grown.

Soils of this type would be well suited for the production of pasture and heavy forage crops Care must be taken, however, to not remove too much of the organic matter from the soil

The mechanical analyses show the following results:

Location.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt and Clay, Per Cent.
North of Sandborn............	Surface, 8 in.......	.05	2.5	2.0	13.5	15.5	65+
North of Sandborn..............	Subsoil, 8 in.-24 in.	.0	.5	1.5	8.0	10.0	80

Clyde Sandy Loam.

The Clyde sandy loam lies in the northeast corner of the county along the western border of the Wabash silt loam. On the west is the Knox sandy loam and the Knox silt loam. The soil lies along the immediate course of Black Creek.

It is a dark gray to black medium textured sandy loam, from 6 to 12 inches in depth. It is very loose and pliable, due to the high organic content and the high percentage of fine sand. The drainage is usually fairly good. The subsoil is a sandy loam of coarser texture and lighter color, which at greater depth becomes a mottled sandy clay, rather sticky. The surface is practically level, with few slight differences in elevation, which in places gives a gently rolling appearance.

This is a good soil for all the general farm crops. The principal crop is corn and the yield is from 50 to 80 bushels per acre. Wheat produces well. In the summer of 1911 a large acreage was being plowed for wheat. Oats grow well. The usual rotation is corn, oats, wheat, clover, and back to corn. Some farmers grow corn for several years in succession. The soil is naturally fertile, but the growing of successive corn crops depletes it very badly and the need for rotation is well shown. Clover grows well and yields well and most years a considerable acreage is grown. No commercial fertilizer is used. Some stock are raised, but chiefly only for farm use. It has been the habit to burn cornstalks to get rid of them, but at present other means are used, such as using cutters and harrows, and thus saving the stalk to be added to the soil.

The land of this area is valued at a good price and the farmers all consider this type of soil, when drainage conditions are good, as the best in this part of the county.

The following table shows the result of mechanical analyses of this type:

LOCATION.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
S. side Sec. 20 east of Sandborn............	Surface 12 in.......	0.5	4.5	15.4	38.5	12.5	17.5	12.0
S. side Sec. 20 east of Sandborn............	Subsoil 12 in.-24 in.	0.3	3.5	16.8	40.5	9.5	18.8	12—

CLYDE CLAY.

Bordering on the Clyde sandy loam and in scattering areas of small extent elsewhere is a type of soil which is a black, silty clay or clay loam, containing a high percentage of organic matter. On dry surfaces the soil is very granular, breaking into small cubical fragments. The surface soil is from 6 to 10 inches in depth. The subsoil is a bluish or drab-colored clay, very tenacious, and practically impervious to water. This soil occurs in low-lying, poorly-drained areas. Timber growth seems to have always been very scanty on these areas, but the growth of grass and other moisture-loving plants has been very heavy. In places the soil becomes very peaty in character.

In general, the soil is easily cultivated, except when plowed too wet, when large clods are formed which are difficult to pulverize. The soil is very fertile and produces good crops, especially of corn. There are very few farms which contain much of this type, because of its limited and irregular distribution.

Sioux Sandy Loam.

This soil is a brown to black, coarse to medium sandy loam or heavy sandy loam. It varies in depth from 8 to 24 inches and contains much organic matter. The texture of the soil varies over the area from the true sandy loam types to loam soils and very sandy soils. The subsoil at greater or less depth is a waterworn gravel. On the average the gravelly content is very marked at a depth of about twe feet; in some places, however, much gravel is not found until five or six feet below the surface, and in other places much gravel is intermingled with the surface material. Considerable areas of pure gravel are known to be present, but in general the gravel is interbedded in a matrix of sandy loam, silty sand, or sand.

Owing to the topographic position of the soil, its open, porous texture, and the fact that it is underlain with sand and gravel, the natural drainage is good and often excessive. In dry seasons crops suffer from lack of moisture, and for this reason consideration should be given early maturing crops.

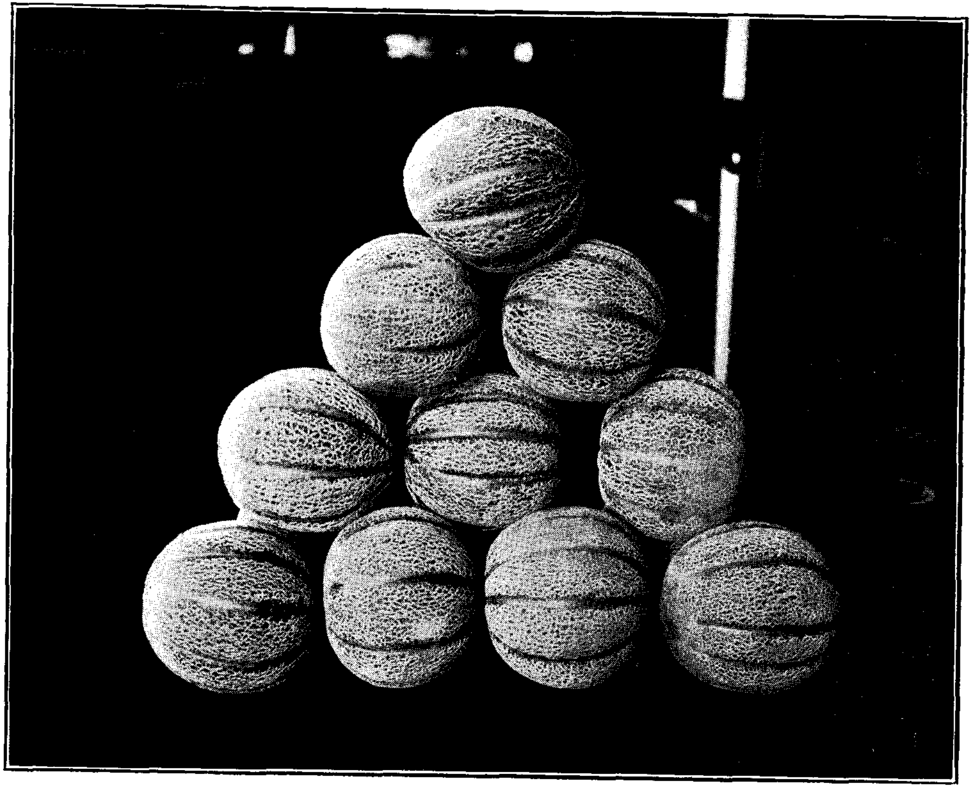
The sandy loam types occupy a large area along the western side of the county, next to the river flood plains. In the central part the sandy loam types give place to soils which are much more sandy and are classified as the Knox sand. Areas of the sandy loam occur also at other places over the county. The areas are known as the "Prairies" and the surface is in general level to slightly undulating. In the northwestern part of the county, and extending into Sullivan County, is a wide expansion of the area, known as the Shakes Prairie. The following paragraph will explain the name and its historical importance.

"Eight miles above Vincennes, we passed from the woodland flats into the south end of the prairie that extends up to Shakertown. * * * Shakertown, the residence of the Shakers, consists of eight or ten houses of hewn logs, situated on a ridge west of the bayou, eighteen miles above Vincennes. The site is moderately elevated. As we approached, the blackness of the soil and the luxuriance of vegetation was peculiarly attractive, but much water was standing on the low ground to the east, and a mill pond on Busseron Creek must suffuse the whole village with unwholesome exhalations. * * * Marriage is prohibited. From dancing, as an act of devotion, their name is derived. Like several other sects, they conform to great plainness in apparel, but their garb is peculiar. In language also they are very distinguishable. * * * In their dealings they are esteemed as very honest and exemplary. Until within a few months they entertained travelers without compensation; but the influx has become so great that they found it necessary to depart from their practice. * * * The estate of this place consists of about 1,300 acres. The mills which they have erected are a great accommodation to this part of the country, and to these they have added carding machines. * * * These people settled here before the late war (1812-1815); but after their estate was ravaged by the troop who went with Hopkins on his expedition, they sought refuge amongst their own sect in Ohio and Kentucky, and only returned last summer.''*

The soil of the area owes its origin to stream action, being river terrace soil. The coarse material which forms the subsoil was deposited at times when the stream had sufficient velocity to transport coarse soil and gravel. Following the deposition of this coarse material, the finer and more loamy material was deposited as the velocity of the stream was diminished, thus forming a sandy loam. Where fine sand is abundant, the wind has aided in reworking the material and building up the mounds and small hills.

All the farm crops are grown. Corn is the chief crop, and the area is considered one of the big corn producing districts of the State. In 1910 the corn crop was very heavy; but in 1911 the crop was very slim. Because of the very dry growing season much of the corn did not ear at all, and some failed to even make a growth sufficient for fodder. Where excavations were made for examining the soil, the soil was entirely without moisture for 18 inches to more than two feet by the latter part of July. The season was exceptionally dry and the crop failure was the worst ever experienced. The average yield of corn is about 40 bushels; oats about

* "Travels through the Western County in 1816" by David Thomas, quoted from C. C. Oakey's "History Vigo County."



Ten Knox County Beauties. Photo—Purdue University.

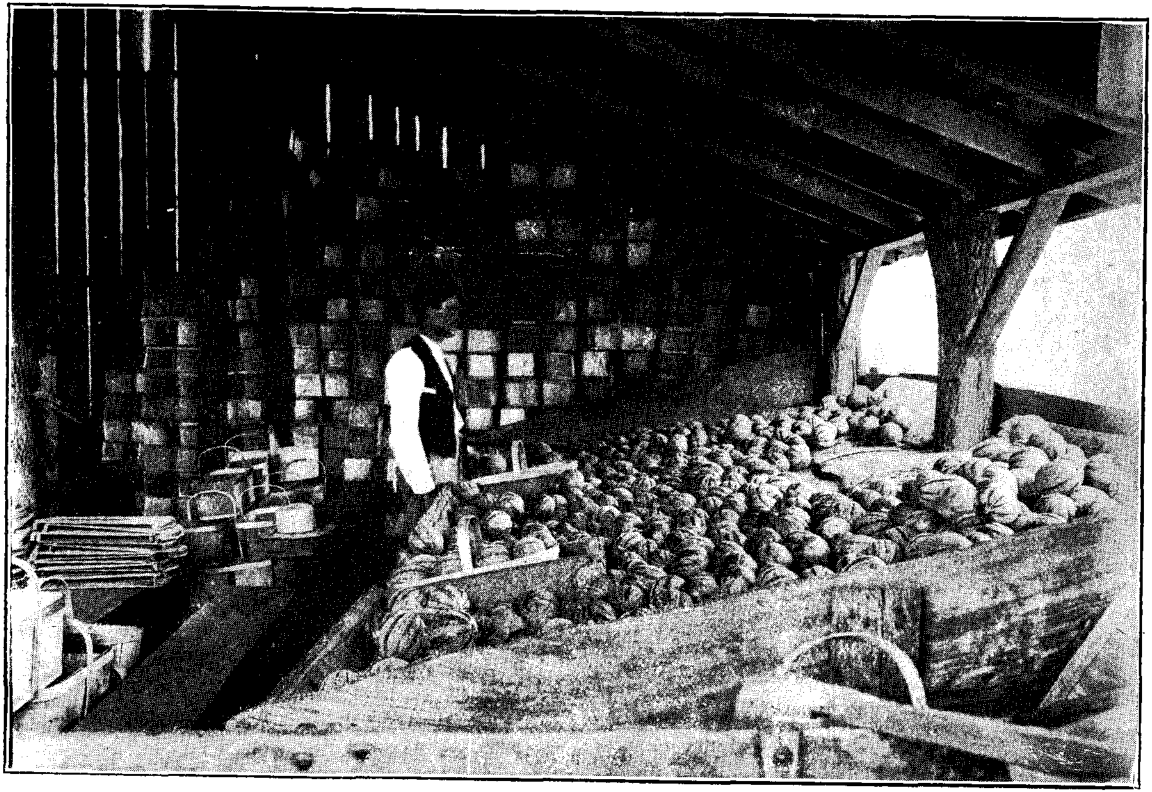
30 bushels, and wheat from 10 to 20 bushels. Clover grows well and a rather large acreage is usually grown.

The following table shows the results of mechanical analyses of the Sioux sandy loam:

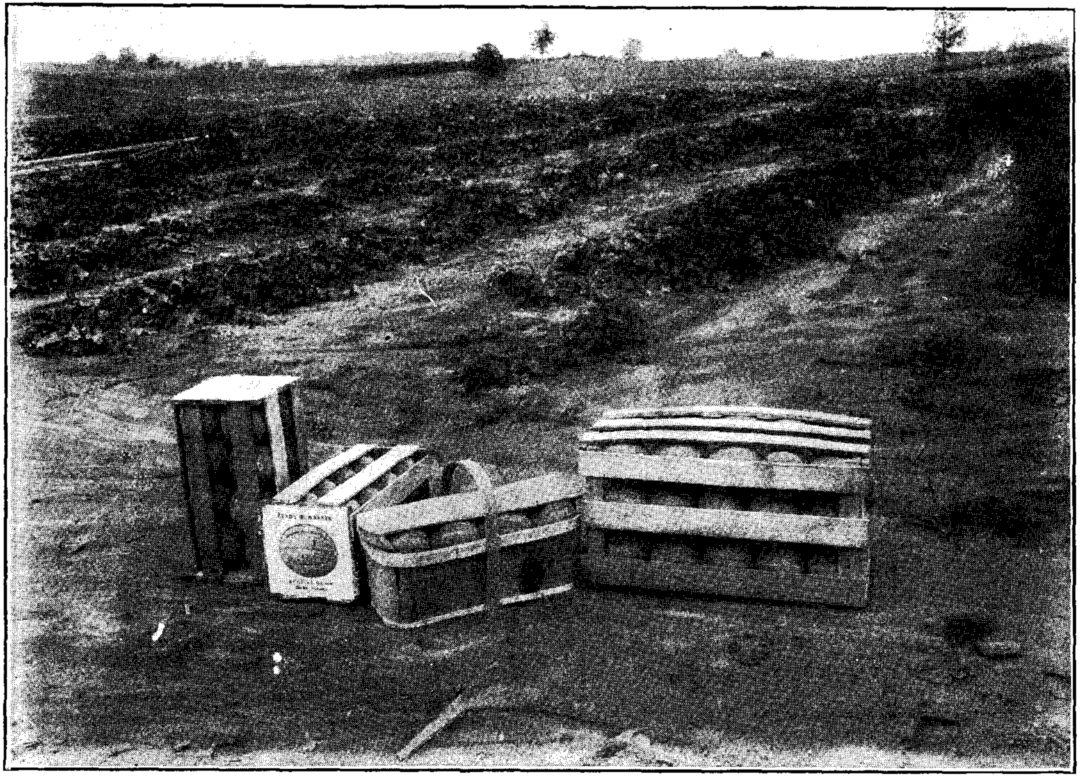
LOCATION.	Description.	Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
3 miles west of Oaktown.	Surface 12 in.......	2.0	20.5	17.4	20.3	10.5	18.5	12—
3 miles west of Oaktown.	Subsoil 12 in.-24 in.	4.5	22.5	14.6	18.5	8.5	20.0	12
1½ miles west of Busseron..................	Surface 12 in.......	7.5	21.4	18.5	19.4	7.5	19.5	11.4
1½ miles west of Busseron..................	Subsoil 12 in.-24 in.	2.5	20.8	12.5	16.4	9.5	20.0	16.5

KNOX SAND.

Extending west from Decker to within one and one-half miles of Iona lies the most productive sand hill area in Knox County. The material is from a medium to a coarse quartz sand. The coarse sand is in some places interbedded with fine or marly sand. The sand has in places a maximum thickness of about 100 feet. It is characterized by a typical dune topography, though somewhat subdued in outline because of the reworking and creep and other influences. This sand is of a dark, reddish-brown color, or light gray where it lies more level and has been leached. The subsoil is heavier than the surface and at a depth of from 12 to 14 inches, because somewhat sticky; at some places the subsoid at a depth of three feet or more is an orange colored sand mixed with enough clay to give it a plastic character. It is composed of pure wind-blown sand, lying in round top hills that raise successively throughout the whole extent of the area. To the northward the wave appearing hills become more rough and rugged, since they merge into the clay gradually, which is a firm loam. North, and bearing a little to the west, the sandhills extend into the district of Vincennes Commons and the Cathlinett surveys, but throughout this distance from Decker to Vincennes occasional clay hills and flats or bottom crop out among the sandy hills and give opportunity for the cultivation of grains, such as wheat, corn and oats. West of E. & T. H. Railroad to the Wabash River lies broad, extensive river bottom land of the Wabash and White River valleys. Upon the surface of the prairies and in the valley of the Deshee, a tributary of the Wabash, are a few hills of sand, similar in composition and appearance to those north and east of Decker, but they are



Crating and basketing for market. Knox County.



Musk Melon Field. Baskets and Crates. Knox County.

more scattering and cover a smaller area and indeed should not be counted as members of the Decker group.

The native forests of the hills are of small area and rather young, bearing fact of the youthfulness of the sand formations which were destructive to plant growth. Oak, white and black, sassafras, poplar, dogwood and maple make up the woodland. The largest forests do not grow far within the sandy soil region, but near the edge, where the sand and clay make a very valuable soil by being mixed together. Sassafras and sumac shrubs grow thick along many of the roadways and at the base of the hills.

The majority of the farms are small, containing 30 to 80 acres, still there a few landowners who have control of large tracts and also retain a deep personal interest in the cultivation of the soil. In the first case, the time of the owner is spent in the development of the crops alone and he neglects the improvement of buildings, fencing and of clearing away of the unnecessary shubbery from the division lines of farms and highways. The larger landowners have clean lands, well fenced, but within the whole area we do not find any modern home dwellings surrounded by landscape gardens, as we do elsewhere. The principal buildings are of rough lumber, are not often located near the home, but are scattered promiscuously over the hills and are used for the packing and preparing of products for the market. Those that have many acres live in the town and take little interest in making improvements.

Indian corn is usually grown on the clay outcrops among the sand dunes and it produces an average yield of 40 to 60 bushels per acre. Often it is tried upon the loose sandy hills, where the clay constituent is almost wholly absent, and under such conditions it is always cut short, since the sand has not the ability to retain sufficient moisture for the corn during the growing season. Wheat yields well, making from 18 to 30 bushels per acre, and is sown in the sandy soil as well as the clay.

Yet gradually these grains are giving place to the growing of the cantaloupe and watermelon. This reddish-gray sand extends to various depths, often reaching as much as 40 feet. The soil is loose and the roots of the melon vine find easy access to sufficient plant food so that they grow quickly and rankly. In the early spring extensive hot beds are used to germinate the seed to give them an advance growth before the warm summer season for transplanting opens. This brings the melons on the market nearly two or three weeks before they would be if the seed were planted directly in the field. The intensive farming of cantaloupes is practiced entirely in the vicinity of Decker, while farther away from the town the older method of field planting is still used. The annual return of the cantaloupe crops has been increasing steadily, and for the year 1911 the output was about 200 carloads. During the gathering and packing season, pickers come from the neighboring towns as well as from the homes of the territory, and are given $1 a day and board, or $1.50 and have the privilege of rooming and boarding at their own expense. Even then there is generally a great loss to the producers from the fact that many melons must be cast aside because they have become too ripe for marketing. The picking season of these melons seldom extends longer than four weeks and is generally several days less. The expense of marketing the cantaloupes is estimated after careful calculation at $120 per acre, but the owner in order to make his returns as large as possible has done away with commission men and ships direct to the eastern and northern markets, to the wholesale and retail dealers. In this way some have received a net gain of $1.25 on a basket during their early shipments. Later in the season the price drops to 35 and 40 cents. Those who practice the intensive farming are realizing a profit of $300 to $500 per acre.

The watermelon seeds are planted in the field and are not cultivated as carefully as the cantaloupes. Yet the return is profitable, ranging from $30 to $90 per acre. The long green melon sometimes known as the "Rattlesnake" melon is grown for early shipment, while the "Sweetheart" melon is grown for district marketing because of its firmness and large size. During dry seasons the crop is cut short and often averages as low as $50 per acre. In shipping the watermelon, the average prices received on the track was $130 per car, although they were retailed at the patch for 5, 10 and 15 cents per melon.

Because of the excellent flavor and quality of these crops, the formerly low rated sand loam is now held at the fabulous prices of $300 to $400 per acre, and the vicinity of Decker is ranked as one of the greatest melon tracts in the central West. More cantaloupes are produced in both Gibson and Jackson counties, but the acreage is more scattered and at no other place has the business reached the development and importance as in this locality. The principal variety grown is a strain of the Netted Gem and even rivals in quality and appearance the famous Rocky Ford.

Rattlesnake Melons. Note heavy, full foliage

SUMMARY.

Knox County is one of the best within the State, and ranks first in some of the crop productions. A very large percentage of the land is under cultivation and the improvements are from fair to good.

The uplands about Edwardsport have a higher percentage of clay than the typical silt loam. The principal timber growth is hickory, black and white oak, elm, sycamore, red maple, sassafras, white maple, Judas tree, ash and persimmon.

A large number of mules are raised in the northeastern part of the county, and throughout the area more mules than horses are used in the farm work.

A large acreage of little red clover is grown in the river bottoms in the northeast part of the county. Excellent stands are secured and heavy crops grown. Over much of the area the crop is cut for hay, and the second crop for seed.

Several plantings of catalpa and black locust of considerable size are put out. The trees are planted close and make a good growth. There are some small wooded tracts in the river bottoms. In general, the fields are cleared to the river banks and cultivated close. At Edwardsport there is a good line of cottonwood and black willow along the river.

Along White River the sand and gravel found in the bars is good and is being used for road material, building sand, etc.

The soils of the White River valley are very productive throughout and the farms are being kept up in good condition. The trumpet creeper and wild morning glory give much trouble in some fields. In the river bottom the tree growth is dogwood, redbud, willow, cottonwood, hackberry, elm, sugar, red and water maple, walnut, wild cherry, chinquapin and cow oak.

Much nursery stock is grown on the upland loess soils in the Knox silt loam east of Vincennes. The soil seems well adapted to the growing of all plants which the nurseries desire to grow.

In the upland area the wells are from 30 to 120 feet. The drilled wells average 60 to 75 feet. The dug wells do not exceed 55 feet. The water obtained is usually good.

In the area for several miles about Vincennes the farmers sell all straw to the paper mills. The farmers receive on the average only about one dollar per ton. The straw is of much more value to the farms for the amount of humus which it would add to the soil. Before the paper mills were established, most of the straw was burned in the field.

A considerable number of hogs are fed through the western part of the county on the upland areas. Dairy herds of from 3 to 13 cows are numerous. Various breeds are used.

Widner and Busseron townships are the best tiled of any part of the county. Twelve carloads of tile have been put in the lowlands below Busseron along the railroad.

In places are found spots of gravel which are called "Lousy Ground," which seem to lack potash. The soil will produce a good heavy yield of straw but will not mature the grain. The burning of straw on the ground increases the yield. Some use an application of about 200 pounds per acre of a fertilizer known as the "Black Soil Special."

In the lowlands along the railroad at Busseron the soil is of a very mucky composition. In one case three crops of wheat were grown in succession; the first two yielded 31 bushels, and the last 24 bushels per acre. Corn yields from 50 to 90 bushels.

Cowpeas have been grown in the region about Busseron and Oaktown for about fifteen years. It has been shown that cowpeas planted about June 15th make much better growth than those planted earlier. If they are planted before the ground is thoroughly warmed they often become stunted and do not make a good growth at all.

Two examples were given of wheat planted in the fall of 1910 which did not come up until the following February, and made an average yield of 26 bushels.

In the black sandy soils are many glistening scales of mica which sparkle over the surface in the sunlight.

In the black soils to the southwest of Oaktown are some areas which are always loose and in which the plow will not scour. Corn does not mature, usually tassels out at height of two to four feet. In the black soil areas to the northeast of Oaktown is an area, near the place of Grizzle, which has a very bluish color. This soil was in tomatoes in 1911 and the growth was only fair, but no conclusion could be given as to an average growth because of the effect of dry weather.

There are some very large farms within the county, but the majority of the farms range from 40 to 120 acres. There is a large percentage of rented farms.

SULLIVAN COUNTY.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Sullivan County, organized in 1817, was named in honor of Daniel Sullivan, who was killed by the Indians on the road from Vincennes to Louisville while making a trip between the two places in Government service.

"It has been erroneously supposed and has been often repeated through mistake that the county of Sullivan upon its first creation extended northward to the lake of Michigan. As a matter of fact, its northern boundary was the Indian line separating Harrison Purchase of 1809 from the purchase of 1818, the line being established in 1809 at the time Harrison's purchase was made. This line extended from near Brownstown, through Gosport, to the boundary between Indiana and Illinois at a point about west of Hillsdale, in Vermillion County, and Sullivan County upon its creation comprised all the country southwest of the line (except a small portion attached to Orange County), and west to the west fork of White River and north of the present boundary of Knox County, or it comprised the greater portion of Owen and Clay, parts of Parke, Greene, Putnam, and Vermillion, and all of Vigo and the present Sullivan.

"The first county seat was Carlisle. It was stated that it was changed to Merom in 1819, but although the writer had access to all the State enactments prior to 1840, the law making the change of location could not be found, though every act was carefully scrutinized. At all events, by some means the county seat was changed to Merom, then probably the most important place in the county, not even excepting Carlisle, owing to the location of the town on the Wabash River and on an important and well traveled State road. Here it remained until 1830 (that date is correct) without serious molestation, though much dissatisfaction was expressed owing to the remoteness from the center of the county.

"The act which ordered the change of the county seat from Merom to the center of the county cannot be given. It was probably passed at the session of 1841-42 and in effect was similar in its provisions to the acts given above, approved January 29, 1830. Property owners of the town of Merom were given the right to exchange their lots with others similarly located in Sullivan, or they were paid the depreciation determined by a board of arbitrators. Considerable inconvenience, and in some cases injustice, grew out of this novel mode of removal and adjustment, but time healed all wounds. Sullivan has since been the county seat."*

The courthouse was erected at a cost of nearly $9,000, and was completed January 1, 1852. In 1872 it was remodeled and the wings were added to the end, leaving the building as at present, except the addition of a fire-bell in 1876. The structure as it is today has cost the county about $50,000. The first settlement in the county was made by the family of James Ledgewood, who located near the present site of Carlisle in 1803. The Ledgewood family were the first settlers north of Knox County and hold a prominent place in the history of Sullivan County. Other of the early settlers were Benjamin Price, Major Watson, Thomas Holden, Edward Parcell and Colonel Benefiel. Colonel Benefiel was a member of the first constitutional convention held in 1816. He represented Knox County, which at that time included Sullivan.

Sullivan, the county seat, with a population of 4,115, is located in the geographical center of the county on the I. C., the E. & T. H., and S. I. railroads, and the Terre Haute traction line. It has 11 mail routes, U. S. and American Express, Postal and Western Union Telegraph, Bell telephone, 1 mile of sewer, 3 bakeries, brick and tile mill, carriage and wagon factory, 3 flour and grist mills, planing mill, saw mill, woolen mill, bottling works, ice cream plant, 2 concrete block factories, 50 stores. The estimated number of employes in manufacturing plants is about 50, with an estimated weekly payroll of $500.

The town of Sullivan was founded as the result of the selecting of the place for the county seat. It was laid out in 1842. At the time of selection of the site the ground was little changed from the state of the virgin wilderness. It is said that the location was formerly wet and swampy, notwithstanding the slope to the creeks on either side. In 1843, water sometimes stood to the depth of two feet on the courthouse square. The coal mining industry has given employment to about 1,000 men, with an average weekly payroll of $1,500. Factories are needed here, and the people would gladly lend assistance by way of a free site and bonus to secure them. It is a good residence town, and good conditions are present to encourage the building of good substantial homes. The agricultural conditions of the surrounding country are good.

Carlisle has a population of 850. It is situated 10 miles south of Sullivan on the E. and T. H. Railroad. The town has industries producing metal kitchen cabinets, lumber, and medicines, also a

* Wolfe's History of Sullivan County.

creamery and two coal mines. There are about 20 stores, handling all kinds of merchandise. The town is situated in a rich and well improved agricultural region. It is chiefly dependent upon the growth and development of the country industries.

Carlisle, being the oldest town in the county, has several historical phases. It is one of the oldest American settlements in the State. The town was laid out in 1808 and a considerable settlement sprang up in that year. The early county courts were held here. The place of meeting often used was a large beech tree in the north part of the town. During the war of 1812 the town sent out several soldiers into the field. It was near this town that the "Dudley Mack" massacre took place during the war.

Hymera has 1,615 inhabitants and lies on the E. & T. H. and S. I. R. R., having four passenger trains daily. There are about 20 stores. It is a good trading center and is situated in the coal area, and mining is the only industry. About 500 men are employed in the industry and the weekly payroll is about $12,000. Factories to utilize the clay and shale of the mines would find a good location.

Merom has a population of about 520. The Union Christian College is located here, and it is this which keeps up the town. The bluffs along the Wabash are magnificent here and each summer a chautauqua is held here for ten days. It brings hundreds of people each summer to the town, and the boarding houses, restaurants and livery stables do a thriving business. Little is known about the early history of the town. It was the county seat for twenty-five years until 1842. It was then the most important town between Terre Haute and Vincennes. The situation on "The Bluffs" makes this an excellent location for campers, picnickers and public meetings. This should be well kept up along this line. A good roadway has recently been constructed from the top of the bluff to the river. A ferry crosses the river at this point. The railroad station is at Merom Station, two and a half miles to the south on the I. C. Railroad. Hack lines connect the two places. Merom Station is a good shipping point. During the melon season it is a very busy place. Much gravel has been shipped from this place. The gravel is very plentiful between the station and the lower river bottoms.

Shelburn has 2,065 inhabitants and is situated five miles north of Sullivan on the E. & T. H. and S. I. railroads, and the T. H., I. & E. traction line. There are three miles of crushed stone streets, five rural routes go out from the town. There are 25 stores of various kinds, two sawmills and lumber yards, and immediately surrounding are extensive coal mines. The coal mining industry has always been the main source of support for the town. A few years ago it was thought that the coal deposits were about worked out and the town began to decline, but a lower and better vein of coal was discovered and since that time there has been a very good growth and development. Groups of houses have been built about the principal mines and make the settlement very town-like in appearance. Most of the mines are within a radius of three miles of the town. About 1,500 men are employed in the coal mines, receiving about $20,000 weekly. There are opportunities for further development in the natural resources. Much good farm land is found surrounding the town, but it has not been well improved. The surface has been neglected for the resources beneath the surface. Rapid development is now being made where the farmers own the land. Excellent offers are made to farmers of experience who wish to rent land either for grain rent or for partnership work.

Farmersburg had a population of about 1,115 in 1910. It is 12 miles north of Sullivan and is on the E. & T. H. Railroad and the Terre Haute traction line. The early town was known as Ascension, because of the founding of the Ascension Seminary there. The growth of the town was dependent upon this institution. At the present time the town is, as the name suggests, a trading point for the surrounding country. The town is far enough removed from other towns of size to insure good trade conditions, and the location would warrant the establishing of various enterprises, such as canning factories, creameries, etc. The water supply is good. Some good timber is still found in the vicinity.

Dugger, with a population of 1,226, is 10 miles east of Sullivan on the Vandalia and I. C. steam road. It has a flour and grist mill and a sawmill. There are several coal mines within a radius of three miles. The population has more than doubled during the past ten years, and the recent development of the coal and increasing transportation facilities are encouraging rapid progress. There are about 25 stores.

Paxton is situated between Carlisle and Sullivan and has a population of about 180. The town was platted in 1868, shortly after the building of the railroad, and was named in honor of an early merchant and physician of Carlisle. The surrounding farm land is very fertile and well improved.

Pleasantville is located in the southeastern part of the county. It is a mining town and trading center. The population is about 250.

The village of Cass is situated in the township of the same name, in the eastern part of the county. It has a population of less than 300. The postoffice has always been called Cass, but the town was formerly called Buell.

Fairbanks, in the northwestern part of the county, has a population of 110. It is situated on the old State road. This was one of the early towns which flourished in the days of the stage coach line from Vincennes to Terre Haute. There are no railroads and the town does not have prospects for much growth unless an interurban line should be built to connect with Terre Haute and Vincennes. An automobile hack line runs to Terre Haute. There is some good farm land surrounding, and some of the farms are being well improved.

Graysville is located on the old State road about four miles north of Merom. It was founded about 1850. The population is about 100.

New Lebanon is a little village located in the central part of the county, about six miles east of Merom. It has a population of about 125. The I. C. Railroad passes about a half mile north of the old town. A grain elevator has been built near the station.

Star City, Caledonia, Farnsworth, Superior and Wilfred are small villages and settlements which sprung up around various coal mines. Curryville is an old cross road settlement, just north of Shelburn. Scott is a site of a former postoffice in the north part of the county.

Land Grants, Donations and Surveys.

"The first settlements in Sullivan County were made on land that the French had obtained from the Indians during the French regime. These lands were in the vicinity of Vincennes and were later known as the Vincennes district. The treaty with the Indians for these lands was made in 1732, and the general description of the boundaries was 'lying between the point above, Pointe Coupee en haut, and the river Blanche below the village, with as much land on both sides of the Wabash as might be comprised within the said limits.' Pointe Coupee en haut was a mile or so above the mouth of the Busseron Creek in the southwest corner of what is now Gill Township. The village referred to in the treaty was of course Vincennes, and the river Blanche was White River. Thus the lands granted to the French by this treaty comprised practically all of Knox County, the southern part of Sullivan County, besides some lands on the west side of the Wabash.

"Some of this land was occupied by the residents of the county during the French and British control of the territory. After the American conquest and while Vincennes was commanded by the governors from Virginia, further dispositions of the lands were made under the authority of local officials. After the organization of the Northwest Territory in 1787, the disposal of the lands was regulated by Congress.

"In 1791 Congress passed a land law upon which were based subsequent titles to the lands of this district. This law provided--

"1st. That 400 acres of land should be given to the head of each family residing at Vincennes, or in Illinois country in the year 1783.

"2d. That a tract of land containing 5,400 acres near Vincennes which had been under fence and used as a pasture for thirty years, should be given to the inhabitants of Vincennes, to be used by them as a common until otherwise disposed of by law.

"3d. That the Governor of the territory be authorized to donate a tract of land of 100 acres to each man who first of August, 1790, was enrolled in the militia, had done militia duty and had not received a donation.

"4th. That the Governor upon application should confirm to heads of families the lands which they may have possessed and which may have been allotted to them according to the usages of the Government under which they respectively settled.

"5th. That where lands had been actually cultivated and improved, at Vincennes or Illinois country, under a supposed grant of the same, by any commandant or court claiming authority to make such grant the Governor might confirm such claim not exceeding 400 acres to each person.

"The bodies of land described in the first section have since been 'donations;' those in the third paragraph as 'militia donations;' and the last classes are generally known as 'surveys.'

"The status of the lands in the Vincennes district at about the time the first settlements were platted in Sullivan County is described in a letter from Gen. Harrison to James Madison in January, 1802. He said that the Governors' courts maintained at Vincennes under the authority of the Virginia commonwealth from 1799 on had assumed the right to grant lands to all applicants; that they did this for a time without opposition and concluded that as they were not interrupted they could continue as they pleased, that finally the whole country to which the Indian title was supposed to be extinguished was divided among the members of the court and perhaps others, the lands thus disposed of extending along the Wabash River from LaPointe Coupee to the mouth of White River and forty leagues west and thirty east excluding only the lands surrounding Vincennes, which had been granted to old residents. The authors of this division had later perceived that their course was illegal and the scheme was abandoned but was revived a few years before 1802, and portions of the land purchased by speculators and sold fraudulently to eastern settlers. Harrison stated that upward of 500 persons had settled or would soon settle upon these lands in consequence of these frauds; that the owners pretended that the court had ample authority from Virginia to grant the land and that speculators had gone to Virginia, had secured a deed for a large tract, and had had it recorded and duly authenticated and had then made their fraudal transfers to the credulous.

"A large amount of litigation arose from this condition of land claims and it was several years before the claims were investigated and settled by the Government commissioner. A more complete account of the subject is now pertinent to the history of Sullivan County, but the fact that much of the land got into the hands of speculators and was offered for sale in Virginia to prospective home seekers no doubt explains the cause that attracted some of the first settlers to the region now included in Sullivan County.

"The lands about Vincennes were, as already stated, ceded by the Indians to the French in 1742, but on June 7, 1803, General Harrison concluded a treaty with the Delawares, Shawnees, Pottawatomies, Miamis, Eel River Weeas, Kickapoos, Piankeshaws, and Kaskaskias which confirmed this cession. The northern boundary of the cession as described in the treaty is a matter of history in Sullivan County. Pointe Coupee on the Wabash just above the mouth of the Busseron was the principal point on this boundary. The line did not run due east and west through this point, but at an angle of 12 degrees from this direction, its general course being from northwest to southeast. The treaty also provided that in case some of the settlements on locations of lands made by the citizen of the United States should fall in the Indian country, the boundary might be altered to include these settlements.

"This is the origin of the 'old Indian boundary' in Sullivan County, the line that so often figures in the land descriptions of the southern part of the county. A small portion of the southwest corners of Gill and Jefferson townships is south of this line, and the greater part of Haddon Township is by this line shown to be the cession which was confirmed by the treaty of 1803. In Haddon Township, the boundary leaves the straight course at right angles, so as to include within the ceded area a rectangular body of land lying about three miles northeast of the general direction of the boundary. In this rectangle is the town of Carlisle. It is probable then when the survey was made this deviation from the regular course was made in accordance with the clause of the above treaty in order to include some settlements that otherwise would have been left in the unceded Indian country.

"To satisfy the claims of the old French settlers, the United States directed to be set apart all the lands bounded on the west by the Wabash River, on the south by White River, on the east by the West Branch, on the north by the north bounds of the old purchase.

"Four hundred acres was assigned to each person entitled to a donation. The land has never been surveyed by the order of the Government, consequently it has never been regularly performed, and the maps of this territory within these boundaries are generally blank. All lands held in this quarter are therefore under French grants, except some militia claims. In locating it was necessary to begin at the general boundary or at some corner of lands, lines of which would lead thither, but no course was given, and the claimant settled the point with the surveyor as he deemed most to his interest."*

Transportation Facilities.—The transportation facilities of the county have passed through the entire line of the evolution by means of travel. The following account from Wolfe's History of the county, page 139 to 147, gives a good account of the early condition:

"Hundreds of flatboats annually descended the Wabash and White River. The trade of the Wabash River is becoming immense. In 1831, during the period between March 5th and April 16th, 54 steamboats arrived and departed from Vincennes. It is also estimated that at least one thousand flatboats entered the Ohio from the Wabash at the same time. In February, March and April of the same year were 60 arrivals of steamboats at Lafayette."

The writer tells us that one-tenth of the flatboats according to the estimate were "loaded with pork at the rate of 300 barrels to the boat;" another tenth said to be loaded with lard, cattle, horses,

* Wolfe's History of Sullivan County.

oats, corn meal, etc., and the remainder with corn on the ear. The value of produce and stock sent annually to market from the valley of the Wabash was estimated by one authority at nearly one million dollars.

"Corn is shipped on the ear. The southern planters preferred is so to being shelled and sacked since it was less liable to spoil. Among the staples brought back from the south was New Orleans sugar. Of course sugar was a luxury and until the steamboat era reduced the cost of transportation the pioneers generally depended on maple sugar, and other home-made substitutes. Even after steamboat traffic became general a large proportion of the imported merchandise used in Sullivan County was brought in overland from Louisville and Evansville. For a number of years a man named Webb of Merom carried on an extensive business of hauling goods overland. He had several good teams in which he took much pride.

"Busseron Creek was also considered a navigable stream during the flatboat era. Owing to the presence of forest growth and lack of drainage, the waters of this and similar tributaries were greater in volume and less fluctuating than in later years and during the spring freshets it was possible to float boats loaded with produce down the current of Busseron. Caledonia was once a center for the flatboat traffic. The boats were also loaded at Carlisle and other points.

"For the transportation of mails and passengers, the pioneer epoch had few regular facilities. Mails were carried overland from Vincennes to Merom and Terre Haute, usually on horseback. Travel was usually by the same means and the individual traveler depended on his own horse and followed such roads as he found through the wilderness. When steamboats began running up and down the river, mail and passengers were conveyed on the boats and about the same time the State Road was constructed from Vincennes north through Merom to Terre Haute. For many years this road was the principal thoroughfare for all kinds of traffic up and down the Wabash valley. The river was not navigable at all times of the year and consequently the stage road was more to be depended upon for transportation the year around. A line of stage coaches ran over this route even for a year or more after the building of the railroad north and south. Merom was a regular station on this line which passed through Graysville and Fairbanks into Vigo County.

"Following the era of river, canal and stage transportation came the railroad. During the stirring epoch of internal improvement of the early thirties railroads and canals were planned to supplement each other. Eight railroads were chartered in Indiana Legislature in 1882 and during the next five years twenty-eight charters in all were granted for the proposed lines, but for the time the canals were pushed with greater energy and the era of railroads in Indiana begins with the middle of the century."

At the present time, the county has fairly good transportation facilities. The E. & T. H. runs north and south through the county, the Indianapolis–Effingham division of the Illinois Central crosses the county from east to west near the center. Branch lines and spurs from the Southern Indiana, the Monon, the I. & V. and the E. & T. H. permeate all parts of the coal bearing area in the eastern and northern parts. The northwestern third of the county is without railway facilities. An interurban line runs from Terre Haute to Sullivan. More interurban lines are needed in the county, a line running from Terre Haute through Fairbanks, Graysville, Merom to Vincennes, would open up great development within the western part of the county.

The Wabash River may be made navigable and will no doubt be so used in a few years.

The county has about 1,000 miles of public road with about 350 miles improved. By far the greater percentage of the roads are improved with gravel, about 100 miles being improved with crushed stone. The stone comes from Thornton, near Chicago, some from Spencer, some from Bedford, and some from local quarries. The stone from Thonton is secured at a very reasonable rate as in that manner the railroad can have loaded cars in both directions, loaded with coal for Chicago and on the return hauling crushed stone. The gravel is derived from deposits along the flood plains and terraces. The principal areas are west of Fairbanks and in the vicinity of Merom Station. The Merom Gravel Company has furnished large quantities for local use and also shipped a great deal. The pits have from 20 to 30 feet of gravel down to water, with very little soil and clay. The deposits extend to the river and the gravel company is pumping gravel from the bed of the river. The eastern townships of the county have no gravel deposits and the native rock is not of very good quality. The first improved roads were built in 1895 and the work has made a very marked progress.

The Sullivan County Agricultural Society was organized at Carlisle in 1852 and the first fair held that fall. In a few years, Merom and Sullivan became rival claimants against Carlisle for the fair, but when the directors decided to let the fair be held at the place which contributed the most money, Carlisle retained the title and thus secured the fair meetings for the following five years. The fairs were held at Carlisle for twelve consecutive years but the attractions were meager and popular interest almost compltely failed during the years of the war. In 1865 it was decided to have all succeeding fairs at Sullivan and the first fair was held at the county seat in 1866. For a few years the fairs were moderately successful, but the one of 1878 was so complete a failure that no more was heard of the association until 1885. In 1886 a very successful fair was held. In 1888 the grounds were improved by a new track and deep wells being sunk on the grounds and a new amphitheater and floral hall. Since 1896 there have been no county fairs.

In 1908 a series of "peoples' Saturday fairs" was inaugurated. These comprised various attractions and events and drew large numbers of people into Sullivan and created great interest. These were held each Saturday from August 15th to October 31st. In 1874-76, the Grange was an important organization among farmers and tradesmen in this county. On July 24, 1899, the Farmers' Mutual Benefit Association was organized at Pleasantville. "The objects of this organization were to unite farmers in all matters pertaining to the interests of their calling, to improve the method of agriculture, horticulture and stock raising, to devise and encourage such systems of concentration and co-operation as will diminish the cost of products."

It attempted to maintain a farmers' store; it also sought to secure a legislation in behalf of the farmers; it also tried to operate a milling plant and a grain and wool warehouse in the interests of its members. It was a part of the great national movement and died out with the passing of the crisis of the movement in the United States. The first farmers' institute was held in 1899 and an organization formed which still holds its meetings at different parts of the county and the attendance and interest is usually good at these meetings. The farmers and wives engage in practical discussions and experts are also invited to the meetings to instruct its members.

General.

Sullivan County has developed rapidly during recent years, due to the extensive mining interests in the county. The population in 1830 was only 4,696; in 1850 it had reached 10,500; in 1910, to 32,439—an increase of 6,434 during the previous ten years. "The Indiana Gazetter," published in 1850, has this to say of the industries in Sullivan County at that time: "There are in the county 11 grist mills, 9 sawmills, 4 carding machines, 4 lawyers, 16 stores, 17 physicians, 20 preachers, 20 blacksmiths, 30 carpenters, 10 coopers, 5 saddlers, 17 shoemakers. The taxable land amounts to 168,129 acres and about 70,000 acres still belong to the United States, of which at least half is of a very poor quality. Coal is found in abundance and Sullivan ought to be among the richest counties in the State."

The total farm area is 272,012 acres of which 227,784 are improved. The average selling price is $50 to $110 per acre unless underlaid with coal, when it is valued much more highly. Some small areas can be bought for $20 to $30. Sullivan County ranks fifth in the State in the production of alfalfa; third in acreage of peas; fourth in acreage of watermelons and cantaloupes. It stands fourth in the sale of sheep.

The county produces annually about 2,085,000 bushels of corn, or an average of about 35 bushels per acre; wheat, 427,465 bushels, averaging about 21 bushels per acre; oats yield about 210,500 bushels, or an average of about 25 bushels per acre; about 7,000 bushels of rye with an average per acre of about 15 bushels; a very small acreage of buckwheat is grown, principally for bees; from 28,500 to 32,700 tons of timothy hay are grown annually, averaging about 1½ tons per acre; alfalfa is grown on about 100 acres each year, yielding from 1½ to 4 tons per acre; a few acres of prairie hay is grown, yielding from 1 to 2 tons per acre; clover has an acreage of over 3,000 acres yielding more than a ton per acre. Potatoes yield over 9,000 bushels or from 30 to 35 bushels per acre. Some onions are grown for the market; they make from 50 to 350 bushels per acre. Berries have a small acreage, but yield from 36 to 75 bushels per acre. Tomatoes are raised on about 50 acres, yielding from 40 to 100 bushels per acre. About 200 acres of cantaloupes and 900 acres of watermelon are grown.

Some horses, mules, and cattle are raised for the market each year, hogs number about 17,000 head per year; sheep average about 17,500 per year, being the fourth county for rank in sheep raising. Poultry raising receives considerable attention in this county.

Physiography and Geology.

The surface of the county is principally level. Some broken country lies in the northeastern part and along the eastern side, but the rougher areas are along the streams; the sand hill regions present an undulating surface. The stream valleys are wide, and about one-fifth of the country is occupied by the flood plains and terraces. At Merom the river bluff has a height of about 170 feet. Here and at the narrows in Section 25 (9 N., 11 W.) the river flows directly along the bluff. Below Merom the Wabash valley is from two to four miles wide, the terrace is made up largely of gravel; above Merom the valley is from one and a half to three miles wide and the terrace is quite sandy.

The coal measures are the only geological formations represented in the surface rocks of the county. The rocks are everywhere, except along the stream, covered with drift or loess to a depth of 10 to 50 feet or more. The eastern part of the county is more broken than the central or western and the soils are thin and poor.

Three coal veins of workable thickness are mined at many places in the eastern half of the county. The main line of the E. & T. H. marks approximately the western limit of present mining operations. To the west of this line the coal veins are so far below the surface that they cannot now be profitably worked under present mining conditions. In future years these deeper parts will be worked, as will also the thinner veins. Good beds of shale and underclays are found in the eastern part of the county. These deposits should be utilized for the making of such wares as conduits, sewer tile and other vitrified wares. The only use now is for ordinary brick and drain tile.

The following description by David Thomas in his "Travels in the West" is here quoted from Wolfe's History of Sullivan County and gives a good description of the surrounding country as viewed from Merom bluffs.

"From the most elevated point of the bluff the eye can be gratified with a charming view of LaMotte Prairie immediately below in front; and with Ellison's and Union prairies on the right and left. The whole stretching along the river a distance of not less than 30 miles, are all now rapidly settling. In the rear of this beautiful sight is a flourishing settlement of 20 or 30 farms, three miles east of town.

"Gill's prairie, south three miles, has at present a handsome population of industrious farmers."

Section at Merom Bluff.

	Feet.	Inches.
Loess and drift	30	0
Soft sandstone, upper beds disintegrating	20 to 25	0
Massive sandstone, Anvil Rock with ferruginous seams and veins	10 to 25	0
Conglomerated pieces of shale, coal, pebbles and sandstone, bedded in calcareous material	2 to 8	0
Fossiliferous limestone	2 to 4	0
Dark clay shale	2	0
Rash coal	2	0
Black slate	1	2
Fire clay with pyritized pebbles	4	6
Light drab clay shale	5	0
Bituminous shale, small iron ore nodules	6	7
Fossiliferous limestone	2	0
Marl clay	1	6
Drab clay marl	1	2
Dark bituminous and calcareous shale	6	2
Black sheety shale	1	6
Coal	1	6
Fire clay	2	8
Fire clay, pyritous	1	6
Dark soapstone, iron stone pebbles	3	0
Silicious flagstones	2	0
Light blue argillaceous flagstones	2	0
Fossils	5	0

Section of Mine Shaft at Star City.

	Feet.	Inches.
Surface and drift	15	0
Shaly sandstone or shale overlying sandstone	45	0
Blue clayey shale	20	0
Coal	4	6
Underclay	6	0
Limestone	3	0
Gray to blue shale	20	0
Coal	5	0
Shale	10	0
Total	128	6

Section at Mine Shaft at Farnsworth.

	Feet.	Inches.
Soil and drift clay	12	0
Gray sandy shale	17	0
Blue clayey shale	8	0
Coal	3	4
Underclay	8	0
Grayish limestone	2	8
Blue clayey shale, with occasional nodules of iron carbonate	18	0
Dark bituminous shale, fissile	3	0
Coal	5	6
Total	76	8
Under clay merging into gray sandy shale	?	?

Section of Mine Shaft at Hymera, S. W. of N. E., Section 23.

	Feet.	Inches.
Soil and drift	27	0
Coal (outcropping)	....	6
Sandstone	3 to 5	0
Clay shale	12	0
Coal	5 to 8	0
Fire clay	2 to 3	0
"Hard rock"	....	..

Section from Oil Well at Sullivan. The Total Depth of Well Is 549 Feet. Depth Here Given Is 111 Feet.

	Feet.	Inches.
Soil	5	0
Gray clay with thin partings of white sand and pebbles	8	0
Glacial hardpan or bowlder clay	2	10
Limestone	0	3
Black shale	0	8
Coal	0	2
Gray, silicious fireclay	8	0
Clay shale, iron nodules	7	0
Brown sand rock	20	0
Gray sand rock sharp	10	0
Clay shale	30	0
Coal and shale	0	9
Clay	5	0
Sand rock	15	0
Total	111	10

Section of Mine Shaft at Dugger.

	Feet.	Inches.
Earth	10	6
Sandstone	19	6
Shale	5	0
Blue shale	10	0
Coal	4	0
Clay shale	7	0
Sandstone	12	0
Limestone	10	0
Hard sandstone	25	0
Shale	3	0
Coal	8	6
Black shale	2	6
Sulphur	1	0
Very light clay shale, very soft	7	0
Black shale, very soft	10	0
Black shale, very soft, occasionally "hard head"	8	0
Sandstone, very hard	2	6
Dark blue clay	4	0
Grey shale	8	6
Very hard limestone	2	0
Black shale	6	0
Coal	6	0
Black shale	2	0
Total	174	0

Drainage.—The drainage of the county is chiefly into the Wabash through Thurman's, Turtle and Busseron Creeks. The southeastern part drains into White River with the exception of a small area which drains into the Wabash by the Marie Canal. The Wabash flows a distance of 40 miles. The low water level at Merom is about 420 feet above sea level. The river is fully described under Vigo County.

Busseron Creek rises on the clay plains at the borders of Clay and Vigo counties near the level of Eel River. It flows diagonally across Sullivan County into the Wabash. For some distance near the mouth, the stream seems to occupy a preglacial line of drainage but the upper portion is apparently independent of preglacial drainage.

Knox Sand.

Since the cowpea is grown so extensively on this type of soil and because there are other extensive areas where the crop should be grown, it will be well to give here some description of the cowpea and information as to its culture.

The assertion that "what red clover is to the North and alfalfa to the West, the cowpea is to the South" was some fifteen years ago strictly true, but today it is not the whole truth for the cowpea has advanced into the regions of red clover and alfalfa. A few years ago the cowpea was scarcely known north of the Ohio River, but during the past few years it has extended to the north limit of successful cultivation of dent corn.

The cowpeas, beans, clovers, alfalfa and vetches are known as leguminous plants. In the variety of its size, habits, production and uses, as well as the soils and localities to which it is well adapted, the cowpea rivals and even surpasses corn. Some sorts mature seeds within sixty days from planting, other maintain vigorous growth for six months or longer, even putting forth flowers until the vines are killed by frost; some are short, stocky and erect in growth; others rapid climbers while others travel along on the ground and produce great masses of vines. The seeds vary in color, size and shape, flat round, oblong, kidney; black, white, red, purple, yellow, striped, mottled; small, medium, large. The cowpea will grow on any soil not too wet and in most climates free from frost during the summer months. The stalks and leaves make fine hay, the best of temporary pastures and most excellent green manure; its seeds, green or ripe, are as nutritious as beans and are as much relished for use as human food, or as ripe grain, afford the richest kind of feed for all farm animals. The selection of a variety will naturally depend upon what is wanted in the crop, for the same reasons which leads many farmers to plant a dent variety of corn for grain and a flint for silage or fodder because the flint may give a larger appropriate stalk and a greater proportion of leaf. If hay is required, the variety should be a vigorous growing, late maturing and erect growth to make harvesting more easy. If pasture or green manure is wished, the pea should be planted early in the spring and be a vigorous growing variety. For seed production, special varieties are selected. For table use, others which are tender and of good flavor. The cowpea readily adapts itself to local conditions and some selected strains of these varieties will doubtless prove most useful to northern growers. By picking the first ripened pods for several seasons in succession and saving the early seed for planting, a very valuable local strain may be developed. This method of selection may be followed to obtain a large or long vine or any size or shape to suit north or south, upland or lowland.

Although the cowpea will, as a rule, make better growth than any other plant under unfavorable soil conditions and even where other crops have failed, no crop thrives better on rich ground or more amply repays liberal feeding and intelligent treatment, than the cowpea. It must be remembered, however, that one of the main gains for which cowpeas are grown is the absorption of nitrogen from the atmosphere, and this cannot take place fully under unfavorable soil conditions. The soil should be mellow, well drained and deep. It should have plenty of air and should not be acid. Acid lands are but little benefited by cowpeas. The soil should be well prepared, deep plowing and working down to smooth fine curface essential. The seed may be sown broadcast or drilled. On most soils, the crop will be benefited by the addition of some fertilizer. If potash or phosphoric acid are deficient, the amount of nitrogen which the plant lives on will also be limited.

Cowpeas make a good cover crop for orchards. Cowpea hay is best if cut and properly cured when the early pods begin to ripen. The hay cures slowly and is subject to heating like red clover and must for that reason be thoroughly dry before storing away. This crop is one of the best for grazing and soiling, as it gives more and better feed in the season with less expense than any other crop.

The cowpea always leaves the soil in a better condition than before the crop was grown. It helps the physical character of the soil by sending the long tap roots down into the subsoil and loosening and making more porous; and it helps the soil chemically by the storage of nitrogen in an available form for other plants.

The examination of the roots of a healthy cowpea or other legume shows many little bunches, nodules or tubercles, varying in size from that of a pinhead to that of a pea. They have about the same consistency and much the appearance of very small potatoes, but a microscopical examination shows them to contain myriads of living organisms or bacteria. These bacteria draw a small part of the mineral part of their nourishment from the roots on which they grow, but the greater nitrogen supply essential to their life is gathered from the air, which circulates through the soil. Each of these low forms of life exists but a few hours and goes through a process of decomposition similar to that which takes place in other organic matter. The only difference is that when vegetable matter decays it leaves the soil only what it has taken from it, but these bacteria add the nitrogen which has been absorbed from the air and changed into an available form for other plants. When plants other than legumes, such as rye, oats, etc., are used for green manuring they really add nothing to the soil except what they absorbed from the same during their growth. They, however, change some of the mineral constituetns of the soil into a more available form.

Nitrogen is the most expensive element of fertility and if this can be supplied through the growing plant it is a great saving in the supplying of one of the essential foods. The value of any material as a soil renovator depends largely on the nitrogen, potash and phosphoric acid it contains. The following table from the year book (1895) of the U. S. Department of Agriculture, gives the percentages of these elements in common hay and fodder crops. As these percentages are largely influenced by the water content of the material, the table also shows the percentage of moisture:

Hay or Forage.	Water, Per Cent.	Nitrogen, Per Cent.	Potash, Per Cent.	Phosphoric Acid. Per Cent.
Cow peas	10.99	1.95	1.47	.52
Red clover	11.33	2.07	2.20	.38
Alfalfa	6.55	2.19	1.68	.51
Timothy	7.52	1.26	.90	.53
Wheat straw	12.56	.59	.51	.12

Any crop cut from the field takes away a certain amount of mineral substance which is lost to the soil. To derive the full value from any plant it is necessary that the whole plant be turned under as green manure. The renovation of the soil by the cowpea depends, then, largely upon the use which is made of the crop. In addition to the taking of nitrogen from the air, the cowpea has the wonderful ability to use the potash and phosphoric acid when these materials are liberally used on cowpeas. The soil gains far more than the cost of the fertilizer. The cowpea stands first among the legumes as a producer of nitrogen fertilizer. The crop may be grown between crops of wheat and thus furnish nitrogen for many succesive crops.

SUMMARY.

There are a number of good silos in the county. On the stock farm of William H. Jones, two miles southeast of Merom Station, near the center of Section 33 is a cement silo 56 feet in height and 36 feet in diameter. This silo at the time of its construction a few years ago was the largest in the United States, and at the present time it is said to be the second largest.

Purdue University Bulletin No. 91 is an excellent treatise on construction, materials and capacity of round silos that may be had for the asking.

VIGO COUNTY.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Vigo County was organized in 1818 and has an area of 402 square miles. It was named in honor of Col. Francis Vigo, originally a Sardinian, a true friend of General Clark in the capture of Vincennes, and afterwards a most worthy citizen of the county. The first settlement made in the county was around Fort Harrison. The march of Harrison's army to the upper Wabash, the battle of Tippecanoe and the establishment of the fort seemed to impress the people with the importance of the region, and soon after the war of 1812, public attention was turned to it. In the survey of the land hostile Indians opposed the work. A company of settlers on Busseron Creek were defeated in 1815 and a number of children taken prisoners, who were never recovered.

At the close of the war in 1816, an act was passed by Congress granting lands to certain Canadian volunteers, who had been citizens of the United States, and during the war joined the United States force, and as a consequence their property in Canada was confiscated. The act permitted the land grants to be located, before the public sale in the land district, which included Vigo County. The sale took place in June, 1816, and many settlers had selected choice places and founded their homes with the intention of buying the tracts at the sale; but it proved that much of the land had been located by the grant refund and many of the settlers left for the prairies of Illinois. The unfriendliness between the Canadian settlers and others greatly retarded the settlement of the county.

The county is divided into eleven townships: Harrison, Sugar Creek, Prairie Creek, Otter Creek, Linton, Nevin, Pierson, Fayette, Honey Creek, Lost Creek and Riley.

Terre Haute, the county seat, and the fourth city in size in the State, was laid out in 1816, and the first sale of lots took place in the spring of 1818. In 1820, the river became very low, the wells were dry and there was much sickness and death. This was a blow which required several years to overcome. The city was laid out by a company called the Terre Haute Company. The original site selected for the town was about three miles below the present location, but it was soon abandoned for the more suitable situation. One of the principal reasons for moving was that the National Road crossed the Wabash at the latter place. In 1817, there were but a few log cabins of the rudest style situated along the river. But when the town was made the county seat in 1818 a very substantial growth began. The first court house was erected in 1821-22.

The word Terre Haute is from the French and means high land. The city is favorable situated on the high bank of the Wabash several feet above the ordinary water level. The population in 1830 was 600; in 1834, 900; in 1850, about 3,500; and in 1910, 58,157, an increase of 21,484 over 1900.

Six main lines of railroads pass through the city, the Vandalia, C., C., C. & St. L., E. & T. H., C. & E. I., Southern Indiana and the Terre Haute and Eastern Traction Company. Some of these roads have more than one line and there are branch lines of other roads into the city. Several rural routes go out to various parts of the surrounding country. According to the Department of Statistics for 1910, there are four daily and six weekly newspapers, 30 miles of sewer, 25 miles of brick and asphalt streets, 25 public schools employing 253 teachers, 4 parochial schools, 4 colleges and 54 churches, 9 banks and 21 building and loan associations, 2 automobile factories, boot and shoe factory, 26 bakeries, 2 breweris, 10 brick and tile mills, 2 carriage and wagon factories, canning factories, 20 cigar factories, 7 garment factories, 4 distilleries, 2 sawmills, 2 architectural iron works, 2 artificial stone works, railway shops, coal mining machinery works, fence factories, and other small factories of all classes. There are many good stores and business houses, the number is about 2,000 of all kinds. The estimated number of employes in the manufacturing plants is 12,000; the estimated weekly payroll $140,000.

The Commercial Club in the past three years has spent $300,000 locating factories. It is always willing to give worthy industries sites for building, in addition to which it is willing to pay a fair cash bonus if the number of people employed will justify it. The industries most suitable to local conditions are those which desire a central location, cheap fuel, an inexhaustible supply of good water, and good railroad facilities. Steam coal is available at 85 cents per ton.

The raw material available in the vicinity of Terre Haute for manufacturing purposes are shale, clay, stone, sand for building purposes, glass sand, gravel and coal, the output of the latter being controlled by more than 20 corporations.

Terre Haute is the only city and West Terre Haute the only incorporated town in the county.

West Terre Haute is on the west side of the Wabash River, one mile from Terre Haute. It is on the Vandalia Railroad and the Terre Haute, Indianapolis and Eastern electric line. Two rural routes go out from the town. There are two public schools employing 16 teachers, 16 churches, 2 banks, 2 building and loan associations, a business men's association and a commercial club, a canning factory, 4 brick and tile mills, about 30 stores. The estimated number of employes in the manufacturing plants is 500, with a weekly payroll of $6,000. The population is 4,000.

Seeleyville is located on the Vandalia Railroad and T. H., I. & E. interurban line, eight miles east of Terre Haute, not far from the Clay County line. The town owes its origin to the mining industry, and is almost entirely dependent upon that work. There is one public school with 6 teachers, 2 churches, 9 general stores and a drug store, and a building material yard. The population is 1,200.

Pimento, which was formerly called Hartford, was laid out in 1852, while the Evansville and Terre Haute railroad was being constructed, and has depended almost entirely for its prosperity on its importance as a shipping point. About 1877, a flouring mill was erected, and this with one or two stores of former years and with occasional additions to business activity has made it a quiet little market for the surrounding country. The interurban line now passes through the town. The population is about 175.

Lockport, or Riley, was one of the early towns which flourished in canal days. It was platted in 1836. The E. & I. Railroad passes through the village. Until a few years ago this was the largest village in the county. The population is about 400.

Lewis is a little village in the southeast corner of the county. It is on the Southern Indiana Railroad. It has a grain elevator and is a good trading center for the surrounding country. Population, 200.

Prairie Creek, or Middleton, is near the south side of the county, in the western part. It was platted in 1831, in the days of stage coach traffic between Vincennes and Terre Haute. A tavern was one of the principal features of the town. A steam mill was built in 1847. The nearest railroad is six miles away and for that reason the town has not made much growth. Good roads lead through the town, both north and south and east and west. The population is 160.

Prairietown is a small village which owes its origin to the stage coach days. It was known as "Hoggart's." It was the center of a Quaker settlement. A few small stores are the only industries. There is a fair school building situated in a pretty grove of oak trees. It is surrounded by a rich agricultural region. The population is about 250.

Youngstown is a little residence village on the interurban line southeast of Terre Haute. It is a good location for persons who wish residences in rural villages and have their business interests in Terre Haute.

Sanford is on the Big Four Railroad on the western side of the county to the northwest of Terre Haute. The interurban line also passes through the village. There are no industries. The population is about 200.

New Goshen is a village of 200 in the central northwestern part of the county, and to the east of Sanford.

Libertyville is an old village in the northwestern corner of the county on the county line.

Tecumseh, or Durkees Ferry, is on the west bank of the Wabash River, about seven miles north of Terre Haute. This point was once one of the main crossing points on the river. It is a German settlement. A few small stores and a postoffice are located here. The view of the river valley from the hills at the back of the town is one of the best in the county.

St. Marys is a little town to the northwest of Terre Haute. The population is about 175.

Coal Bluff (500) and Fontanet, which formely had a population of 500 but now much less, owe their origin to the Coal Bluff Mining Company, which operates several mines in the northeastern part of the county. The towns are on the Big Four Railroad. Fontanet was the site of the Indiana Powder Mills, which were destroyed in 1906 by an explosion which practically destroyed the town and killed several persons. The mill will never be rebuilt. The land, property and houses have been offered for sale.

Atherton is a mining village on the northern edge of the county. Burnett, Heckland, Edwards, Ehrmandale, and Hutton are place names, such as former postoffices and mining settlements. Blackhawk is a station in the southeastern corner of the county.

Transportation Facilities.—The transportation facilities of the county are good. There are ten or twelve railways within the county. These are the St. Louis Division of the Big Four and the main division of the Vandalia, both of which pass east and west through the county; the Peoria division of the Vandalia, running northeast to Peoria, Ill.; the T. H. & L. division of the Vandalia, northeast to Logansport and South Bend; two of the main divisions of the C. & E. I., running northwest and northeast; and the Chicago division of the Southern Indiana to the northwest, and the Southern Indiana to the southeast; the E. & T. H., running south; and the E. & I to the southeast. There are interurban lines to Indianapolis, Paris, Illinois, Clinton, Sullivan, Youngstown and other points.

There are in the county 723 miles of public roads, with about 250 miles improved. The improvement has practically all been done with gravel. During the past few years a little stone has been used. The average cost of the gravel roads per mile is about $1,415. The first improved roads were built in 1898. There are extensive deposits of sand and gravel in the Wabash valley. These deposits are inexhaustible and the supply is being utilized both by the railroads and in the construction of public roads. On the eastern side of the river is a big terrace, fully three miles wide and twenty-four miles long. The terrace is composed of sand and gravel to a depth of many feet. West Terre Haute is situated on a gravel terrace of about 400 acres extent. The Big Four Railroad Company has a pit of about 50 acres in the northwest quarter of Section 20, and the Vandalia has a pit of equal size. The gravel has been worked to a depth of 15 or 20 feet and large quantities have been pumped from below water level. The gravel is rather coarse, containing some pebbles up to five inches in diameter. There is also a considerable quantity of fine sand. In many other places throughout the county good road gravel occurs.

The main line of travel through Clay and Vigo counties is the old National Road, which forms Main street through Brazil and Wabash avenue in Terre Haute. The proposition for a national road first took practical shape in 1806, when an act passed Congress authorizing the appointment of three commissioners to lay out a road from Cumberland, at the head waters of the Potomac in Maryland, to the State of Ohio. This was the beginning of the old Cumberland or National Road, the only highway of its kind ever wholly constructed by the Government of the United States, and a road of wonderful significance in the development of the West and the greatest and one of the most romantic highways of America. The existence of this road and the part it played in directing and distributing emigrants should be thoroughly understood and kept in mind when discussing the history of the counties through which it passed. The road was first opened to the public in 1818. In 1827, the National Road was completed through

Wayne County, Indiana. From Wayne County westward, the road passed through Henry, Hancock, Marion, Hendricks, Putnam, Clay and Vigo counties. The Government work on the road was done in Vigo County in the early thirties and was the means of bringing much capital and many workmen to Terre Haute.

General.—Vigo County, when enumerated in 1830, numbered 5,737; in twenty years it had increased in population to 16,500; another fifty years raised the number to 62,035, and in 1910 the total number of inhabitants was 87,930.

An early history of the county gives the following information concerning business in and prospects for Vigo County: "There are in Vigo County 12 grist mills, 18 sawmills, 40 large retail stores, 20 others with limited assortments, 3 printing offices." * * * "Coal is found in abundance and of a good quality." * * * "The enterprise of its citizens and other advantages possessed there, must, at no distant day, make Vigo one of the most important points in the West."

The area of the county is 402 square miles, with a farm area of 239,996 acres, of which 192,043 acres are improved. Land sells from $50 to $200 per acre.

Vigo ranks among the ten leading counties in yield of potatoes and tomatoes, also in raising watermelons and cantaloupes. It stands high in acreage of tobacco. It is among the most productive in cheese manufacture.

Wheat yields about 400,000 bushels each year, with an average from 14 to 16 bushels per acre, with some producing 25 to 30 bushels; corn produces about 1,300,500 bushels annually and averages about 25 bushels per acre; the average for oats is about 300,000 acres, yielding from 11 to 20 bushels per acre; rye averages 7 to 15 bushels and is grown on about 4,000 acres; timothy is given about 9,500 acres and averages from 1 to $1\frac{3}{4}$ tons per acre; alfalfa yields from a ton to three tons per acre and is grown on about 200 acres; prairie hay yields from one to one and a half tons per acre and has about the same acreage as alfalfa; clover yields about 9,000 tons, averaging from 1 1-3 to $1\frac{1}{2}$ tons per acre. Potatoes receive about 300 acres and make from 70 to 80 bushels per acre; onions are raised to considerable extent, in 1909, 617 bushels were grown, and in 1908, 2,463 bushels, an average of from 7 to 55 bushels per acre; tobacco yields from 100 to 350 pounds per acre, but not many acres are given to the crop; tomatoes yield from $2\frac{1}{2}$ to 9 tons per acre, and usually are planted on about 200 acres; berries of various kinds are raised, yielding from 10 to 30 bushels per acre and occupy from 15 to 25 acres annually. Horses, mules, cattle, hogs and sheep are grown to moderate extent for market.

In the early days it is said some cotton was grown. In a few places as much as ten acres was planted in the crop. Hemp was also grown, from which cordage was made for flatboats and other purposes. Flax was raised and made into linen. All kinds of fruits were cultivated and each farmer soon grew enough for his own use. Wild nuts were abúndant—walnut, butternut, hickory, hazel and pecans. These were all a source of food. The growth of prairie grasses made winter feed plentiful for the stock.

PHYSIOGRAPHY AND GEOLOGY.

"Vigo County is a portion of a double slope. Its rocky strata incline westward toward the Mississippi and southward toward the Ohio, the westward slope being the more rapid. This circumstance seems to have had much to do in determing the topography of the county. The river flowing toward the south crosses the more rapid slope nearly at right angles. This dip of the strata westward probably causes the river to crowd its western bank, making it more abrupt than the eastern. The tributary streams flow easterly and westerly, with a trend toward the south, this trend being more pronounced in the western streams. The southerly dip of the rocks not only causes a southerly trend in the direction of the streams, but it causes them to crowd their southern banks, making them more abrupt than the northern. In general there are no streams flowing toward the north, the south branch of Honey Creek being the only stream of any size flowing in that direction. The greater portion of the surface of the county slopes toward the river, but portions of Riley and Pierson townships are in the valley of Eel River. The divide between the two rivers is a massive body of land lying in Linton and the western part of Pierson townships, and trending northeasterly through Riley Township. The N. E. ¼ of Sec. 18, 670 feet, and Sec. 20, 660 feet, of Pierson Township are the highest points in the county. Sec. 1 of Linton Township, and Sec. 6 of Pierson, and portions of Riley have an elevation of from 640 to 650 feet, which is about the same as the higher portions of Fayette, Nevins and Lost Creek townships. While the strata in general dip to the west, there are some local exceptions or irregularities. In Sec. 1, Linton Township, there is a sharp dip to the east, and another in Riley Township, with some evidences of another in Pierson, but the evidence is not sufficient to determine whether the divide is an anticline or not. This divide is a rocky mass with just a thin veneering of bowlder clay and soil, and must have divided these valleys in preglacial times.

"The most marked feature in the topography of the county is the immediate valley of the river. It is from five to six miles wide and extends through the whole length of the county, but as the river forms the western boundary of the southern third of the county, only that portion of the valley on the east of the river belongs to Vigo County. This valley is an old channel that has been partly filled with sand and gravel. The numerous wells drilled in Terre Haute and vicinity shows the rock bed of this old channel to be from 120 to 150 feet below the general level of Terre Haute. The high land just east of the river, in the north part of the county, was part of an island in the ancient river. The channel east of the island is now occupied by Raccoon Creek of Parke County. This eastern channel of the old river accounts for the sudden widening of the valley just south of the county line. In Prairie Creek Township there is another island. The narrow channel east of the island is now occupied by Prairie Creek. The valley of the river turns abruptly towards the west above the island and is somewhat narrow below. The main channel of the old stream was along the west bank. The rocky banks, the islands, the main channel, the secondary channels and shallow places are so well defined that we can almost see the old river, whose waters carved out such a broad, deep trough through our county. The river and its flood plain occupies the western one-third of the valley. The river washes the western bluff at Durkey's Ferry and its flood waters wash them at various places. The greater portion of the flood plain is from 14 to 18 feet above low water in the river, and scattered over them there are many ponds and sluggish streams, indicating a very uneven surface. Between the flood plain and the bluffs there are fragments of a low terrace, which is sometimes of gravel and sometimes of rock. The eastern two-thirds of the valley is occupied by a massive gravel terrace, which has a somewhat irregular surface.

"The thickness of the bowlder clay in Vigo County is from nothing up to 150 feet. The thicker beds are probably in older channels. Frank Leverett, who has given the matter much attention, says that the average thickness of this portion of Indiana is about 25 feet.

"In coal mines abundant evidence is found of much more extensive erosion than appears upon the surface. The Union Mine, at Fontanet, is about 110 feet deep, through hard pan 55 feet, and rock 55 feet. But within 150 yards of the shaft the rock has been cut away and the bowlder clay rests on the coal; while a few yards farther, in the same direction, the coal has disappeared, the rock and coal both being cut out by erosion and afterward replaced by sand, gravel and bowlder clay. It is a common thing for the miner along Otter Creek or Raccoon Creek, and in other localities, to find the coal that is less than 125 feet below the plateau surface cut out by sand bars, gravel beds or bowlder clay. So common and extensive are these old channels, that Mr. Talley, of the Coal Bluff Mining Company, tells me they never buy 40 acres of coal land without drilling at least four prospect holes in order to make sure they are buying coal and not simply bowlder clay. Near Fontanet one drill hole penetrated bowlder clay 120 feet. At St. Mary's it is 100 feet to bed rock, and at Sandford it is about 150 feet. A little beyond it is 180 feet to shale, while the rock comes near the surface within a short distance of each of these localities. The south part of the county would probably yield similar testimony if it were tested with a drill. These facts indicate extensive local erosion prior to the glacial period, and, I think, indicate that the proportion between the main river and its local tributaries was formerly much the same as at present. These channels vary in depth. The river wells reach bed rock about 80 feet below low water in the river, or about 365 feet above tide, while the plateau in many places is over 600 feet above tide. Wells in other parts of Terre Haute reached shale at about the same distance below the river, so that we are sure that a considerable portion of the main valley was formerly 225 feet or more below the general surface of the uplands. The tributary channels are probably much shallower than the main valley, but little is known of them beside an occasional well. Drift materials are known to be of considerable thickness in the valleys of Sugar Creek and of Otter Creek. The beds of the present streams are from 60 to 80 feet below the general surface of the uplands, and the bed of the old channel is at least as much as 60 feet to 80 feet lower still. The walls of these old channels, where exposed, are often quite abrupt, so that the county in all the myriads of years had not been base-leveled. It is evident that a vast amount of material has been removed from Vigo County by erosion, but when we consider the length of time, the amount does not seem to be relatively great, and it seems probable that for much of the time this region was near the level of the sea, so that the action of eroding agents was weak and ineffectual.''

After describing the formation and advance of the ice sheet, and the spreading out of the bowlder clay on its retreat, he says: ''This material filled up the old drainage channels, so that the surface was a plain of gently undulating surface.

''But the floods from the retreating ice soon began to form drainage channels, sometimes reopening old channels in general, but occasionally cutting off some bend, giving rise to many curious features in the streams of glaciated areas. The retreating ice for a long time made a dam across the Maumee valley, so that a lake was formed. The surplus waters of this Maumee lake were discharged across the divide near Ft. Wayne into the Wabash valley, and through it to the gulf. This extra supply of water seems to have cleared the old valley of bowlder clay, at least in this region. While the new drainage channels were being opened, the surface of the bowlder clay weathered into soil, and became covered with vegetation. The remains of this vegetation, partially decayed, mingled with the clay, forming a black soil. Similar soils are formed at the present time on poorly-drained tracts in the northern latitudes. This old soil occurs in the eastern and southern parts of the county, under several feet of material deposited at a later period.

''Above this old soil there is a deposit of loess. 'Loess is a fine-grained, yellowish silt or loam, which overspreads the southern portion of the glacial drift of North America. It consists principally of quartz grains, but it usually contains a variety of such other minerals as occur in the drift. It is apparently derived from the drift, either by the action of water or of the wind. It often contains calcareous matter, which partially cements it. Sometimes irregular nodules of lime and of iron and of manganese oxide are found in this material. It also often contains fossil shells of land and fresh water mollusks, and occasionally remains of insects and bones of mammals. It has a strong tendency to vertical cleavage, and usually presents nearly perpendicular banks on the borders of streams which erode it.' It occurs at several places along the bluffs east of the river, and probably west of the river as well, but I have not noticed it there. There is a thick deposit in the bluff on the Bloomington Road; in the bluff just south of Otter Creek and in the bluff at Atherton on the north line of the county. Over this loess there is, in southern Indiana, a continuous layer of pale silt called 'white clay,' which is the surface soil over much of the uplands of Vigo County.

"Later, a second ice sheet overspread the country, reaching as far south as the northwestern part of our county, including Sandford. When the ice sheet halts for some time accumulations of gravels, sands and clays are formed by the materials dropped by the melting ice. Such accumulations are called moraines. Sometimes a continuous ridge of considerable extent occurs, but more generally the moraine consists of low, rounded hills. The hills east and northeast of Sandford are parts of the Shelbyville or Wisconsin moraine that marks the southern boundary or limit of a second ice-sheet. The moraine extends northeasterly across the river into Parke County, being well marked to the north of Atherton. In the northwestern part of Fayette Township the white clay has been covered by a deposit of darker material brought down and deposited by this later ice.

"At several places in bluffs of bowlder clay I have found old wood from 20 to 45 feet below the surface. Sometimes this old wood was fragile, soon crumbling on exposure to the air; in other cases it was in good condition, and is still firm after being exposed to the air for a year. Wood has been found in digging wells in different parts of the county, so that old wood is quite common in the bowlder clay of Vigo County. The specimens found were of cone-bearing trees, probably some kind of cedar. One specimen showed over thirty rings of growth in a quarter of an inch. One ring was composed of only two layers or rows of ducts. These narrow rings of growth seem to indicate that there had been more *winter than summer* in the life of that little tree or shrub.

"The glacier accounts, in a general way, for the soils and drift materials of the uplands, but the soils and other materials in the valleys need explanation. The old channel of the river was swept of bowlder clay, probably by water from outside its ordinary watershed. After a time the ice melted out of the Maumee Valley, and the waters of Maumee Lake found a new outlet. The Wabash, diminishing in power, began silting up its bed with sand and gravel. This process continued until, in Vigo County, there was deposited a bed of gravel 20 miles long and four to five miles wide, and over 100 feet thick. This bed is of unknown extent toward the north and south. The great masses of gravel at Lafayette, and at intervening points, are, perhaps, parts of the same great bed. How can it be accounted for? In the record of some of the deep wells, the upper portion of the drift materials is shown to be coarse, while the lower is of smaller size. This, if a fact, suggests delta formation. One who studies the gravel pit will feel sure that the sands, gravels and bowlders were arranged by water, but under what circumstances could the water get these rocky fragments of varying sizes together? A study of the upper portions, as seen in the gravel pits, suggests stream action, and possibly the whole mass was a delta formation whose upper portions were rearranged by stream action. Of something over 600 gravel stones examined, about 35 per cent. were limestones; the remainder were fragments of different kinds of granite rocks. The fragments vary in size from fine sand up to stones six inches in diameter, with occasional large bowlders. The surface features, at least, seem the work of a strong stream. The ridge, just west of Seventeenth street, which extends southward east of the old canal, seems to be an old sandbar. The ridge along Fifth street, which terminates in Strawberry Hill, is apparently another old sandbar. This mass of sand and gravel in the main stream must have dammed up some of the tributary streams, forming long, narrow lakes.

"Later, the river seems to have become narrower and more rapid, possibly on account of elevation of the northern portions of the continent, so that the western one-third of the valley was cut down some 20 feet or more, leaving the eastern two-thirds as a gravel terrace. The margin of the terrace has a direct course a little west of south from three miles north of the county line in Sec. 13-14-9 to Sec. 5-11-9, Honey Creek Township, where it turns to the southwest.

"Sometime after this the energy of the river seems to have been concentrated upon narrower limits, and a channel was cut deeper into the gravel, leaving a narrow fringe of second terrace or second bottom along the western bluff, which as about 30 feet above low water in the present river, while the main terrace rises from 40 to 70 feet above the low water. Then the river ceased to erode the gravel, and even when in flood it can only work over the materials of its own floodplain. As one watches the river when in flood, with its deep, strong current, and finds it unable to erode the gravel, he cannot help wondering as to what manner of a stream it was that cut out that great mass of gravel and carried it to unknown distances below. The river flows along or near the western bluffs, and its tributary streams flow along the southern bluffs. This is universal. There is hardly a rock cliff or bank of bowlder clay that does not face toward the north or toward the east. I can think of only two or three exceptions along the narrow parts of Coal Creek valley. This is perhaps due to the fact that the strata generally dip toward the south and west. It is possible that the main current of the stream that deposited the gravel was on the west, and that the gravel was not as deep on the west. If true, the later streams had less work to do than we have ascribed to them. The lands of Vigo County were surveyed in 1815 and 1816. The meander of the river made at that time was not carefully done and the records are incomplete, so that no very definite conclusions can be reached as to the amount of change made in the course of the river since that time. But it seems certain that in no instance since that date has the river been able to erode the gravel. Those portions of its channel, where at least a fringe of timber has been left along the river, have not materially changed. But on the curves, where the timber has been cut away, the erosion has been extensive, so that the bed of the river has moved from 600 to 800 feet as at the bends in S. E. Sec. 8, and S. W. Sec. 16-12-9, and in S. W. 32-12-9, Harrison Township.

"The main terrace descends gradually towards the south from the north part of Honey Creek Township to the northern part of Prairie Creek Township, where it becomes the flood plain. Whether the terrace formerly extended farther south and has been cut down by erosion to its present extent and form, or whether it never extended any farther than at present, and has the original termination modified only by ordinary atmospheric influences, are questions which I can not solve. I am inclined to the opinion that the high terrace never extended much beyond its present position.

"Just above Clinton, Vermillion County, about five miles north of our county line on the west side of the river, a section of the high terrace terminates quite abruptly. It rises about 60 feet above low water, while the second terrace on which Clinton stands rises from 35 to 40 feet above the same level. The river valley is narrow, only about two miles wide in this locality. The high terrace appears again about two miles below, but on the east side of the river, and in full force just below the narrow place in the valley. The high terrace does not seem to have been formed in the narrow portion of the channel. Many streams flowing into the main valley are lost in the sands and gravel. In time some of them brought down clay enough from the hills to puddle large areas of sand, making it impervious to water, and marshes, swamps and wet prairies were formed. Fort Harrison Prairie, which extended through nearly the whole length of the county was largely wet prairie that had its origin in obstructed drainage. The Macksville terrace across from Terre Haute is a typical gravel terrace, but much of the second bottoms is really a rocky shelf. Near the I. & St. L. R. R., it is a shelf of shale above Coal "N" (VII). South of Sugar Creek, for some distance, it is a shelf of limestone. Other interesting features of the old valley might have been mentioned, but enough has been said to show that the channel of the ancient Wabash contains many interesting problems for the one who has time and opportunity for studying them.

"The tributary valleys differ widely from the main valley. In them the drainage was purely local, and it, at times, was not relatively as strong as in the main valley. The great floods from the retreating glacier soon ceased to influence the local streams, but continued for centuries to strengthen the river. Changes of level that would materially affect the character of the main stream might have little effect on the tributary. The bowlder clay was all removed from the main channel in a comparatively short time, while the tributaries are still, after thousands of years, working on the bowlder clay with which the glaciers long ago filled their channels.

"In general, the tributaries seem to have cut downward as rapidly as the river, but could not open their channels to the full width as did the river. When the river silted up its channel with sands and gravel, they filled theirs mainly with sand, the local streams not being able to move as coarse material as the river. In some instances, at least, the main stream filled its channel so rapidly as to shut off the tributary stream, making it a pond or lake. In one of the branch valleys of Sugar Creek, on the N. W. ¼, S. E. ¼, Sec. 22-12-10, there is a deposit of very fine laminated clay, with occasional partings of fine sand, the whole resting in a trough of bowlder clay. Where this deposit outcrops on the main creek it is from 12 to 15 feet in thickness, becoming thinner as it extends back from the creek. In some places it has the appearance of shale, but to the touch it is fine clay. I found some similar material about a quarter of a mile down the creek, which seems to indicate that the deposit was formerly more extensive, but had been carried away by erosion. I once saw an extensive deposit of similar material in Sullivan County, northeast of Merom.

"The deposit is an interesting one, and indicates that this valley was occupied by quiet water for centuries, and that then the barriers were removed, the lake flowed away and the obstructed drainage system was reopened. The valley of Suger Creek, in Secs. 16, 22 and 23, is wider than below, and the same thing seems to be true of East Little Sugar Creek, in Secs. 12 and 13. None of the other valleys have a similar form. The flood plain of the tributary streams is of different material from that of the main stream. It is more local in its character—sometimes clayey and impervious, again sandy or loamy. In many cases the smaller streams carry away valuable materials from their flood plains, while in general the river leaves its flood plain covered with a coating of rich, fertilizing sediments.''*

The following sections will show the thickness of the surface material and the character of the geological formations in various parts of the county:

Section on Otter Creek, in N. W. Quarter of N. W. Quarter of Section 30 Township 13 N., Range 7 W.

	Feet.	Inches.
Soil, etc.	28	0
Gray to drab shale	20	0
Dark blue shale	1	0
Hard, blue, calcareous shale	0	2
Dark blue shale	5	0
Black, bituminous, sheety shale	2	0
Coal and shale partings	1	4
Gray fire clay	2	0
Hard gray to brown calcareous sandstone	1	0
Gray shaly sandstone	1	6
Gray to brown, hard micaceous sandstone	0	6
Gray, shaly sandstone	3	0
Gray sandstone with carbonaceous partings	1	6
Blue shale	4	0
Coal with partings	6	0
Total	77	0

Section of Bore at Coal Bluff, N. W. Quarter of N. W. Quarter, Sec. 12.

	Feet.	Inches.
Surface	10	0
Sand or gravel	77	0
Bowlder clay	22	0
Fire clay	3	0
Black shale	6	6
Coal	2	6
Very dark fire clay	2	0
Total	123	0

* Dr. J. T. Scovell, Ind. St. Geol. Report for 1898, pp. 684-693.

General Connected Section Along Sugar Creek, West of Wabash River, by Dr. J. T. Scovell.

	Feet.	Inches.
Surface, soil and clay	1	0
Subsoil, yellow clay	4+	0
Bowlder clay	10+	0
Shale	5+	0
Coal	1	4
Fire clay and shale	3	0
Limestone, crystalline fossiliferous	2	0
Shale, light colored to red	6–12	0
Limestone, impure, flinty	1	0
Sandstone, massive	11	0
Sandstone, merging into shale	14	0
Shale, bluish with ironstones in upper part	28	6
Bone coal and sheety shale	1	0
Coal	4	8
Fire clay	10	0
Total	108	6

Section at Sandford Hill, Along Russel's Run, Section 1. By Dr. J. T. Scovell.

	Feet.	Inches.
Soil, white and yellow clay	8	0
Bowlder clay	2	0
Sandstone, reddish and shaly	10	0
Shale, light colored	5	0
Sandstone, shaly	5	0
Sandstone, compact	9	0
Shales, light bluish, many fossils	17	0
Coal	3	3
Fire clay and shale	3	0+

Drainage.—"The Wabash River flows in a southwestern direction, through the northern part of the county, and from a point about nine miles southwest of Terre Haute it forms the western boundary. The immediate valley of the river in Vigo County is from four to five miles wide, occupying about one-fourth of the area of the county. The river at the ordinary stage of water has an average width of about 600 feet. Low water at Terre Haute near the middle of Township 12 North, is about 445 feet above sea level. The river and its flood plains occupy the western third of the valley, the eastern portion being a broad terrace. The flood plain of first bottoms rise from 14 to 20 feet above low water in the river, while limited areas of second bottoms rise from 10 to 15 feet, above the flood plain. The terrace rises from 50 to 75 feet above low water in the river, but toward the south and Prairie Creek Township it merges into the flood plain. The highlands on either side of the valley have an elevation of from 100 to 200 feet above the river, the bluffs in some cases being quite abrupt. The greater part of the county is drained by the Wabash and its tributaries. The principal streams from the west are Brouiletts Creek, Coal Creek, Sugar Creek with several large branches, Clear Creek and Hawk Creek. These streams rise in Illinois and flow southeasterly into the river through valleys from one-quarter to one-half mile wide and 30 to 80 feet in depth. The streams from the east are Otter Creek, Lost Creek, Honey Creek, Prairie Creek, Turmans Creek and Busseron Creek. Portions of Pierson and Riley townships are drained by Splunge Creek and Eel River. The valleys of the river and its tributaries seem to be channels of an earlier drainage system that have been partly filled with sand and gravel so that in many cases the beds of the present streams are from 25 to 100 feet above the rocky beds of the older channels. These streams are for much of the summer 'lost creeks,' a fairly good stream among the hills disappearing in the sands and gravels of the main valley.

"The rocks of the county as seen in the bluffs and beds of the streams and as revealed in ordinary wells and mines are the sandstones, shales, limestones and coals of the Carboniferous Age.

"The soils are in general of glacial origin. In the valleys there are alluvial sands and clays and wide areas of black prairie soil, resting on a subsoil of sand or gravel. On the uplands the top soil is usually a fine white clay, resting on a subsoil of yellow clay which passes gradually into bowlder clay or hardpan which lies upon the bed rock. Along the eastern margin of the main valley there are extensive areas of dune sand, and at some localities on the eastern bluff there are thick beds of loess."*

"The large drainage basin of the Wabash River, with an area of about 23,000 square miles, extends from western Ohio embracing on the west side of its watershed considerable portions of southeastern Illinois. About one-half of this drainage area was covered by the Illinoian glacial lobe and many important changes have resulted from its occupancy of the region. Indeed, there appears to be very little similarity of outline between the present watershed and the watershed which in preglacial times had a discharge through the lower course of the Wabash. The westward flowing portion of the Wabash, with its several tributaries, traverses a dis-

*Dr. J. T. Scovell, Ind. St. Geol. Report for 1896, p. 507-508.

trict lying mainly outside the limits of the Illinoian lobe and appears to be entirely independent of pre-glacial drainage lines, for the drift deposits have been built up to a level above the preglacial rock divides. The head water portion of White and East White rivers, which are the principal tributaries of the Wabash, seem also to be very largely independent of glacial lines. There remains only the lower courses of the Wabash, and of tributaries entering below the great bend near Covington, Indiana, which are governed to any considerable extent by the pre-glacial lines of drainage. These all fall within the limits of the Illinoian lobe, or of unglaciated districts immediately outside.

"The Wabash River enters a pre-glacial valley just above the city of Lafayette, which probably furnished a line of discharge for a considerable territory on the north and west. The river, however, remains in this pre-glacial valley for only a few miles. It soon turns southwestward across a rock point, while the preglacial valley apparently takes a longer route to the west and south, coming to the river at its great bend near Covington. From Covington southward, the stream follows nearly the line of the preglacial valley to its mouth, though in a few places it cuts off rock points which projected into the pre-glacial valley.

"Above Terre Haute, this pre-glacial valley has been opened only a part of its width by the present stream, yet it shows a breadth of two to four miles. Below Terre Haute, the bottoms of the present stream extend from bluff to bluff of the pre-glacial valley. The breadth increases from about five miles at Terre Haute to fully 15 miles near the junction of the Wabash with the Ohio.

"Few data have been obtained concerning the elevation of the rock bottom, but these uniformly indicate a level considerably below that of the present stream. So far as collected they do not show descent in passing from north to south, but they are scarcely sufficient to prove a warping of the valley floor. A boring in the abandoned channel west of Lafeyette enters rock at a remarkably low altitude, of about 300 feet above tide, while at Terre Haute several borings made in the middle part of the valley enter rock at 345 to 360 feet above tide. Between these two points, borings at Clinton and Montezuma enter rock at an elevation slightly higher than at Terre Haute. The elevation of the rock floor of Shawneetown, Illinois, just below the mouth of the Wabash, is shown by an oil boring to be about 245 feet above tide. As this boring was made near the border of the valley, the rock floor may there reach a still lower elevation."

The valley occupied by the Wabash River has not had a uniform development from source to mouth. In the upper part, from the source to Huntington, the valley has been formed chiefly by the present stream, and is a shallow and narrow trench. At Huntington the river enters the old outlet of Lake Maumee, a glacial lake that occupied part of the basin of Lake Erie. This outlet has a valley several times as large as that occupied by the Wabash above this point. It opened a new or post-glacial line of drainage in its westward course across Indiana, except for a few miles in the vicinity of Lafayette, where it crosses or follows a pre-glacial valley for a few miles. It has been compelled to do considerable excavation in rock from Huntington down as far as Covington and still carries rapids at several points. Below Covington, the stream follows very nearly the lines of a partially filled pre-glacial valley, and its work has been largely the removal of a portion of the glacial deposits left in that valley. However, it makes some deflections into the edge of the upland, cutting off points of the bluff. At such places, the channel is occasionally in process of excavating rock. The cause for these deflections is not in all cases clear, but it is probable that in the majority of the cases the filling was such that the stream was free to pass across these points and thus take a more direct course than that of the old ones around them. In some cases it is possible that the ice-sheet may have had an influence in guiding the stream across projecting points beneath it or on its border.

"The length of the valley occupied by the Wabash is about 450 miles; but the length of the stream is much greater, for the river in its lower course makes several ox-bow curves within the valley. The source of the valley is about 1,000 feet above tide, while its mouth at low water is about 311 feet. The average fall, if we estimate the stream to have a length of 500 miles, is therefore about 16½ inches per mile. The rate of descent is far from uniform, being much more rapid in the upper portion than in the lower. There are also many rapids separated by pools or sluggish portions of the stream. The elevation of the stream has been determined at many points, but in the absence of a careful measurement of its length, the rate of fall is only approximately known. The portion of the river above the point where it enters the old lake outlet, estimated to have a length of 100 miles, has a fall of about 300 feet, or three feet per mile. Railway levels and canal surveys at the point where the river joins the old lake outlet shows its elevation to be nearly 700 feet above tide, the altitudes reported varying between 696 to 699 feet. The canal survey below Huntington shows a fall of 32 feet to the mouth of the Salamonie, a distance of about 15 miles, and a fall of 34 feet between the mouth of the Salamonie and the mouth of the Mississinewa, a distance of perhaps 20 miles. In the next 20 miles to Logansport, there is a fall of 50 feet. From Logansport to Lafayette, a distance of about 50 miles, there is a fall of 77 feet; from Lafayette to Attica, a distance of 25 miles, the fall is but 19 feet, and from Attica to Covington, a distance of 20 miles, but 17 feet. From Covington to Terre Haute, a distance of 55 miles, there is a fall of only 22 feet, this being the lowest gradient for so long a section on the river. From Terre Haute to the mouth of White River, an accurate survey by the United States Army Engineers shows a fall of 71.18 feet in a distance of 122.55 miles, or about 8 inches per mile. In this distance there are 13 riffles, each but a fraction of a mile in length, which have a combined fall of 17.86 feet. These reduce the fall of the 120 miles not embraced in the riffles to 53.32 feet, or about 5.33 inches per mile. The greatest fall at a riffle in this sction of the Wabash is at Grand Rapids, just above the mouth of White River, where it amounts to 4½ feet. The fall from the mouth of the White River is 65 feet in a distance of perhaps 90 miles by the windings of the streams.''*

''Otter Creek, rising by several branches, generally in Clay County, drains a large and interesting area of country, including the greater part of Nevins Township, and the southern portion of Otter Creek Township. The two main branches unite near the western boundary of Nevins Township. The valleys of these streams are from one-eighth to one-fourth of a mile wide, the stream usually nearer the southern bluff, which is generally more abrupt and frequently rocky. The southern tier of sections in Nevins Township is drained by a third branch which enters the main stream in the southeast part of Otter Creek Township. The branches of these streams are not large nor numerous but the land along the streams is badly broken up. On the divide between the north branch and Raccoon Creek valley there are several sections of good farm land and some between the two branches, but fully one-half of the township is too broken for first class farm land.

''The extreme southeastern portion of Otter Creek Township is very broken; the heavy bluff south of the creek extending southward into Sction 31; north of the creek there are some hills but

* Leverett, U. S. G. S. Monograph XXXVIII, pp. 528-30. U. S. G. S. Monograph XLI, pp. 187-89.

no regular bluffs. There is also some broken land in Sections 5, 6 and 7, but in general the surface of this township is well adapted to agricultural purposes.

"Lost Creek is a small stream that drains the central portion of Lost Creek Township, flowing through Harrison Township into the river. The valley is shallow and the banks are seldom abrupt. Some of the smaller branches of the Otter Creek are evidently young streams; but the main creeks seem to flow in old channels. The valley of Lost Creek seems to be of recent origin. The extreme northeastern portion of Lost Creek Township is drained by a branch of Otter Creek and a few branches in the southeast are drained by branches of Honey Creek, while a portion of the southwest is drained by Church's Run. Sections 1, 2, 11, 12, 34 and 35 contain about all the broken land in this township. Some sections, as 22, 23, 27 and 28, are nearly level, seeming to have about the same surface that was left by the glacier, as the drainage channels have not penetrated them to any extent.

"Honey Creek rises in Clay County, flows through the northwestern portion of Riley Township. It is about the size of Otter Creek, but has a much longer course in the county than any other creek. It drains the north and west of Riley Township. In its southwesterly course to Section 10 in Riley Township, the valley is somewhat symmetrical, but in its westward course the south bank is much more abrupt and extensive as it continues into Section 21 of Honey Creek Township, while the north bluff stops in Section 13 and is not strong there. It has several branches from the east and southeast, but the largest is the south branch, which drains parts of Pierson and Lenton Townships, being the north side of the highest elevation of the county. The valley of this branch and its tributaries are deep but somewhat irregular, perhaps more bluffy on the west, but not much difference. The southeast portion of Riley Township lies in the valley of Eel River and is drained by Splunge Creek. The surface of this township along Honey Creek is much broken, but the greater portion of the township has a good surface.

"Sugar Creek is the largest in the townships, and topographically is perhaps the most interesting. Big Sugar Creek runs from west to east across the center of the township. It is a strong stream having a course of 20 or 25 miles in Illinois before entering the county. In Vigo County it is from 70 to 100 feet deep and from one-half to three-fourths of a mile wide. The creek in general is near the south bank, which is more abrupt than the one on the north. In Section 23-12-10, the creek cuts through the limestone above Coal 'N.' At this point the rock channel is not more than 30 rods wide, while the valley proper is as wide as ever. In northeast quarter section 25, where it joins the main valley, the rocky walls of this valley are not more than 40 rods apart. Above Section 23 the walls of the channel in this county are mainly of bowlder clay. Sugar Creek receives only two or three small streams from the south, but has two large branches from the north. West Little Sugar Creek, which rising in Illinois, enters at the southwest corner of the township and from a little east of south joins the main stream in the east part of Section 22-12-10, and East Little Sugar Creek, which rises in Fayette Township, near Coal Creek and flowing southerly, enters the big creek in the west one-half of Section 30-12-9. A branch of this creek rises in Section 34, Fayette Township, and flowing a little east of south enters the east branch in Section 24-12-10, so that the northern portion of the township is drained by three nearly parallel streams, each of which has a narrow deep valley. Each of these streams show some rocks in its bank or bed, but in general their channels are of bowlder clay. The narrow channels of the main stream and of the east branch in their lower course suggest the idea that these streams may flow in recent or post-glacial channels in the lower portion of the course. The rocky strata dips toward the west, but the surface inclines towards the east and the thick beds of bowlder clay towards the west may have changed the drainage area somewhat, so that a much larger territory is tributary to the present Wabash than to the ancient stream. Clear Creek, rising in Illinois, enters the county in the south part of Section 28-12-10, and flowing southeasterly joins the river in Section 11-11-10. Its valley is as deep as that of Sugar Creek, but not as wide. Its channel is also rocky and narrow in its lower course. The extreme southern portion of the township is drained by two streams that rise in Sections 3 and 4-11-10 and running in nearly parallel courses, flow into Hawk Creek, which flowing through Section 16 reaches the river near the center of Section 22-11-10. The surface of the township is very much broken, more so than that of any other township. The long river bluffs and the bluffs of the two streams that cross the township and the bluffs along Three Streams that drain the northern portion occupy fully 75 per cent. of the area of the township. The rocks associated with coal N (VII) crop out along the river bluffs and to some extent in other places, but in general the bluffs are of bowlder clay, and one comes to think of the township as a mass of bowlder clay and other glacial debris, through which the surface waters are digging channels as day by day they work at their task of carrying these materials down to the gulf. This task is only well begun. Wide areas on the divides are practically level, with no established drainage lines, showing little evidence of change since the retreat of the ice. The tributary streams with their deep narrow V-shaped channels are reaching up into these areas and rapidly curtailing their extent. One can find numerous instances of from 6 to 10 of these little streams heading up into one 20-acre tract. Similar features occur to some extent in Fayette Township, and east of the river also, but in no place are they as well marked as in Sugar Creek Township. These peculiar forms of relief give the region a new and unfinished appearance. The broken nature of the surface is well indicated by the direction of the roads of the township.

"Fayette Township is mainly drained by Coal Creek. A few little streams flow into Brouilets Creek and the river, and a few sections are drained by East Little Sugar Creek. Coal Creek rises in Illinois and the west part of the township and flows southeasterly into the river. Its channel is deep, narrow and rocky and its bluffs are abrupt. It seems to be a new or recent valley. The same is true of its branches and of two or three small streams that flow directly into the river.

"A few sections of Honey Creek Township lying south of the main stream and along the south branch are broken, but by far the greatest portion, about one-third, is upland; the balance is in the river valley. Some of the valley land is low and flat and has been drained with considerable difficulty.

"Prairieton is wholly in the main valley. Along the river there is considerable flood plain and several bayous, but in general the surface is good, though some parts are marshy or swampy.

"Prairie Creek rises by three branches in the north half of Lenton Township. These branches unite in Section 8 of Lenton Township, forming Prairie Creek. The branch of the old channel occupied by the main stream is about three-fourths of a mile wide, with some high bluffs and some low sandy hills. Prairie Creek and its branches drain the greater part of Prairie Creek Township. The valley of Prairie Creek, or the old channel east of the channel, occupies about four sections, so that more than one-half of the township is bottom land. There is some broken land along the bluffs, but it would not amount to more than three or four sections. The valleys of the streams are comparatively narrow and shallow and there is very little broken land."

SOILS.

The soils of the county have a large acreage of the two great divisions of soils—the uplands and the river bottoms. The soils are mainly of glacial origin. Native rocks have contributed considerable material to the soils, but the amount is very small compared with the amount which is the product of glacial action. These soils have been modified into many types by water and wind transportation and by the processes of weather. The bowlder clay is weathered into the yellow, silty clay, which is the principal subsoil of the uplands. Practically all of the upland type was originally covered with a dense forest growth, and a large amount of vegetable matter intermingled with the soil has made the area a very fertile one.

On the slopes in many places the surface has been washed away, exposing the yellow subsoil, giving the fields a spotted appearance. All of the staple crops are grown in the county, and in addition many special crops are grown on the various soils adapted to the needs of such crops.

The following table gives the names of the various soil types and the area occupied by each:

	Sq. Mi.
Knox silt loam	205
Wabash silt loam	70
Sioux sandy loam	61
Morainic area	20
Sandy clay loam	20
Knox sand	10
Mode silt loam	7
Wabash clay loam	5
Vigo black prairie	3
Wabash gravelly loam	1
Total	402

Knox Silt Loam.

The Knox Silt loam and the modified silt loam are the same as those described under the headings in the discussion of Clay County soils. The topography in general is level or gently undulating, except in limited tracts over the area. In the central western part of the county, west of the Wabash, occurs the most broken and rough land of this soil type.

These upland silt loam types are good, productive soils and many of the best improved farms in the county are found on these soils. In a very large part of the area, however, through the mining region there are few good farm improvements, because the chief work of the people is mining, and the surface is neglected, only small fields and patches in cultivation. These soils are well adapted to all the staple crops, and truck farming and fruit growing have been carried on with good results.

Sioux Loam and Sandy Loam.

The eastern two-thirds of the Wabash River valley is occupied by a massive sand and gravel terrace. This area is from two to four miles in width and at least twenty-four miles in length. The surface is rather irregular, but there are no very marked differences in elevations and in many places the surface is very level for great distances. Through Otter Creek Township along the river, a terrace rises from 50 to 80 feet above low water and gradually slopes to the eastward. In Harrison Township it is 50 or less above low water, with low ridges and shallow valleys extending north and south, but has no slope toward the east. Through Honey Creek and Prairie townships the elevation of the terrace gradually diminishes until it merges with the flood plain in Prairie Creek Township. In the flat portion of the terrace are many parts in which the natural drainage is very poor, and before artificial drainage was begun, swamps, marshes and wet prairies occurred.

The soils of this terrace area vary considerably in character. Along the southern border it merges into the Knox sand. In the northern part along the north side of the tributary stream, it is built up into dune-like hills, also of the Knox sand type. The great expanse of the area grades through all phases from coarse sand and gravelly type to sandy loam and true loam types. The greater part of the area is composed of the two latter types.

In the sandy loam, the soil is from brown to black, coarse to medium sandy loam, from 10 to 24 inches deep and containing a considerable portion of organic matter. The color becomes lighter with depth. The subsoil at varying depths consists of almost pure water-worn gravel. Gravel is found at all depths, from a few inches to several feet, and is usually many feet in thickness. Extensive gravel pits have been opened in the terrace gravel and it affords an inexhaustable supply of good gravel for building public roads and for railroad ballast. In many places the subsoil is a mixture of gravel, sandy loam and silty sand, etc.

In the Sioux loam area the surface is usually level and the soil contains a smaller percentage of sand and a higher percentage of silt and clay. It is free from pebbles of any size. The subsoil is of a loamy texture for a depth of 24 to 48 inches, where it begins to grade into the gravelly beds.

At the present time, drainage conditions are such as to insure good results. In places where the gravel comes nearer the surface, the soil is so open that the water passes through so readily that crops suffer from drought. This was especially noticeable on the crop of 1911, much of the crop being entirely destroyed, and in other parts the lower corn blades were badly fired. When the gravelly layers are two or more feet below the surface the moisture is better retained.

In many places the depth of the material down to rock has been shown by wells. The wells are usually from 12 to 30 feet deep in the part of the area south of Terre Haute and reach the solid rock at such depth. North of Terre Haute the material has greater depth.

The land of the area is valued at $75 to $150 per acre. There is not much for sale at any price. North of Prairieton, the prices range from $150 to $300 per acre. This part is devoted very largely to truck farming and is called "Garden Town." A considerable area to the west of Middleton also raises considerable truck for the market. A great number of melons are grown, but not to as great an extent as a few years ago. The reason is said to be because other regions can produce melons at a lower cost. More cantaloupes are raised than formerly.

Corn yields from 40 to 85 bushels. This year it was badly burned before August 15th because of the long drought. Much had scarcely put out shoots, but in good seasons the best results are obtained on ground which is properly cared for. Wheat averages 20 bushels. Some pieces of clover sod made 30 bushels. The ground must be kept up by clovering. Wheat straw is not heavy. All straw is used on the farm for feed.

It is often difficult to get a good catch by clover, but it grows well when well started. Will yield from one to one and a half tons per acre. Very little is cut for seed, but when so used gives about one bushel per acre. Cowpeas have not been tried until the past two or three years, then only on very limited areas. They make good growth and a greater acreage will likely be grown. Timothy does not grow well and but very little attempt is made to secure the crop. Some pieces of land have been in corn and wheat almost continuously for fifty years, but the production is low on such tracts. A large acreage of this area should be devoted to truck farming and the growing of small fruit. The market opportunities offered because of the nearness to Terre Haute should be an incentive for much of this kind of work.

The following table gives results of the mechanical analyses of these soils:

DESCRIPTION.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
4 miles N. Prairieton Surface 12 in	3.0	10.0	8.2	28.5	10.5	25.4	13+
Grays Addition E. Terre Haute	2.2	10.5	11.4	30.0	12 0	20.0	14.5
3 miles S. E. Atherton	2.5	10.2	10.5	28.7	10.8	20.5	17.5

WABASH SILT LOAM.

The soils included under this heading are those of the river flood plain. The soil varies from the Wabash silt loam to the Wabash clay and the Waverly clay. The area comprising the two types is chiefly north of Terre Haute. It consists of a heavy silt loam or clay loam, with an average depth of about 18 inches. The color varies from light to dark brown, according to the amount of organic matter present. The soil is quite sticky when wet. In poorly drained areas it has a tendency to bake and crack, and if plowed when too wet it forms large clods which are difficult to break. The clay content increases with depth except where the immediate subsoil is underlain with gravel deposits. The surface is about level, with a very gentle slope toward the stream. The natural drainage is not very good, and the entire area is subject to frequent overflows. The floods occur principally in late winter and early spring. If the ground gets in condition for planting before too late in the spring, the crop usually has a chance to mature without being destroyed by flood. The soil is renewed by the overflow and is very fertile. Corn is the chief crop grown and yields from 50 to 65 bushels per acre. Early frosts sometimes catch the late crops because of the good supply of moisture the crop is kept green and growing throughout a rather long period.

WAVERLY GRAVELLY SANDY LOAM.

In connection with the soils of the river bottom and the low terraces are areas which become very gravelly. The type in general consists of a coarse, gravelly, sandy loam, varying in color from light to a reddish brown. The surface is usually covered by considerable gravel. The majority of the pebbles are less than two inches in diameter. The gravel increases with depth. Corn is grown upon this type and in ordinary seasons produces well. In most cases there is enough sand, silt and clay with the gravel to admit of successful cultivation, but in some small areas the gravelly content is too high to allow profitable and easy cultivation.

The Morainic Area.

In the northwestern part of the county is an area to the east and north of Sandford which has received an accumulation of sand, gravel and clay from the material of the Wisconsin glacier. In part of the area, ridges of considerable extent occur, but in general the surface is of low, rounded hills. There are also areas of practically level surfaces. The "yellow" or "white" clay found as a surface over the uplands in the rest of the county are covered by material of more recent origin. In parts of the area the hills wash badly, as is evidenced by the erosion channels to the north of New Goshen, and extending over to the river bluff.

The following lines are summarized from the work of Mr. Leverett, in U. S. G. S. Monograph No. XXXVIII.

Along the Wabash River valley extensive gravel terraces occur, both above and below the points where the ridges of the morainic system cross (the Champaign). Possibly a portion of the gravel connects with this morainic system, but by far the larger part connects with moraines of later date which cross farther up the valley. East of the Wabash in Parke County, wells along the outer or main belt and on the plain north of it are seldom more than 30 feet in depth. They pass through about 13 feet of yellow till, while others enter gravel. These beds of sand or gravel are often found associated with the yellow as well as the blue till. In the vicinity of the Wabash valley, the Shelbyville drift sheet is found to be generally coated with a yellowish loess like silt, to a depth of several feet. This is especially well shown on the west side of the valley in the vicinity of St. Marys to the northwest of Terre Haute. This silt is better developed on the borders of the river than at points a few miles back, there being scarcely enough silt in the latter situation to conceal the bowlders which cap the till. The distribution of the silt seems to be such as would be expected from the drainage conditions, which were inadequate to carry off the water from the melting ice. There are, however, other features which seem to indicate good drainage conditions. At the point where the moraine crosses the river, near Atherton, a gravel plain is built up to a height of about 75 feet.

In going over this area in the northwestern part of the county, no attempt was made to map separately areas of sand, silt and clay. On the western side are small areas extending as arms from the black prairies of eastern Illinois. These black soil areas were in part mapped and are described in the following paragraph. About fifteen samples of soil were taken over the morainic area. The results of mechanical analyses are given in the general table. In the area immediately surrounding New Goshen, the surface is very level. The soil is a light yellow, rather compact, not of as loose texture as the typical upland soils of the southern and eastern parts of the county. The subsoil becomes gravelly. Improvements are from fair to good. To the east the land becomes more gravelly and sandy, and this part of the area is devoted chiefly to pasture. In the area two to four miles to the north, surface becomes rather rough and is eroded considerably.

In the better parts of the morainic area the land is valued at $80 to $150. Corn yields from 60 to 75 bushels; wheat 10 to 20 bushels. Not so much wheat is grown as formerly, more attention being given to oats. Clover and timothy are both grown for hay. Considerable sorghum is usually grown, but crop is small this season.

The native timber growth consists of white, black, chestnut and burr oaks, shell bark and pig nut hickory, sycamore, sour gum, elm and black walnut.

Wabash Clay Loam.

In the southeastern portion of the county is the low land region of the Splunge Creek valley. The area has the appearance of an old lake bottom. The soil is a light to yellowish-white clay. There are several square miles of this soil. It was formerly covered with a heavy growth of prairie grass.

The drainage of this area is at present receiving much attention. In the margins of the area much of the land is uncultivated, but in the part next to the stream and lying adjoining Clay County a large part is never under cultivation, and during wet seasons the uncultivated area is much increased. This area is fully discussed under the discussion of Wabash Clay loam in the Clay County report.

SUMMARY.

On the terrace soils, in the vicinity of Terre Haute, truck farming is receiving much attention. The soils are the best for this purpose and the local demands for the products give a very profitable occupation.

The interurban lines have aided in the expansion of the area devoted to truck farming by affording a quick means of transportation. These lines have also been a great help in the dairying business.

The growing of tomatoes for their food value was begun in Terre Haute in 1830, at the time tomatoes were first cultivated for the purpose of making catsup, pickles, etc. Prior to this time, tomatoes were cultivated as curiosities only and were called "love apples."

Indiana stands second in the quantity of tomatoes canned. In Vigo County are large areas of soils well adapted to the growing of the crop and many parts not now yielding a profitable return would be made to produce well with this crop. The establishment of more canning factories should be encouraged.

In raising tomatoes for canning, the grower first of all seeks for a large yield. Early maturity is of less importance, since he contracts to sell the whole crop at a fixed price. This fact must be taken into consideration in selecting the varieties of tomatoes to be raised, the soil and the kind of fertilization. The usual practice is for the canneries to furnish the plants, so that the grower has only to deal with the selection of soil, the fertilization, the cultivation and harvesting of the crop.

Tomatoes will grow well on any soil which will yield good corn. For the earliest tomatoes grown for market purposes, the soil must be light and warm, but for the main late crop a heavier soil is better. The average growing season is from May 15th to September 15th. In very favorable seasons the growing weather may extend a month longer. Often the rainfall is low in July and August and the growth of the crop is checked. This may be guarded against by deep planting and careful cultivation, maintaining a layer of fine earth on the surface to serve as a mulch.

Lands which have had green crops turned under, or to which applications of barnyard manure have been applied, will have the water-holding capacity increased. Where barnyard manure is used on tomato land, it is advisable to apply it in the fall and work it well into the soil at that time.

While it is more difficult to cultivate tomatoes on heavier lands, it is the experience of catsup makers that on these lands a tomato of superior quality is produced, and the quantity of pulp increased. For the best yields, it is necessary to have heavy fertilizers. The price paid for the canning crop is relatively low, and the purpose is to produce good yields and the question of fertilization must be well considered.

The tomato plant requires an abundant supply of food. It has been established that ten tons of fruit with the accompanying vines would contain 57 pounds of nitrogen, 16 pounds of phosphoric acid and 94 pounds of potash. There is little danger that the soil be made too rich, but the cost and amount of fertilization must be adjusted to conditions. For heavy crops, an application of 500 to 1,000 pounds per acre should be given of a fertilizer containing nitrogen 4 per cent., actual potash 6 per cent., and available potash 7 per cent.

When an early ripening is desired for the market, the plants are tied to stakes and pruned to single stems, bearing from three to six clusters of fruit, but for canning or a late crop, a heavier yield is secured by allowing the plants to fall on the ground or rest on pieces of brush or wood.

Great care should be taken in the selection of seed corn. In the fall of 1911 corn did not properly mature, and it is very probable that much bad seed will be used in the spring of 1912. All seed should be tested by taking a few grains from the ear and germinating in some soil.

Many of the farmers complain about statistical reports being too high on grain production, but blame the farmers themselves for giving exaggerated information.

Several good catalpa plantings are found over the county. Most of the trees are from three to four years old, and where they have not been troubled with Catalpa Sphinx the trees have made a good growth.

In the region about Tecumseh some good vineyards have been grown. The vines are planted on the upland slopes on the west side of the river. The situation and soil seem well adapted to the growing of grapes, and good yields are obtained. In the winter of 1909 and 1910 many vines were partly killed by the icy freezes and it was necessary to cut them back to mere stubs to take a new start. Usually the vines are not injured by weather conditions. Many new vines have been put out during the past two years.

Soil Survey of Laporte County.

By E. J. Quinn.

LOCATION AND DESCRIPTION OF AREA.

Laporte County is bounded on the north by the State of Michigan, on the east by St. Joseph County, on the west by Porter County, and on the south by Starke County. It derives its name from Door (Laporte) prairie, so called by early French settlers, because a narrow opening or passageway in the timber served as a means of approach to this prairie from the east. The county is one of the largest in the State, comprising an area of 562 square miles, or 359,680 acres. There are twenty-one civil townships: Michigan, Springfield, Galena, Hudson, Coolspring, Centre, Kankakee, Wills, Lincoln, Pleasant, Scipio, New Durham, Clinton, Noble, Washington, Union, Johnson, Cass, Hanna, Dewey and Prairie. The population of the county in 1870 was 27,062; in 1900, 38,386; in 1910, 45,797.

Laporte, the county seat, is situated in the north-central part of the county. Its population in 1910 was 10,525, an increase of 3,412 in the last ten years. The principal industries of the city are: carriage and wagon works, thrasher and traction engine factory, bicycle factory, two furniture factories, piano factory, woolen mill, milling and feed establishments, and various other smaller enterprises.

Michigan City, with a population of 19,027, is situated thirteen miles northwest of Laporte, on Lake Michigan. This city is an important lake port, and this, together with excellent railroad facilities, makes it one of the leading commercial cities in the State. The Indiana State Prison is situated here. The city supports numerous manufacturing industries and gives employment to many men. An estimated number of employes in the manufacturing plants of the city, according to statistical reports, is 5,000, with an estimated weekly payroll of $60,000.

Other towns and villages throughout the county are: Lacrosse, Hanna, Union Mills, Kingsbury, Stillwell, Westville, Haskell, Wanatah, Otis, Rolling Prairie, Wellsboro, Waterford, and Hudson.

The county has about 89 miles of improved roads, all of which have been improved with crushed stone. Fine macadam roads have been built for some distance out of the cities of Laporte and Michigan City, and one of these fine stone thoroughfares now connects these two cities. There is little, if any, gravel suitable for road purposes to be found in the county.

The county has the best of railroad facilities. There is not a township in the county that is not crossed by either a railroad or interurban line. The Lake Shore and Michigan Southern crosses the north central part of the county in an east and west direction; the Grand Trunk Western, the south central part in a northeast and southwest direction; and the Baltimore and Ohio, through the southern part. Besides these three principal east and west lines, there is the Pittsburg, Ft. Wayne and Chicago, the New York, Chicago and St. Louis, the Pittsburg, Cincinnati, Chicago and St. Louis, the Chicago, Cincinnati and Louisville, the Pere Marquette, the Lake Erie and Western, and the Chicago, Indianapolis and Louisville. The Michigan Central cuts the northwestern part of the county at Michigan City. There are two interurban lines—the Chicago, Lake Shore and South Bend, which crosses the northern part of the county, and the Chicago, South Bend and Northern Indiana, which enters in the northeastern part, near Hudson Lake, and makes a loop through the central part of the county, taking in Rolling Prairie, Laporte, Waterford and Michigan City.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

When the early missionaries and traders and trappers came to this county, they found the country in possession of the Pottawattomie Indians, the same tribe that held sway in St. Joseph County. The members of this tribe were not hostile to the new comers and readily accepted the religious teachings and customs which were given them. It was probably this friendly attitude of the Pottawattomies toward the white man that caused this northern part of the State to become so quickly settled.

The first settlements are believed to have been made about the years 1828-1829 in what are now New Durham and Hudson townships. The first immigrants came from New York, Pennsylvania and other eastern States. Among the names associated with early settlement we find those of Henry Clyburn, Asa M. Warren, Joseph Bay and Joseph W. Lykins.

The hardships and privations that usually accompany the settlement of a new country were their common lot. It is said, however, that this country did not pass through the usual interim between savagery and civilization, where men have to defend themselves and families with a rifle and to resort to strategic measures to maintain their rights. They who came to these parts were generally well educated, and being of a law abiding and thrifty class soon provided themselves with everything conducive to their interests and the interests of the community at large.

The forests were gradually cleared and the vast stretches of prairie land put under cultivation. The rudely constructed log hut gave place to the small frame cottage, and more modern agricultural implements supplanted the wooden plow and other inefficient tools. School and other public buildings were constructed, and good roads took the place of Indian trails.

The sale of the Michigan Road lands occurred in the fall of 1831, and at the end of the Black Hawk War settlements were more readily made. History tells us that in some of the townships nearly all the Government lands were taken up by 1835.

In the year 1832, on January 9th, Laporte County was formed and organized. The county as it was first formed did not contain the southwestern projection, which now includes Cass, Hanna, Dewey and Prairie townships, but was more regular in outline, being nearly square in shape. The addition of these four townships and the irregular projection of Wells and Lincoln townships was made about ten years after the county's organization. By this addition the size of the county was increased about one hundred square miles.

Corn, wheat and oats were the important crops of the early days, as they are now. Potatoes, beans and garden produce were raised to a large extent, especially on the sandy soils. Before the advent of the railroads, in the late thirties, it was difficult to dispose of the surplus wheat and produce, and we learn from a recent history of the county that in 1838, 200,000 surplus bushels of wheat were produced in that season.

Where the supply exceeded the demand, as it did at this time, extensive preparation was not necessary and rude implements were sufficient for ordinary purposes. Such was doubtless the belief of the average farmer, and it is perfectly natural that little or no progress should be made with such conditions existing.

With the coming of the railroads, things were changed. Not only was a means given for transportation of produce to markets in the east, but population increased and with it a demand for grain and other things to support life. It was evident that intensive methods should be practiced, that increased facilities and more improved machinery should be had in order to work to the best advantage. All these things slowly but surely came.

Within the last fifty years great progress has been made in the agricultural line, until now Laporte County ranks among the first in production and land value. Probably no other county in the State contains so much good land as is found in the prairies of the central and southern parts of this county.

Great interest in agricultural pursuits is manifested in the county. An agricultural society was formed as long ago as 1841 for the purpose of holding annual fairs and thus promoting general interest in the science of farming. These fairs have been held almost every year since the organization of the society. The Grange is an educational and social society which was organized in 1874. Farmers institutes are held during the winter season, and well known and accomplished agriculturists are usually procured to address the meetings.

Geology and Physiography.

Laporte County, like St. Joseph County, lies in the glaciated territory. The thickness of the glacial debris varies considerably in different parts of the county, as the following data will show: A boring made at Michigan City, some years ago, showed the drift at this place to be 250 feet deep, one at Laporte gave the depth as 295 feet, while a boring at Lacrosse found the depth to be only 38 feet. The average depth, it will be seen, is about what would be expected in this region, but at Lacrosse and other places along the Kankakee River it falls somewhat below the average.

The surface features are much more varied in this county than they are in the county to the east. Here the surface is diversified with sand dunes, sand ridges, morainic hills, level to rolling prairie land, and reclaimed marsh land. The areas occupied by each of these physiographic features are quite uniformly distributed through the territory and their boundaries may be easily traced.

The most prominent elevations in the county are found in the morainic belt which enters the county a little north of the town of Westville and extends in a northeasterly direction to the borders of St. Joseph County. The hills continue at about the same elevation in a northeasterly direction to near Rolling Prairie; they then turn southeastward, taking in almost all of the northern part of Willis Township. Near Laporte, the greatest elevation is attained, being 800 feet above tide. The breadth of the belt is about six miles at the widest place.

The high crest of this ridge is the watershed of the county. North of the crest the drainage is toward Lake Michigan; south of it, the streams flow into the Kankakee River and thence into the Mississippi.

Extending northward from the morainic belt, which is known as the Valparaiso moraine, are found a number of sand ridges descending gradully to the north. These ridges extend through the northwestern part of the county, nearly parallel with the lake shore, and are believed to be the former shore lines of Lake Michigan. The ridges, of which there are five in number, are about one-half mile apart and vary in height from 30 to 225 feet above the lake.

Along the immediate shore of Lake Michigan are several mounds or hills of fine light colored sand which have been formed from the wind-swept sand of the lake. These mounds, which are known as sand dunes, are scattered along the shore in great irregularity. Some are low and rounded, while others have been heaped up so that their sides lie at an agle of nearly sixty degrees. The height varies from 30 to 175 feet. One of these hills, known as "Hoosier Slide," is situated on the lake shore at Michigan City. Its height was formerly about 175 feet, but much of the sand has of late years been shipped away and it is now only about 75 or 100 feet above the surface of the lake. The ridges and hills next to the water are nearly destitute of vegetation, but back some distance from the lake they are often covered with small pines and scrub vegetation peculiar to a light soil of this kind.

South of the morainic ridge and extending with a gradual descent as far south as the Kankakee River is a broad, gravel outwash plain. This plain is about 810 feet above tide at Laporte, 770 feet at New Carlisle in St. Joseph County, 760 feet at Wellsboro, and 730 feet at Wanatah. The plain includes the vast prairie lands of the central and south central parts of the county and the reclaimed lands bordering the river.

"The head water portion of the Kankakee River leads through a gravel plain which descends toward the river from the moraines on either side. On the north side, the gravel plain connects with the Valparaiso morainic system, while on the southeast it connects with the Maxinkuckee moraine of the Saginaw lobe. In the vicinity of Laporte, Indiana, the gravel plain which is connected with the Valparaiso morainic system attains an elevation of 800 feet above tide on the immediate borders of the moraine. This great altitude, however, is apparently maintained for only a short distance, for the railroad surveys show that there is a descent in it along the border of the moraine, both toward the northeast and the southwest, as well as a descent in passing southeastward from the moraine to the Kankakee River."*

The altitudes of various points taken from a list of elevations compiled by the Chicago, Indianapolis and Louisville R. R. are given in the following table:

	Feet Above Tide.
Michigan City	617.8
Otis	747.3
Westville	788.0
Alida	781.4
Haskels	767.0
Lacrosse	680.0
Wanatah	732.2

Elevations compiled by the Grand Trunk Western R. R.:

Mill Creek	698.2
Stillwell	741.0
Kingsbury	740.0
Union Mills	747.0

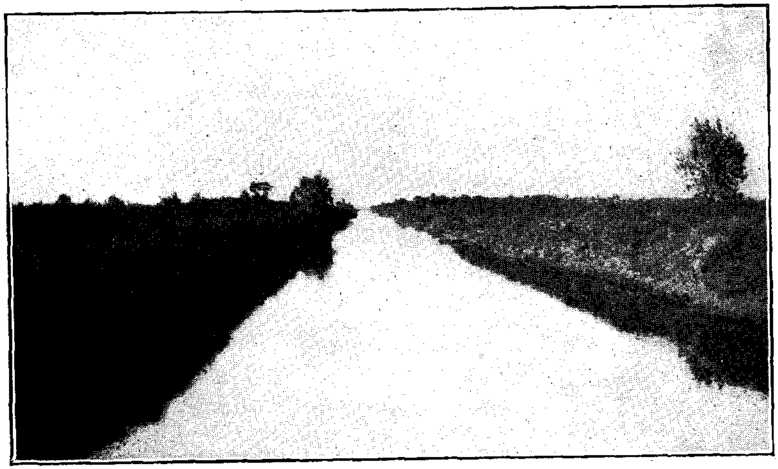
The natural drainage system of Laporte, especially in the southern part, is not very well developed. No large streams are found within the territory, although the Kankakee River forms the southern boundary. Trail Creek and its tributaries, which flow north into Lake Michigan, is the principal drainage system north of the divide. The Brown and Warwick ditches have been constructed to drain the depressions and ponds in Springfield and Galena Townships.

The streams south of the divide are Little Kankakee River, Trans Creek, Hog Creek, Kingsbury Creek and Mill Creek. Numerous dredge ditches have also been constructed in the southern townships and along the old marsh land.

The Kankakee, which was formerly a sluggish stream flowing southwestward from the St. Joseph County line and forming the southern boundary of this county for some distance, has been dredged and its channel straightened. A few years ago this stream

* Frank Leverett. Monograph of U. S. Geological Survey, Vol. 38.

would overflow its low banks and spread far out over the level prairie lands which bordered its channel, making them appear as one great morass. All this wet and swampy land has been drained and the waters of the river flow freely through a well-defined channel.



Kankakee River after dredging and straightening. Laporte County.

CLIMATE.

The climatic conditions of this county are slightly affected by the influence of Lake Michigan; but as will be seen the temperature and precipitation do not differ materially from that of St. Joseph and other northern counties.

Mean Normal Monthly Temperature and Precipitation for a Period of Eleven Years.

	°F.	Inches.
January	25.3	2.30
February	21.9	2.83
March	37.2	3.49
April	46.3	2.30
May	59.1	4.02
June	68.5	3.11
July	73.8	3.66
August	71.1	3.19
September	64.6	3.21
October	53.5	2.43
November	39.5	2.80
December	26.8	2.52

A record of twelve years shows the average date of first killing frost in autumn to be October 5th, and last in spring May 1st. The earliest date of killing frost in autumn is September 14th; latest date of killing frost in spring, May 21st.

AGRICULTURE.

Laporte ranks as one of the leading agriculture counties in the State. It has within its boundaries a comparatively small area of sandy soil, which may not come up to the standard for general crops, but its vast expanse of rich prairie soil and reclaimed marsh land by far makes up for the shortcomings of the lighter type.

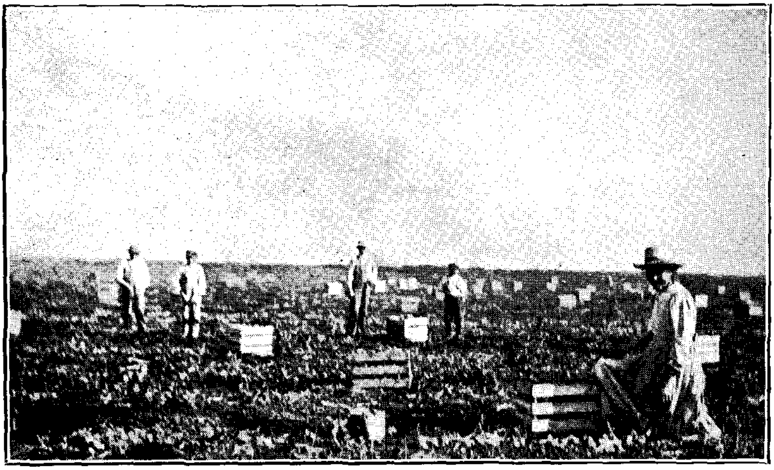
The kind of farming carried on is mostly of a general character, although truck farming on the sand land is becoming of considerable importance and promises to increase extensively. In the neighborhood of Michigan City the sandy soil is well adapted to the growth of small fruits, of which huckleberries and raspberries are the most important. Watermelons and cucumbers are also well adapted to this kind of soil and are grown extensively. Transportation facilities are very good and a ready market is always to be had in Chicago and other nearby cities.

The following statistics for 1909 show the acreage and the average yield of the principal crops of this county: Corn, 42,732 acres, average 29 bushels per acre; wheat, 30,393 acres, average 20 bushels per acre; oats, 26,204 acres, average 31 bushels per acre; timothy hay, 19,644 acres, average 1 7-10 tons per acre; alfalfa, 18 acres, average 1 1-5 tons per acre; clover, 3,061 acres, an average of about one ton per acre; and 9,664 acres of marsh or prairie hay, an average of about one ton per acre.

Of the special crops, potatoes and onions are probably the principal ones. Statistics show that there were 2,868 acres cultivated to potatoes in 1909, with an average yield of 92 bushels per acre. On the lighter soil in the northern part of the county, especially in Springfield, Cool Spring, and Center townships, the yield is much greater than the above average, in some years 200 to 250 bushels being considered a fair estimate. Onions are grown extensively, especially on the muck areas in the southern part of the county. Extensive onion cultivation is carried on in Hanna Township, the largest patch devoted to this crop being just outside the town of Hanna on the farm managed by W. H. Tuesburg. In 1909 there were 21 acres in this county cultivated to this crop with an average yield of about 322 bushels to the acre.

There are two thousand, five hundred and thirty-six farms in this county, varying in extent from less than three acres to over 1,000 acres. According to the thirteenth census of the United States, there are four farms of less than three acres and three farms of more than one thousand acres. There are seven hundred and fourteen farms varying from 100 to 174 acres, which seems to be about the average size of most of the farms throughout the county.

About 30 per cent. of the farms of the county are occupied and



Onion Farm managed by W. S. Tuesburg, near Hanna, Laporte County.

tilled by renters. The land is rented on the share basis, the owner receiving one-half the grain, delivered at the nearest market. Hired help is usually secured at $20 to $30 per month.

The total valuation of farm lands for the year 1910 was $8,617-290 with a valuation on the buildings of $1,459,160. The above figures, however, represent only 50 per cent. of the actual value.

The farmers are progressive and prosperous. What mortgages are held against the farms are being rapidly paid off, which is a good indication of the financial standing of the community.

Soil Survey of St. Joseph County.

By E. J. Quinn.

LOCATION AND DESCRIPTION OF THE AREA.

St. Joseph County is situated in the extreme north central part of the State, and is one of the northernmost tier of counties bordering on the Michigan State line. It is bounded on the west by Laporte County, on the east by Elkhart County, on the south by Marshall and Starke counties, and on the north by the State of Michigan. The county comprises an area of five hundred and sixty square miles, being twenty-four miles in length from east to west, and having an average width of about twenty-one miles.

The territory is divided into thirteen civil townships—Warren, Olive, German, Clay, Harris, Portage, Penn, Greene, Center, Liberty, Lincoln, Union and Madison.

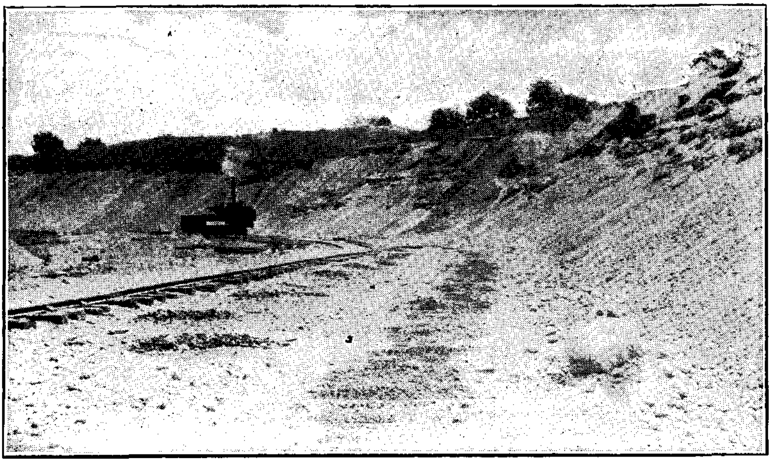
South Bend, the county seat, was laid out by Alexis Coquillard and Lanthrop M. Taylor on the 28th of March, 1821. It is located on the south bend of the St. Joseph River and from this derives its name. The population of this city was in 1910, 53,684, an increase of 17,685 over 1900. The Studebaker Wagon Works, the Oliver Chilled Plow Works, Birdsell Manufacturing Company, South Bend Watch Factory, and numerous other world-famed enterprises make this one of the most important commercial cities in the State. The best of facilities are offered for education in this city. A good high school and a number of private schools are located here. The University of Notre Dame and St. Mary's Academy, two of the most noted educational institutions in the country are situated about two miles from the city.

Mishawaka, with a population of 11,886, is another important city of this county, situated about four miles east of South Bend. Other principal towns are Walkerton, North Liberty, River Park, New Carlisle, Lakeville, Osceola, and Wyatt.

The transportation facilities for this county and the surrounding country are excellent. The country is traversed by the Lake Shore and Michigan Southern; Grand Trunk Western; Michigan

Central; Vandalia; New Jersey, Indiana and Illinois; Chicago, Indiana and Southern; Cleveland, Cincinnati, Chicago and St. Louis; Montpelier and Chicago steam roads, and the Chicago, Lake Shore and South Bend and Chicago, South Bend and Northern Indiana traction lines.

Good deposits of gravel are found throughout the county, especially in the northern part. All of the principal roads of the county have been graveled, and many of the side roads. With the abundance of such fine road-building material, more of this work should be done.



Pit of Glacial Gravel, 2½ miles northwest of South Bend.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The territory that now comprises St. Joseph County was the first in the State to be traversed by the white man. Tradition and history tell us that Father Marquette, the French missionary, came here as early as 1675, while LaSalle in his tour of exploration passed up the St. Joseph River about four years later. The country was inhabited at this time by the Miami and Pottawatomie Indians, and these two tribes remained in the locality until the year 1832, when a treaty was made and the last of their possessions were ceded to the Government.

Two years prior to the treaty of 1832, a great tide of immigration set in from the eastern States and it was deemed necessary by the State authorities to organize the territory as a county. Accordingly, on January 29, 1830, by an act of the General Assembly, St. Joseph County was duly formed and organized.

The development of the county progressed rapidly. The facilities for travel afforded by the St. Joseph River and the great Michigan Road, which was completed in 1832, attracted many immigrants to this part of the State. Along the great State Road, settlements were readily made, but often the productive soil of the prairie induced many to leave the much traveled thoroughfare and to settle there, where the soil was more easily cultivated and where luxuriant grass afforded excellent grazing to their horses and cattle.

One of the large drainage ditches which are frequently seen both in Laporte and St. Joseph County.

The crops which were first grown were those which would meet the immediate demands of the family. Corn, wheat and potatoes were the leading crops. Corn was grown usually two years in succession, then followed by wheat. Often corn was the principal crop and was grown continuously for years without any system of rotation.

Gradually the forests were cleared and the low-lying lands or marshes drained. These reclaimed lands proved to be most productive and induced further work along this line. For years this question of drainage was of utmost importance in the minds of the farmers. What was formerly utterly useless land, useless and unproductive because of continual wetness, has by a well regulated system of ditching and tiling been redeemed and is now considered the most productive soil in the county. Not only has the drainage of this land brought money to the hands of the farmer but it has done far greater good by ridding the country of much stagnant water. These low lying lands with their confined marsh water were ideal breeding places for the mosquito and malaria germs, but drainage did away with such a state of affairs and health conditions thereby improved.

The rude methods of carrying on agriculture that were employed in the early days are no longer to be seen here. Scientific farming has forged to the front, and it is uncommon to find a farmer who is not willing to take advantage of opportunities offered for advancement in this line. Many of the farmers or their sons attend the special sessions held at Purdue, Illinois and other agricultural schools. Several agricultural societies have been formed and yearly farmers' institutes are held during the fall or winter season. The county fair was a great attraction for many years, but these were discontinued in 1872. The Scientific Agricultural League is a farmers' association that has been but recently formed in this county. This society has for its object "the study of scientific farming and the promotion of things pertaining thereto." Scientific road building, farmers' short courses and institutes, and improvement of the rural school system are other things to be taken up for consideration by the members of this league.

CLIMATE.

Climatic conditions are favorable for growing all the leading crops of the State. A record of the average temperature and rainfall of this region for the past fifteen years is given in the following table:

Normal Monthly Temperature and Precipitation.

Month.	Temperature. °F.	Precipitation. Inches.
January	25.2	2.60
February	21.8	2.21
March	36.5	3.22
April	48.2	2.50
May	60.2	3.79
June	68.6	3.20
July	73.4	3.61
August	71.6	3.26
September	66.0	3.81
October	53.3	2.29
November	39.5	2.80
December	27.9	2.98

Records for the past fifteen years show the earliest date of killing frost in autumn to be September 20th, and the latest date of killing frost in spring to be May 28th. The average date of the first killing frost in autumn is October 12th, and the last in spring is May 5th. On the prairie land and low lying muck beds of the county, frosts often occur much later in the spring and earlier in fall than is shown by the dates above.

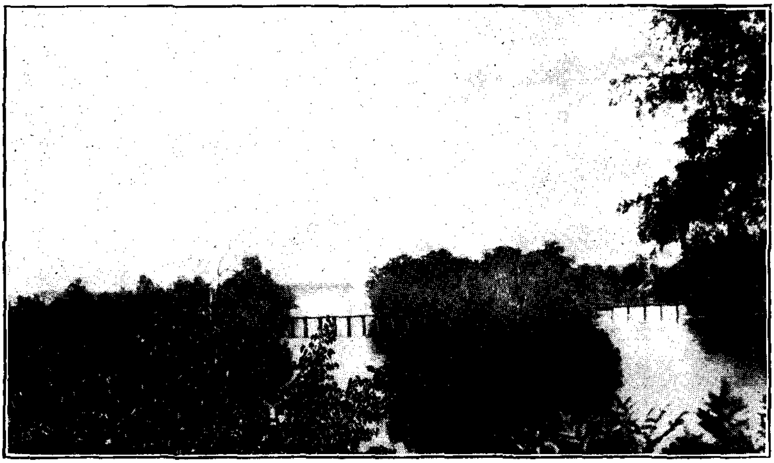
Physiography and Geology.

The surface features of this county are those characteristic of all the northern counties of the State. The entire county is covered with drift material brought by the great ice-sheet as it passed southward. No where in the county were any outcrops of stratified rock found, and borings show that many feet of glacial material overlie the rock floor. The drift varies in depth from 50 to 200 or more feet and is composed of a mixture of clay, sand and gravel. Large granite boulders were a noticeable feature in the morainic areas. Some years ago a boring made near South Bend showed the drift here to be 160 feet deep, but this boring was made in the valley of the St. Joseph River which lies considerably lower than the morainic uplands surrounding it. The surface features vary from low, level prairies and marsh land to morainic hills and rolling upland. The hills south of the cities of South Bend and Mishawaka and the elevations extending from about one mile northeast of South Bend in a general northeasterly direction into the State of Michigan plainly show the result of the ice action in this vicinity. The northwestern part of the county is also crossed by morainic hills and uplands which mark the southeastern margin of the Michigan ice lobe.

These morainic hills with their confused mass of land, clay and gravel were deposited with great irregularity and between the knolls which were thrown up water readily accumulated to form small lakelets. St. Joseph County is noted for its numerous small and beautiful lakes, but many of these are becoming extinct. Marsh land and muck areas now mark the location of many of these former small bodies of water. Many or all of the prairies of this county were once the site of shallow lakes, but by drainage their waters were removed.

On either side of the Kankakee River the land is somewhat lower than it is farther back, and extensive marshes once extended from just southwest of the city of South Bend to the Laporte County line. Most of these marshes are now a thing of the past, for a large acreage of this land has been reclaimed. Steam dredges have been used to dig wide, open ditches wherever the depressions of the area needed to be drained of their excess water. Laterals have also been constructed and from these secondary ditches, both open and underdrain, branch out in every direction.

The drainage of the county is principally through the St. Joseph and Kankakee rivers. St. Joseph River rises in the State of Michigan and enters the county in Section 9, Penn Township. This river flows through the old Kankakee valley in a southwesterly direction until it reaches a point near South Bend; here it turns



View on the St. Joseph, near South Bend.

abrutly north and flows through the old channel of the Dowagiac River to Niles, Michigan, and thence to Lake Michigan by a later eroded channel.

There are only a few small tributaries within the county which empty into the St. Joseph River. A State ditch extending through Clay and Harris townships is the main outlet for the surface waters of the northeastern part of the county. The western and southern parts of the county are drained into the Kankakee, the principal tributary being Grapevine Creek. A line drawn from the eastern part of the county about four miles south of the St. Joseph River and extending west to a point a little to the west of south of the city of South Bend, thence northwest through Warren Township, marks the watershed of this part of the county. North and northeast of this line the waters flow to the northward into the St. Joseph River, and finally reach the Gulf of St. Lawrence and the Atlantic Ocean. South and southeast of this line the waters flow to the southeast through the Kankakee and by the Illinois into the Mississippi and thence into the Gulf of Mexico.

Agricultural Conditions.

St. Joseph County is an agricultural county, with few superior in the State. The soils are well adapted to all the leading crops of this latitude and, with suitable climatic conditions, favorable yields can always be expected. Good markets for the produce are to be found in the cities of South Bend and Mishawaka. Chicago is about 86 miles from South Bend and also furnishes an excellent outlet for the produce of the county.

The farmers of the area are prosperous and have fine homes and buildings. The houses are well built, well painted, and usually modernly equipped. The total valuation of farm buildings, according to the report of the State Board of Tax Commissioners for 1911, is $1,380,120, and the true value of lands $6,505,420.

General farming is the usual type followed, although dairying and truck-farming are becoming of great importance. This county ranks among the first in the State in the number of milch cows and the production of milk. In 1909, the average number of cows milked was 8,212. The total value of dairy products for this same year was $559,462.

Truck-farming is being carried on more extensively every year. On the sandy soil, potatoes, melons and small fruits are the principal crops, while on the muck area onions, celery and cabbage receive the most attention. Both South Bend and Mishawaka are growing rapidly, and with the increase in population there is a resulting increase in demand for special crops, such as fruit and vegetables.

Corn and wheat are the principal crops of the county. Corn does well, especially on the black prairie soil and on the "clay" land in the southern part of the county. According to agricultural statistics, the average number of bushels to the acre in the year 1908 was 20; in 1909, 32. The average yield of wheat is about 18 bushels per acre, but the yield for the past year will fall far below this estimate. Considerable damage has been done of late years by the Hessian fly. The crop does not do well on the low-lying lands, as it is usually affected by the late frosts in the spring.

Among the minor crops, cucumbers and onions are the most important. Cucumbers are largely grown on the sandy soils and are sold at the salting stations, several of which are scattered through the county. The price usually paid is 75 cents a bushel for the small size and 35 cents a bushel for the larger ones. The different grades are sorted in the field by the pickers and then delivered at the station. Onions are grown chiefly on the muck areas. Two hundred and thirty-nine acres were devoted to this crop in 1909.

Clover was formerly grown with great success, but of late years it has been found hard to secure a good stand. In 1908 there were 20,072 tons of clover hay raised on 18,884 acres, and in 1909, 8,632 tons produced on 7,515 acres. Cowpeas have taken the place of clover to some extent in the sandy areas. This legume has been found of great value on these lands both as a forage and manurial crop.

Alfalfa is beginning to be an important crop in the county. It has been grown successfully on nearly every type of soil in the territory providing the ground was properly prepared beforehand. Most farmers lime their soil heavily and then inoculate with earth taken from a good alfalfa field. A few have had success with this crop without the preliminary work of liming and inoculation, but it was invariably found that the natural condition of the land in regard to drainage and fertility were exceptionally good.

The mint industry has become one of great moment in this county within the last few years. On the muck soil it may be grown for six or seven years in succession without any rotation, although it is very exhaustive to the upland soil. The land to be used for peppermint is plowed in the fall and harrowed in the spring. The small roots are placed in shallow furrows, then covered with the mucky soil and this in turn treaded and packed firmly down. The rows are made about 30 inches apart, so as to allow room for cultivation. It is necessary to keep the field free from weeds as it is believed they injure the crop by contaminating the oil. In August or September, when in full bloom, the herb is mowed with the scythe and is then dried and hauled to the distillery. The price of peppermint oil varies nearly every year. In 1899, it brought 75 cents a pound; in 1902, the oil was rather scarce and brought as high as $4.75 a pound. Good prices have prevailed in the last few years and as a result a great increase in culitivation of this crop has been made. The yield varies from 12 to 50 pounds per acre.

Commercial fertilizers, as a general thing, are not used to such an extent as they are in the counties farther south. Barnyard manure is quite plentiful and ordinarily is the only kind of fertilizer used on the high ground. Potash salts are used on the muck areas with good results. On the sandy areas where the land is very porous, fertilizers are readily leached out and great care should be taken in selecting a fertilizer for this land so as to get one that will act quickly and readily yield its plant food.

Mint Farm, St. Joseph County.

Liming as a manure and as a means of improving the physical condition of the soil is generally understood. The soils in this county are as a general thing quite sour, especially the prairie lands, which are exceedingly rich in organic matter. Large quantities of crushed limestone are used, but a few prefer the caustic lime which acts quicker. The latter is not to be recommended, however, as it tends to exhaust the soil. The amount of crushed limestone usually applied is two tons to the acre. This is applied as evenly as possible, either by hand or by a spreader especially constructed for the purpose.

SOILS.

The soils of both Laporte and St. Joseph counties are of glacial origin, having been formed from material as originally deposited or after being modified by wind and water.

St. Joseph County has nine distinct types, while Laporte has eleven. All the light soils have been classed in the Coloma or Miami series, but where organic matter has entered into the makeup of the soil to any great extent, so as to impart a dark brown or black color to the material, they have been classed in the Carrington and Waukesha series. Muck, dune sand and Kankakee marsh land soil are the additional types found in this territory and do not enter into the above two classes.

Variations occur among the general types, due to better tillage or perhaps to some other local causes, but these variations occur only in small areas and mention can only be made of them in the general discussion.

Carrington Loam.

The Carrington loam covers most of the terriotory in the southeastern part of St. Joseph County and is also found in Olive Township in St. Joseph County and in Galena and Hudson Townships in Laporte County.

The surface soil of this type to a depth of 12 inches is dark brown or dark gray in color and of a loamy texture. The subsoil from 12 to 36 inches is heavier in texture and lighter in color, becoming yellowish or brownish gray, often mottled or stained with iron oxide. Both surface and subsoil contain a high percentage of fine sand, while in places considerable gravel is encountered at a depth of two to three feet. The subsoil also contains a higher percentage of silt than the surface soil. Scattered over the surface of this soil are found many granitic boulders of various shapes and sizes.

There are small areas throughout the type which are quite sandy, especially on the higher elevations. One of these narrow sandy streaks in Madison Township, St. Joseph County, extends through Sections 13 and 14 northward through Sections 35 and 36. This was not a continuous ridge but is broken here and there and appears to lose itself in the "clay" land, only to appear again a little farther on. These sand patches are readily noticeable in the growing season, due to the scantiness of the vegetation upon them.

The soil of this type has been derived from glacial till, the deep subsoil consisting of sand, gravel, clay and boulders. The topography varies from gently rolling to almost hilly in places, while here and there scattered throughout the area are found numerous depressions—the sites of former ponds and lakes.

Part of the areas included under the head of Carrington loam was once heavily timbered, but very little of the original timber now remains. The black color of the soil is due to its rich humus content, derived from the leaf mold and decayed grasses which once covered its surface.

Although the subsoil contains a high percentage of fine sand, it nevertheless is compact and requires to be artificially drained before good results can be looked for. Artificial drainage with tile has been carried on extensively in both Madison and Union townships, St. Joseph County, and a number of open ditches have also been constructed to remove the surplus waters of the depressions and muck areas which abound in this locality. Because of this compactness of subsoil, this type probably suffers less from drought than any other soil in the territory. Outside of the Carrington sandy loam, this type is considered the best all around soil of the two counties.

If plowed when wet, the Carrington loam is hard to manage, as it turns up in clods which become compact and hard when dry. With proper care and sufficient tillage, however, it can be brought to an excellent state of productiveness. It is especially adapted for corn, oats and wheat. Timothy also does well on this type. Corn yields from 35 to 50 bushels; wheat, 18 to 25 bushels; oats, about 50 bushels, and timothy, from 1 to 2 tons.

The result of mechanical analysis of a typical sample of Carrington loam is given in the following table:

MECHANICAL ANALYSIS OF CARRINGTON LOAM.

Locality.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
S. W. Corner Sec. 35 T. 36 N. R. 4 E.	Soil....	.3	.8	6.0	25.0	34.0	13.3	20.2
	Subsoil.	.0	.2	9.3	20.8	27.1	26.7	20 7

Chemical Analysis of Carrington Loam.

Collector, Quinn.

Description	28-3
Reaction to litmus	Neutral
Moisture in air dried soil	1.24%
Total soil nitrogen	0.112%

Analysis of fine soil dried at 105° C.—

Volatile and combustible	3.27%
Insoluble in 1.115 HCl	88.94%
Soluble silica (SiO_2)	0.13%
Ferric oxide (Fe_2O_3)	1.63%
Alumina (Al_2O_3)	4.01%
Phosphoric acid anhydride (P_2O_5)	0.40%
Sulphuric acid anhydride (SO_3)	0.06%
Calcium oxide (CaO)	0.28%
Magnesium oxide (MgO)	0.36%
Potassium oxide (K_2O)	0.15%
Sodium oxide (Na_2O)	0.27%
Total	99.50%

Waukesha Sand.

The soil of the Waukesha sand is a dark brown or reddish brown sand, containing a small percentage of clay and silt. The color becomes lighter at a depth of about 10 inches, the subsoil proper being a yellow sand with a lower content of silt and clay. Often gravel is found scattered through the soil and subsoil.

In the depressions and lowlands, the soil of this type becomes much deeper and its humus content higher. These patches are usually more productive than the upland, and are cultivated to the fullest extent by those who own them.

The material is derived from the reworking of glacial till by wind and glacial waters. The effect of wind action is plainly visible and to this agency is due, to no little extent, the topographic features of the type.

The type is found principally in the southwestern part of St. Joseph County, covering parts of Lincoln and Liberty townships. There are a few areas in Laporte, but they are small and scattered. The monotony of the sandy soil is frequently broken by muck and marsh land, this being especially true in the southwestern extremity of St. Joseph County.

The soil is light and easily tilled, but is apt to dry out quickly. Drainage is quite excessive, and crops often suffer from lack of moisture.

The greater part of the area is under cultivation. Corn, wheat, and rye are extensively grown, but with only fair yields. Corn will average 35 bushels; wheat, 15 bushels, and rye, about 15 bushels to the acre. Potatoes yield from 50 to 100 bushels per acre.

The growing of cowpeas and soy beans should be encouraged on this soil, so that the organic matter content will be increased and the soil thereby be better able to withstand the drought.

A mechanical analysis of a typical sample of the Waukesha sand follows:

MECHANICAL ANALYSIS OF WAUKESHA SAND.

LOCALITY.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
N. W. Cor. Sec. 28, T. 35 N., R. 1 E.	Soil....	1.0	.4	8.6	34.7	37.0	13.7	4.4
	Subsoil.	.2	7.5	9.4	34.4	38.1	6.9	3.4

KANKAKEE MARSH LAND SOIL.

This soil is peculiar in so much as it varies continuously in respect to its sand and organic content. Because of its varying character and since it has not been identified by the United States Bureau of Soils under a distinct type-name in the latest classification, it has been thought best to retain the old name of Kankakee marsh land and to speak of the soil that comes within the confines of the old undrained area as Kankakee marsh land soil.

Generally, this soil is a sandy, silty loam, with a very high percentage of organic matter, either wholly or partly decomposed. The sand particles themselves are white, but the large amount of decayed vegetable matter and dark silt make the whole appear black. Often the sand and silt are absent and only the vegetable matter is found. Where such is the case, and where it was found expedient, such places have been included under the type of Muck. These mucky spots were usually encountered at the beginning of the old marsh near South Bend and along the borders on either side of the marsh throughout the two counties. On the higher elevations, which were doubtless islands in this great marsh at one time, the soil is rather deficient in sand and organic matter, especially the former, but contains a high percentage of silt and clay. The soils of the whole type are very changeable, being nearly as variable as the main uplands in the remaining parts of the territory.

The surface soil, if it can be designated as such, is ordinarily 15 to 18 inches deep. Beneath this is a whitish sand containing little or no organic matter. Often when boring with the auger a blue clay was encountered at a depth of 24 to 36 inches, while in other places the clay would be found nearer the surface, with little sand intervening.

The valley through which the Kankakee River now flows was formed by a post glacial river, and for a time constituted a line of discharge for the St. Joseph River. By some movement of the glacial ice and its load of material, the course of the waters flowing through the St. Joseph was changed and the amount of discharge through the old post glacial valley greatly decreased. Coupled with this decrease in volume was the small gradient of the stream. At Momence, Illinois, a rock formation obstructed the discharge, causing the waters to be backed up over the level lands along the borders of the river, and making the stream aggrade its bed. This aggradation still further checked the flow of the Kankakee, filling its valley with heavy sedimentation. Where the water was not very deep, aquatic vegetation rapidly encroached from the sides. These plants began to decay and, together with the wash from the uplands, gradually filled the stream and started the formation of the marsh soil of the present time.

This type sets in a short distance southwest of South Bend and extends, with an average width of about two miles, through to the Laporte County line. Here it cuts the southeastern corner of Laporte and extends along the southern part in a southwesterly direction to Porter County. The city limits of South Bend now extend to this former marsh land, but the soil here is mostly a deep muck, to a depth of three feet or more, with little sand and clay in evidence.

Much of this land has been drained and is now being cultivated. The work of drainage has been undertaken by syndicates and private individuals. Where this system has been carried on extensively, so as to include both large and secondary ditches, the land has been brought to an excellent state of productiveness and the large yields of corn and wheat will compare with any in the State for both quality and quantity.

It is hard for one to conceive of the great benefits that have been derived from the reclamation of these lands. Hundreds and hundreds of acres which formerly were covered with water for the greater part of the year, are now dry and cultivated. Houses have been erected and roads have been built on land that but a few years ago was accessible only to the hunter with his boat; and land that was practically of no value has been transformed into the most valuable in the county.

The topography is comparatively level. Back away from the river, on either side at a distance of from one-eighth to one mile, the higher land begins, gradually getting higher until the morainic hills are approached.

Hemp Farm, St. Joseph County, on reclaimed Marsh.

Truck crops, such as onions, cabbage and celery, do well on this soil, and are extensively grown. Transportation facilities are good along the river, and produce can easily be disposed of. This "Garden of Chicago," as it has been called, will doubtless continue to be a favorite soil for this class of farming, although good crops of corn, wheat and timothy are grown. Excellent crops of corn are produced, the yields often being 75 or 80 bushels per acre. Frosts in the spring sometimes do some injury, but corn planted as late as June 10th has matured. There are two large hemp farms situated within this type, one of these having 450 acres devoted to the crop. Where drainage is not complete, great quatities of marsh hay are grown, and in 1909 over 10,000 tons of this wild hay were harvested in the two counties.

This land generally sells in the neighborhood of $75 or $100, but much of it is not for sale at $150. The price depends upon the extent the land has been drained and the improvements, such as buildings, fences, etc.

The following table gives the result of mechanical analyses of the Kankakee marsh land soil:

MECHANICAL ANALYSIS OF KANKAKEE MARSH LAND SOIL.

LOCALITY.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
S. E. Cor. Sec. 36, T. 33 N., R. 4 W.	Soil...	.3	.0	1.3	20.2	49.6	19.6	7.0
	Subsoil.	.0	.4	1.8	45.7	30.0	10.0	9.0
N. E. Cor. Sec. 4, T. 33 N., R. 3 W.	Soil....	1.7	1.1	7.4	35.6	29.2	17.5	7.4
	Subsoil.	1.5	.6	6.4	45.5	30.6	12.0	3.2

Chemical Analysis of Kankakee Marsh Land Soil.

Collector, Quinn.

Description	178–a
Reaction to litmus	Neutral
Moisture in air dried soil	1.40%
Total soil nitrogen	0.268%

Analysis of fine soil dried at 105° C.—

Volatile and organic	6.27%
Insoluble in 1.115 HCl	89.46%
Soluble silica (SiO_2)	0.05%
Ferric oxide (Fe_2O_3)	0.92%
Alumina (Al_2O_3)	1.85%
Phosphoric acid anhydride (P_2O_5)	0.60%
Sulphuric acid anhydride (SO_3)	0.07%
Calcium oxide (CaO)	0.46%
Magnesium oxide (MgO)	0.23%
Potassium oxide (K_2O)	0.07%
Sodium oxide (Na_2O)	0.23%
Total	100.21%

Coloma Sand.

The sand is very similar to the Waukesha sand, heretofore described, but occupies a more rolling topography and is lighter in color.

The surface soil to a depth of 10 to 15 inches is a light brown, slightly loamy sand, containing a small percentage of fine gravel. The contact between the soil and subsoil is, as a rule, not very well marked, the texture and color remaining about the same to a depth of 36 inches.

The topography varies from undulating to hilly. Often on the hills and higher elevations the sand becomes very light and fine, and would be classified and mapped as a new distinct type if the areas were large enough to warrant such separation. A few small areas or pockets of gravel are also found throughout the type.

The Coloma sand is by no means considered a superior soil for general farming, but is well suited to small fruits and vegetables. Truck crops are particularly adapted to a light soil of this kind and most farmers in the area realize the fact. The soil warms up early in the spring, causing the crops to mature in time for a profitable market. Good markets are to be had in South Bend, Mishawaka, Laporte and Michigan City.

Little commercial fertilizer is used on this soil. Probably the thing most needed is a liberal supply of vegetable matter and good barnyard manure. This would not only enrich the soil but would make the light sand more retentive of moisture. This sand being so light, is shifted about by the winds considerably and until the humus content is increased, little benefit will be derived from fertilizers by him who uses them.

Vegetables and fruit receive the most attention on this soil, although corn and rye are grown to some extent. Cowpeas are an important crop, both as a forage and a manurial crop. Clover is grown, but of late years it has been hard to get a good stand, owing to it being burned out. Alfalfa has been grown quite successfully on the lower lying land, where the clay and humus content are high, but little attention has been paid to it on the higher ground.

The following table shows the result of mechanical analysis of the Coloma sand:

MECHANICAL ANALYSIS OF COLOMA SAND.

Locality.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
N. E. Cor. Sec. 14, T. 38 N., R. 3 E.	Soil....	.1	.4	4.5	36.9	38.0	13.6	6.3
	Subsoil.	.7	1.0	5.5	44.2	37.2	6.6	4.5

Chemical Analysis of Coloma Sand.

Collector, Quinn.

Description	889–a
Reaction to litmus	Neutral
Moisture in air dried soil	0.78%
Total soil nitrogen	0.102%

Analysis of fine soil dried at 105° C.—

Volatile and organic	2.72%
Insoluble in 1.115 HCl	92.36%
Soluble silica (SiO_2)	0.09%
Ferric oxide (Fe_2O_3)	1.24%
Alumina (Al_2O_3)	2.18%
Phosphoric acid anhydride (P_2O_5)	0.58%
Sulphuric acid anhydride (SO_3)	0.05%
Calcium oxide (CaO)	0.31%
Magnesium oxide (MgO)	0.20%
Potassium oxide (K_2O)	0.10%
Sodium oxide (Na_2O)	0.18%
Total	100.01%

COLOMA SANDY LOAM.

This type of soil is found in both counties, associated with the other sands and fine sands of the Coloma series. The line of demarcation between the sandy loam and the sand is often not well defined, and only an arbitrary separation was possible in mapping the different types of this series. The surface soil of the Coloma sandy loam, to a depth of 10 or 12 inches, is a grayish brown loamy sand underlain to a depth of 36 inches with a material coarser in texture and containing varying amounts of gravel. The line of separation between the soil and subsoil is usually well pronounced, as the color of the underlying material is much lighter and its texture considerably coarser.

The Coloma sandy loam has been formed from glacial material reworked by water and wind. As a general farming soil, it is considered to be very good and is well adapted to truck crops. The crops grown are those ordinarily grown on the Coloma sand, but the yields are much better than on the latter type. The surface configurations are also similar to those found in the Coloma sand area. Because of its irregular features and light and porous nature, it is naturally well drained.

The same treatment and care recommended for the other sandy soils of the area will also apply to the Coloma sandy loam. A liberal incorporation of green manurial crops is necessary. It has also been found that commercial fertilizer, relatively high in phosphoric acid, are very beneficial.

Chemical Analysis of Coloma Sandy Loam.

Collector, Quinn.

Description	172–a
Reaction to litmus	Neutral
Moisture in air dried soil	1.39%
Total soil nitrogen	0.132%

Analysis of fine soil dried at 105° C.—

Volatile and organic	4.27%
Insoluble in 1.115 HCl	87.70%
Soluble silica (SiO_2)	0.23%
Ferric oxide (Fe_2O_3)	1.64%
Alumina (Al_2O_3)	4.59%
Phosphoric acid anhydride (P_2O_5)	0.45%
Sulphuric acid anhydride (SO_3)	0.04%
Calcium oxide (CaO)	0.28%
Magnesium oxide (MgO)	0.38%
Potassium oxide (K_2O)	0.17%
Sodium oxide (Na_2O)	0.24%
Total	99.99%

MUCK.

Muck consists of black or dark brown decomposed organic matter, varying in depth from six or eight inches to three feet or more. The subsoil varies and appears to depend considerably upon the material which makes up the surrounding upland. In a few places the underlying material is a whitish sand, but ordinarily a blue-white sandy clay is encountered.

The type is found in nearly every township in St. Joseph County and is also well developed in Hanna and Springfield townships, in Laporte County. Besides the muck of the upland soil, there is considerable of this type found in the Kankakee valley bordering the river. Many of the small lakes of both counties are bordered by embryo muck beds, with their heavy growth of water-loving plants.

All of these muck areas are low lying, and it is the general belief that they mark the site of old lakes, which became filled by the wash of the uplands and the slow accumulation of organic remains. Natural drainage is very poor, and until these beds are artificially drained they are of little agricultural value. Considerable work along this line has already been done, but there are areas of this type that can never be profitably cultivated.

These lands were once of no value except for the little hay and pasturage they furnished, but now large yields of cabbage, onions, celery and peppermint are derived from them. The selling price of such lands is as high as $150 per acre, and as their value as truck soils becomes more recognized they will, without doubt, demand a still higher price.

Farmers that have a considerable area of this kind of soil, or even enough to affect the value of their farm, are particularly anxious to bring it to a state of cultivation and production. Commercial fertilizers are used quite extensively, especially for truck crops. Such fertilizers are usually selected that have a high potash content, as it is believed this element is most needed on these soils. Wood ashes are used to some extent. Liming with crushed limestone and caustic lime has been tried, but seems to have little effect.

A few farmers were found who hauled the muck of their lowlands onto the upland clay. It was believed by those who tried this experiment that good results were obtained and that the increase in yield of corn and wheat was well worth the labor of hauling. In certain cases, the reverse might be profitably done, but the labor would hardly justify such an action.

These muck lands it is believed improve with age and cultivation. When first drained, most of the material is still undecomposed, much of it being in the form of peat. Such a confused mass allows the moisture to rapidly pass through, to be drained off into the tile or open ditches, and it is then unable to bring the moisture again to the surface when needed. After being cultivated and cropped for one or two years, the peat and vegetable matter become more decayed and mixed with soil, thus giving to it more body and weight, and consequently greater power to conserve the required amount of moisture.

After a rain, this soil becomes soft and sticky, but it does not require very long for the sun to shine on the dark surface, before it is dry. When drying, the material contracts considerably, and large cracks are often formed over the surface, but these are of little consequence and are readily filled in with cultivation.

A factory has been started at Lakeville, St. Joseph County, for the purpose of utilizing the muck from one of the large areas located near that town. The muck is used as a fertilizer filler and in making briquets. The analysis of this muck has shown a very high percentage of nitrogen and is thought to be a valuable material as a filler. Large standing orders were on hand last summer for both the briquets and the filler, and it was found necessary to furnish the plant with more modern machinery in order to supply the demand.

Miami Loam.

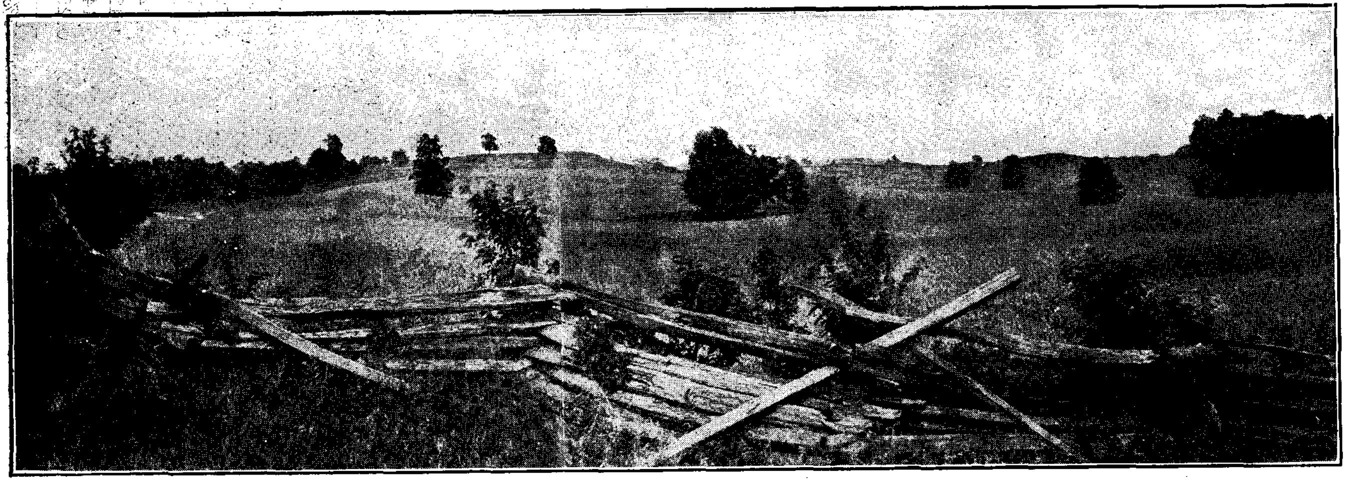
The soil of the Miami loam is from eight to 12 inches deep, and varies in color from a light grayish brown to a brown. One would ordinarily call this a ''clay'' soil, but mechanical analysis shows it to fall short of this class. The subsoil from 12 to 20 inches is a yellowish brown loam of heavier texture than the surface soil, often approaching a clay loam. Sometimes at a depth of 20 to 24 inches, gravel and coarse sand are encountered, but the loam usually extends to the three-foot limit. The light color of the surface soil is due to the small percentage of organic matter.

This type is not confined to any one part of this territory, but is most extensively found in St. Joseph County bordering the Carrington loam, in Union and Liberty Townships. In Laporte County, the Miami loam is associated with the Miami clay loam, and, because of their similarity, it is often hard to find where the one begins and the other ends.

The surface features of the Miami loam vary from gently rolling to hilly. One of the pictures accompanying this report gives a good idea of the physiographic features of this type. Large bowlders are frequently found scattered over the surface, but are not so numerous as to impede cultivation to any extent.

The Miami loam is of glacial origin, having been formed by the weathering of glacial till. Much of this type represents morainic material as originally deposited.

This soil is not difficult to cultivate, but like the Carrington loam will clod badly if plowed when wet. The natural drainage is better than the Carrington loam, owing to the more porous nature of the subsoil and to the irregular features of the surface. Kettleholes are seen throughout the area. Most of these depressions



View of Topography of Miami Loam Soil in St. Joseph County.

are dry the greater part of the year and are marked by a much darker soil than that of the uplands.

General farming is practiced on this type almost exclusively. Corn, wheat and oats are the principal crops. Corn will average about 45 bushels, oats 40 bushels, and wheat 18 bushels per acre. Timothy does well and will yield about one or one and one-half tons per acre.

Commercial fertilizers are used to some extent, but it is the belief that a complete fertilizer, i. e., one having the "2-8-2 formula," or two per cent. nitrogen, eight per cent. phosphoric acid and two per cent. potash, does the work better than any other. Stable manure gives the best results, as it not only adds the necessary plant food but increases the organic matter, thus improving the physical condition of the soil.

The following table shows the results of mechanical analysis of the Miami loam:

MECHANICAL ANALYSIS OF MIAMI LOAM.

Locality.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
S. E. Cor. Sec. 35, T. 36 N., R. 3 E.	Soil....	.0	.0	.8	8.0	14.7	57.0	19.1
	Subsoil.	.1	.2	5.0	8.7	10.0	58.4	15.3

Chemical Analysis of Miami Loam.

Collector, Quinn.

Description	55–a
Reaction to litmus	Neutral
Moisture in air dried soil	0.93%
Total soil nitrogen	0.099%

Analysis of fine soil dried at 105° C.—

Volatile and combusible	3.31%
Insoluble in 1.115 HCl	89.48%
Soluble silica (SiO_2)	0.17%
Ferric oxide (Fe_2O_3)	1.62%
Alumina (Al_2O_3)	3.79%
Phosphoric acid anhydride (P_2O_5)	0.47%
Sulphuric acid anhydride (SO_3)	0.05%
Calcium oxide (CaO)	0.44%
Magnesium oxide (MgO)	0.42%
Potassium oxide (K_2O)	0.14%
Sodium oxide (Na_2O)	0.26%
Total	100.15%

Carrington Sandy Loam.

The Carrington sandy loam, generally to a depth of 12 or 14 inches, is a dark brown or black, silty, sandy loam, containing a high percentage of fine sand and organic matter. From 14 to 18 inches the material becomes lighter in color, being a yellowish brown sandy loam, gradually grading into a sandy, gravelly clay of a dark gray color, mottled with iron rust.

This type was originally covered with prairie grass, and to the decomposition of this vegetation is attributed the high organic content of the soil. Here and there scattered over the prairie land were groves of burr-oak, maple and elm. The former location of these groves may now be readily distinguished by the lighter color of the soil upon which they grew.

The surface of the Carrington sandy loam varies from level to slightly undulating or rolling. Natural drainage is fairly good wherever the subsoil is of sand and gravel, but where clay is the underlying material artificial drainage is necessary. There are a few sandy, gravelly knolls where the drainage is excessive, but the main phase of this type is fairly well able to retain its moisture.

Much of this type was formerly covered with water, due to the backing up of the waters of the streams that now flow through or near the comparatively low and flat areas which represent the type. The shallow lakes and ponds thus formed became filled with sediment and decayed vegetable matter, and remained as a great marsh until they were drained. This is particularly true of the prairies of St. Joseph County, for within only comparatively recent years Terre Coupee and Harris prairies were covered in whole or in part with water for much of the year. Perhaps the coarser and more sandy nature of the prairies of Laporte County is due to the longer time that they have been exposed to the elements, and because a much longer period has elapsed since conditions were favorable for increasing the organic content. Although primarily these areas were made up of soil of glacial origin, they have been modified greatly by water and plainly show the presence of their alluvial matter.

This type of soil includes the extensive prairies of both counties. Door Prairie and Rolling Prairie are the largest in Laporte County, and Terre Coupee and Harris prairies occupy the greater part of the type in St. Joseph County. Although the soil of all these prairies is practically the same, there are a few variations due to local conditions, such as drainage, nature of adjacent upland, and methods of cultivation. Mechanical analysis has shown the soil of Harris Prairie to contain more fine sand than the others, due no doubt to the wind swept sand from the northern part of the county.

No soil is more prized in either of the two counties than the Carrington sandy silt loam of the prairies. Because of its loose and granular character, the soil is easily tilled and no hills occur to interfere with cultivation. No rocks and very few large stones are to be seen in the area.

On account of its rich and mellow character, and its power to withstand droughts, it is well suited to most crops of this latitude. Corn, wheat, hay, oats, clover and vegetables are grown, but corn, oats, and hay are the leading crops. The native vegetation is prairie grass, much of which is still harvested in the poorly drained places.

Fertilizers are not used extensively on this soil, barnyard manure being generally applied. The black soil is and has been very productive, but there is a decrease in the crop yields of late years where rotation has not been practiced and where little or nothing has been returned to the soil. As a general thing, this soil is sour, and a heavy application of crushed limestone would be found very beneficial. Most of the farmers practice some kind of rotation, but a few are still found who continue to crop their land with corn and wheat with no rotation of timothy or clover. Although this land is the best in the territory surveyed, and no doubt as good as any in the country, still fertilization and rotation must be considered or it too will in time be depleted like many of the other soils of our State.

The following table gives the result of mechanical analysis of the Carrington sandy loam:

MECHANICAL ANALYSIS OF CARRINGTON SANDY LOAM.

Locality.	Description.	Fine Gravel. Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
Southern part Sec. 30, T. 36 N., R. 3 W.	Soil....	.4	.3	1.9	8.6	17.9	50.3	20.0
	Subsoil	.3	.1	5.6	17.2	28.0	34.2	9.2

Chemical Analysis of Carrington Sandy Loam.

Collector, Quinn.

Description	78–a
Reaction to litmus	Neutral
Moisture in air dried soil	1.51%
Total soil nitrogen	0.248%

Analysis of fine soil dried at 105° C.—

Volatile and combustible	7.02%
Insoluble in 1.115 HCl	85.04%
Soluble silica (SiO_2)	0.13%
Ferric oxide (Fe_2O_3)	1.89%
Alumina (Al_2O_3)	3.99%
Phosphoric acid anhydride (P_2O_5)	0.39%
Sulphuric acid anhydride (SO_3)	0.08%
Calcium oxide (CaO)	0.41%
Magnesium oxide (MgO)	0.35%
Potassium oxide (K_2O)	0.16%
Sodium oxide (Na_2O)	0.25%
Total	99.71%

Coloma Gravelly Sandy Loam.

There is probably no soil found throughout the territory more varied in texture and topographic features than this type. The surface soil is usually composed of a light brown, sandy, gravelly material to a depth of 10 inches, underlain to a depth of 36 inches by a gravelly sandy subsoil. Sometimes very little gravel is found in either soil or subsoil, and the material approaches a loam or almost a clay loam.

The type occupies a rolling to a hilly part of the country and is derived from glacial till. There are a number of large bowlders strewn over the surface of this soil, but they are not so numerous as to interfere with cultivation.

The type, except for the large quantities of small stones and gravel throughout the soil and subsoil, often appears very much like the Coloma loam, and in the south central part of St. Joseph County where the two occur, some difficulty was encountered in separating the areas. Besides being found quite extensively through the central part of St. Joseph County, the type is also well developed in the northwestern part, south of New Carlisle, and extending westward into Laporte County.

As an agricultural soil, this can only be spoken of as fair. The crops most commonly grown are corn, wheat and hay. Probably this type, especially the rougher phase of it, would bring better returns if used for pasturage. The soil is well adapted to fruit, and most farmers have their own home orchards for supplying their needs in this line.

Because of the irregularity of the surface features and the gravelly subsoil, natural drainage is very good, but often excessive. Crops, especially on the hills, suffer during a hot spell, and frequent rains are needed to make crops yield anywhere near what they should. The soil between the knolls and hills is considerably darker in color and is deeper than that on the higher land. When boring in the uplands, it was impossible often to get below eight or 12 inches with the auger, but in the depressions usually no gravel was struck down to a depth of three feet.

The following table gives the result of mechanical analysis of the Coloma gravelly sandy loam:

MECHANICAL ANALYSIS OF COLOMA GRAVELLY SANDY LOAM.

LOCALITY.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
S. E. Cor. Sec. 3, T. 37 N., R. 1 W..	Soil....	16.9	.8	9.9	47.6	8.1	6.5	10.1
	Subsoil.	2.8	.6	11.6	62.8	9.6	3.1	9.3

MIAMI CLAY LOAM.

The Miami clay loam is a light colored, usually a yellowish gray, soil eight to 12 inches deep. The subsoil is a yellowish, more compact material, containing small stones and gravel. In the localities where this type is found it is usually spoken of by the farmers as "white clay."

The Miami clay loam is not found extensively in either county, but occurs in small areas in the western and north central part of Laporte, particularly well developed in Cool Spring and the northern part of New Durham townships. The type enters the county in two small strips and extends in a northeasterly direction to the north central part of the county, where it becomes mixed and confused with the Coloma gravelly sandy loam and the darker Carrington loam.

The general features vary from gently rolling to hilly. In the more level areas, the type is fairly uniform, but near the small creeks and streams, the surface is badly cut up, and the hills, with their whitish yellow soil, present a striking contrast to the dark lands of the valleys and depressions. In the vicinity of Otis*, a small town in the northern part of New Durham Township, the surface becomes very rough and broken, and considerable washing and gullying has taken place on the hills. The confused mass of clay, silt, sand and gravel which makes up this type is of glacial origin, and represents the product of weathered glacial material. There are a number of igneous stones and boulders found on the surface, and in boring with the auger, stones were encountered in the subsoil. In the deep subsoil, is found the boulder clay, typical of the underlying material of this type.

In the rougher sections, drainage is very good, but tile drainage is required in the more flat and level parts.

The type was once heavily timbered, but few wooded areas now remain. It would have been much better had the rougher areas been left timbered, as little farming in the way of field cultivation can be carried on, on the slopes now. In the rough portions, dairying could be carried on profitably, as the soil is well suited to blue grass, and would furnish excellent pasturage. Fruit, especially apples, could be grown successfully on soil of this kind, but little interest has been taken in this line.

On the more level areas, wheat, oats and corn are the principal crops. The soil is well adapted to wheat, and a large acreage is devoted to the crop. Hay yields well, timothy averaging about one and one-half tons to the acre.

This, like the other soils of the Coloma and Miami series, is in great need of humus. The heavy application of barnyard manure and the turning under of green manurial crops will doubtless do more for the soil than anything else that can be done. Commercial fertilizers are all right in their place, but the physical conditions of all soils deserve first consideration; and then if plant food needs to be added it can be done later.

Mention was made above of the black soil of the valleys. Ordinarily this type would be classified as a distinct type, but as the areas are too small to map on a scale of one inch to the mile, it was thought best not to make a separate classification but to include it under the Miami clay loam.

This soil is about 14 inches deep, of a dark gray color, very compact and stiff and often hard to manage. The dark color is due to the high percentage of organic matter. To the large quantity of

* The Valparaiso Moraine passes through Otis.

humus and its high clay and silt content are attributed the stiff and cohesive properties of the soil when wet. This black, stiff soil is sometimes called "gumbo" by the farmers.

If handled when dry the soil may be brought to an excellent state of tilth and good crops of corn, hay and oats may be produced.

The following table gives the result of mechanical analysis of the Miami clay loam:

MECHANICAL ANALYSIS OF MIAMI CLAY LOAM.

LOCALITY.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Mepium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
N. W. Cor. Sec. 16, T. 37 N., R. 4 W.	Soil....	.1	.2	6.7	.0	3.1	13.6	47.7
	Subsoil.	.0	.1	.8	6.8	32.0	40.3	19.8

DUNE SAND.

The material that makes up this soil is a whitish, silicious sand, very fine grained and light in weight. Because of its porous nature and excessive drainage, it is of little agricultural value. The type occupies hillocks and ridges bordering Lake Michigan, especially in Michigan and northwestern part of Cool Spring townships in Laporte County. None of this type is found in St. Joseph County, but the finer particles of the Coloma sand, after having been blown and drifted about, often appear very much like the typical dune sand, both in form and appearance.

The light sand is continually changing its position and consequently allows little chance for vegetation to get a start. About the only growth found on the hills is small pine and scrub trees.

Back from the lake, a little farther, where the sand becomes more loamy, small fruits, especially huckleberries, do well. Melons are grown and are of a very superior quality.

The following table gives the result of mechanical analysis of the dune sand.

MECHANICAL ANALYSIS OF DUNE SAND.

LOCALITY.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
N. E. Cor. Sec. 30, T. 38 N., R. 5 W.	Soil and Subsoil	.0	.0	.4	10.1	89.2	.3	.0

Coloma Fine Sand.

The Coloma fine sand is very much similar in appearance to the Coloma sand, but is finer in texture. It is nearly as fine grained as the typical dune sand around Lake Michigan, but is more loamy in texture. The type occupies a rolling and hilly country and is found principally in LaPorte County, in a narrow strip extending parallel with Lake Michigan.

The type has been derived from the reworking of glacial material by wind and water. Most of this sand marks the former short lines of Lake Michigan when the lake extended father inland.

Because of its open character and its rolling and irregular surface features, drainage is excessive. Crops often suffer from drought, especially on the higher land. The crops to be grown should be carefully selected, as the soil is too light for general farming. Potatoes, wheat, rye, and small fruits are the principal things cultivated, but during a wet season, corn yields fairly well. The lower lands and depressions contain more organic matter and are much more productive than the higher land.

The following table gives the result of mechanical analysis of the Coloma fine sand:

Mechanical Analysis of Coloma Fine Sand.

Locality.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
N. W. Part Sec. 2, T. 37 N., R. 4 W.	Soil....	2.5	.8	3.0	28.6	47.5	13.1	14.5
	Subsoil.	2.9	1.2	3.5	25.6	53.1	10.4	3.7

Soil Survey of Bartholomew County.

By E. J. Quinn.

LOCATION AND AREA.

Bartholomew County is situated in the south central part of the State. It is bounded on the north by Johnson and Shelby counties, on the east by Decatur and Jennings, on the south by Jackson and Jennings counties, and on the west by Brown County. It comprises an area of approximately 256,000 acres, or 400 square miles. There are fourteen civil townships in the county—Ninevah, Union, Harrison, Jackson, Ohio, German, Flat Rock, Haw Creek, Columbus, Clay, Clifty, Sand Creek, Rock Creek and Wayne.

The only city in the county is Columbus. The principal towns are Hope, Hartsville, Elizabethtown, and Jonesville. Columbus, the county seat, had a population in 1910 of 8,813. It is situated on the P., C., C. & St. L. and C., C., C. & St. L. steam roads and Indianapolis, Columbus and Southern traction line. The city is well located and furnishes a market place and trading center for the farmers of the surrounding country. Numerous manufacturing establishments are situated here. There are two agricultural implement factories, three brick and tile mills, two carriage and wagon factories, canning factory, flour, woolen and planing mills, structural iron works, two tanneries and several smaller industries.

Hope, a town in the northeastern part of the county, has a population of 1,223. It is located fourteen miles northeast of Columbus, on the C., C., C. & St. L. Railroad. One brick and tile mill, carriage and wagon factory, canning factory, two flour and grist mills, and a planing and sawmill are the industries of the town.

Hartsville is another town in Haw Creek Township, and has a population of 358.

Jonesville, a small town situated on the P., C., C. & St. L. in Wayne Township, lies in the fertile bottoms of East White River, and affords a good trading center for this region.

Elizabethtown, in the southeastern part of the county, has a population of 250. Clifford, South Bethany, Ogleville, Taylorsville, and Waymansville are other small villages in the county.

HISTORY AND AGRICULTURAL DEVELOPMENT.

The territory which now comprises Bartholomew County, was up to the year 1818 in the possession of the Delaware Indians. By a treaty made in that year, the land was given over to the whites. About two years later, the tide of immigration began poring in and settlers came from Virginia, New York, North Carolina and Kentucky. In the early history of the State this county formed a part of Delaware and Jackson counties and was organized as Bartholomew County under an act of Legislature approved January 8, 1821.

The first settlements were made north of the present site of Columbus, on what is now locally known as the Haw Patch. The sand area in the south central part was also readily taken up. Not until ten or twelve years later did the western part of the county attract any of the new comers. The soil with its rich humus accumulation for many years required little care. Vast areas of timberland were cleared and cultivated for corn, potatoes and other vegetables. Where such lands began to show signs of growing less productive, new areas were cleared and these in turn cultivated. The cut timber was the source of income for many years, and it was not until the forests began to be well cut off that the lumber industry gave place to more intensive farming.

Climate.

The following table was compiled from the 1910 report of the Weather Bureau Station at Columbus:

Normal Monthly Temperature and Precipitation.

Month.	Temperature. °F.	Precipitation. Inches.
January	29.1	3.18
February	29.9	3.02
March	41.2	3.73
April	52.3	2.92
May	62.7	3.25
June	71.9	3.64
July	75.6	2.87
August	73.7	3.48
September	67.2	2.92
October	54.4	2.33
November	42.3	3.33
December	33.1	2.84

The records show that the average date of the last killing frost in the spring and the first in the fall for a period of sixteen years is April 26 and October 6 respectively. Latest date of killing frost in spring for this same length of time is May 21; for the earliest date of killing frost in autumn, September 14.

Topography and Geology.

The topography of the county varies greatly. In the western part the Knobstone formation is the prevailing type. From the weathering of this formation many hills or knobs have been formed which give to the locality a rough and broken surface. Nearly all of Jackson, Ohio, Harrison, Union and part of Wayne townships are covered with soil resulting, to a great extent, from the disintegration and erosion of this formation. Taylor's Hill, Mt. Healthy and Dial Hill are some of the highest of these knobs. In Brant and Fuller's history of Bartholomew County, the altitude of Taylor's Hill is given at 1,003 feet above tide level and 360 feet above the city of Columbus. From this high point a magnificent view may be had of the surrounding country. Considerable sandstone has been quarried from the hill in past years, but of late it has not been worked to any extent.

The central portion of the county is comparatively level, much of it being made up of the rich bottom land of the East White River. Extending from the city of Columbus to the Shelby County line is the well-known Haw Patch, a level tract of land unexcelled in this county in productiveness and value.

From the level central plain, extending eastward to Decatur County is the "limestone upland." The topography here can hardly be called hilly, but is more of an undulating or rolling character. Near the town of Hartsville and in the northeast part of Clifty Township, especially along Clifty Creek and its tributaries, are fine exposures of the heavy limestone of the Corniferous group. Here the most picturesque topography of the county, and it is said of the State, has been developed. Borings and examinations of outcrops along the creeks show the Corniferous limestone and Devonian shale to underlie the drift which covers nearly all of Clifty, Rock Creek, Clay and Haw Creek townships.

Geological maps show the glacial boundary to extend through the southwestern part of this county, cutting off a small section which ordinarily would be considered outside of the glacial territory. Evidences of ice action were found here, however, and with the exception perhaps of the highest knobs and ridges in Harrison and Union townships, the entire county was glaciated. The following is taken from Frank Leverett's Water Supply and Irrigation Papers of the United States Geological Survey:

"The entire county was apparently glaciated, although the glacial boundary lies but little west from the front of the prominent hills on the county line. The portion of the county east of the East White River valley was nearly all covered by the later ice sheet, and a narrow belt along the west side of the stream in the north part of the county was also covered by that invasion. There remains, therefore, only a narrow strip on the southern and western borders of the county where the older sheet of the drift alone is present. There are morainic features along the borders of the East White River valley from the north line of the county southward to the vicinity of Columbus. There are also two well-defined moraines eastward and northeastward from this valley across the county. The southernmost one, which lies near the line of Bartholomew and Jennings counties, marks the southern limit of the later Wisconsin sheet of drift. The other lies near the borders of Clifty Creek. Each of these moraines has a breadth of two or three miles, but stand only 30 or 40 feet above the bordering plain.

The surface of the older drift in this county is generally plane. The thickness of the drift ranges from a mere trace to a deposit fully 100 feet in depth. Along the East White River valley there is a gravelly belt from two to five miles or more in width, and the morainic knolls just referred to appear in the midst of this gravelly district. Flat Rock valley also contains a broad gravel plain. In the remainder of the county the drift is mainly till. Very few deep wells occur, there being generally an abundant water supply within 35 or 40 feet of the surface."

Drainage.

East White River, the chief water course, enters the county near Edinburg and flows in a general course southeast through the central part of the county. Just west of the city of Columbus the river, which is locally known as Driftwood to this point, unites with Flat Rock Creek and forms the east branch of White River.

The general slope of the western half of the territory is southeast, the principal streams being Big Ninevah, Catherine, and White Creeks. The tributaries on the east side are Haw Creek, Middle Fork, Fall Fork, Flat Rock and Clifty Creek.

From the map it will be seen that the natural drainage is well developed, but artificial means have to be resorted to on the flat uplands in the eastern half of the county. The practice of tile drainage has been introduced and is being carried on extensively on every type of soil included in the county. Most farmers realize that this is necessary in order to derive the greatest benefit from manures and fertilizers.

According to the table of altitudes of the P., C., C. & St. L. Railroad, Columbus is 628.4 feet above tide; Edinburg, six miles north in Johnson County, 674.2 feet; Rockford, 10 miles south in Jackson County, 577.9 feet. From these altitudes, it can be seen that there is considerable fall from Edinburg to Columbus— almost eight feet to the mile—while from Columbus to Rockford the fall amounts to a little over five feet to the mile. These differences in gradient are readily noticeable in the velocity of the river in its course through the county. From Edinburg, the river runs south with a comparatively swift current, often confining itself to permanent banks on either side. Below Columbus and south toward Seymour and Rockford, the current becomes slow; the banks are low and are frequently overflowed, and extensive bottoms two or three miles wide have been developed. The valleys formed by the tributaries on the east and west of East White River are usually narrow with only small flood plains. Many of the smaller streams which flow through the Knobstone formation on the west have cut deep V-shaped valleys with little or no bottoms at all.

Agricultural Conditions.

The farmers of this area are intelligent and energetic and their homes and farm buildings are the finest to be found in the State. Fine schools and roads are found throughout the entire county. There is a considerable number of large farms owned in this county, although with increased population the farms are becoming smaller. The population of the county in 1880 was 22,777; in 1910, 24,813.

The value of farm land ranges from $10 to $300 an acre. Very few farms are sold for cash in the western part of the county, the property being usually exchanged for town property. The valuation, however, is usually placed at $10 to $35. Very few farms exchange hands in the central part; the farmers usually if they do not live there themselves rent their farms and move to town to enjoy the rich harvest which their land yields. The valuation of all the farm land according to the census of 1910 was $7,590,285.

Oats, corn and wheat are extensively grown, especially the latter two. Special crops of rye, Irish and sweet potatoes are grown, but only to a limited extent. A comparison of the statistics of 1880 and those of 1910 show a vast difference in the yield of the principal crops. This county in the year 1880 produced 568,708 bushels of wheat from 36,458 acres, or about 17 bushels to the acre; in 1909, it produced 720,563 bushels, an average of 14 bushels per acre. Corn, in 1880 averaged 45 bushels, 1,489,208 bushels being produced from 32,779 acres; in 1909 the same crop grown on 54,530 acres gave 2,093,400 bushels, or an average of 38 bushels. Only a small acreage is given to rye, buckwheat and barley. The acreage of tomatoes is increasing rapidly. In the year 1908 there were 369 acres cultivated for the crop; in 1909, over 3,130 acres. A large acreage of timothy is raised, yielding on an average of one and one-half tons to the acre. Clover, when cut for hay, will average about one and one-fourth tons per acre. Alfalfa has been experimented with and found to grow successfully on every type of soil in the county.

Fruit growing is becoming a leading industry in the Knobstone section. Many people, who live outside the hills, ridicule this part of the county and claim the soil is worthless. This is not true and many are beginning to realize that this "Brown County Edge of Bartholomew" is valuable as fruit land. A number of good size orchards were found in this section and where they had had careful management showed that the owners had invested well.

Dairying is not an important industry, although most of the farmers keep a few cows to supply their own needs. The lack of interest in this line is very noticeable. On the average farm the amount of manure is very small compared with what is necessary for the land. Much dependence is placed in commercial fertilizers and a great deal of this applied with little of an idea of what is required. On the river bottoms and sandy areas, very little fertilizer is used, the natural productiveness being sufficient at present to meet the requirements. The majority of farmers realize the value of clover as a fertilizer, but with the price of clover seed as it is, it seems to be a great temptation to cut the first crop for hay and to harvest the second for seed.

The benefits derived from crop rotation are generally understood. The system usually practiced, especially on the clay land, is clover, corn and wheat; on the bottoms, corn has always been the favorite crop, but of late years it has been found necessary to alternate wheat and clover. Fairly good stands of clover can be secured on all the types of soil found in the area. Alfalfa growing should be encouraged, especially on the sandy soil north of the city of Columbus. This soil, because of its porous nature, is especially adapted to alfalfa culture.

A great difficulty encountered in the rough country west of East White River valley is soil erosion. At present, the washing of the surface soil and the exposure of the unproductive subsoil is a very important problem to be considered in this locality. Judicious cultivation is necessary to remedy the trouble. Crops should be selected that, during the winter and spring months, will not leave the ground exposed. Soil binding plants that will furnish pasturage or meadow land and at the same time enrich the soil are recommended. Blue grass or clover, when a stand can be secured, should be grown, or in extreme cases reforestation with black locust may be necessary. Under drainage should be encouraged, particularly on this land, as by this means the water can find an outlet in drainage channels instead of rushing over the surface.

SOILS.

The soils, representative of this county, are mostly of glacial origin, except in the western part of the territory, where they have been derived to some extent from the underlying sandstones and shales of the Knobstone formation.

Roughly speaking, the east fork of White River, which flows through the central portion of the county from north to south, separates the more heavily glaciatel area from the thinner deposits. The western townships lie in the loessial belt and the material has been mostly derived from glacial material, deposited either by wind or water. Granite and other igneous stones and small boulders, too heavy to have been carried by the wind, were found on some of the hills, clearly indicating that there must have been some other agency besides wind alone at work in conveying material to this region. From these observations, it is evident that water and perhaps ice brought material to the highest parts of the western hills.

Each type extends quite uniformly through the sections where it occurs, and with but a few exceptions has little variation from the typical phase. Wherever these variations occur, mention can be made of them in considering the main type in which they are found.

Knox Silt Loam.

The Knox silt loam, to a depth of eight or 10 inches, is a light brown to ashy gray, silty material, containing a small percentage of fine sand. The subsoil, to a depth of 36 inches, is a pale yellow, compact silt loam or silty clay. Both soil and subsoil resemble each other in texture, but mechanical analysis shows the clay content of the subsoil to be higher than that of the surface.

The greatest variation or departure from the typical phase is found in the white soil, locally known as ''white slash'' land, south of Ogleville, in Ohio Township. Here the surface is more level and the natural drainage more poorly developed. After rains this material, which makes up the surface soil of these spots, appears to run together, forming a close, compact crust which, on drying, not only excludes the air, and therefore oxygen, but also interferes with capillary attraction, or the drawing up of the moisture from below. At a depth of two or three feet water is usually found and this wet condition makes the land cold and backward. This is an ideal home for the crawfish, and its presence is readily seen by the numerous white mounds which stud the surface.

The improvement of the physical condition is absolutely necessary before this soil can produce well. The addition of humus, either by application of a liberal supply of manure and straw or the plowing under of green crops, like corn, oats, or better still a legume crop like clover, will do much in improving the soil, as the earth will then become more loose and porous, thus allowing a circulation of air and a freer movement of the underground waters in working to the surface.

Excepting the small areas referred to above, the remainder of the type which covers most of Wayne, Jackson, Ohio, Harrison and Union townships is quite uniform. The material has been derived principally from loess, or wind and water deposited glacial material. On the higher hills and slopes, where the original soil has been removed or is very thin, the underlying sandstone and shales have contributed considerable to both soil and subsoil.

Very few stones are found throughout the area, except on the hills or along the streams where the sandstones and shales have been exposed and fragments of the formations have been broken off. Iron concretions are frequently found in the soil and subsoil of the upland areas, and in the beds of the smaller streams. Concretions which appear as gravel in the creek beds furnish an excellent material for road metal. A few glacial stones and boulders were found in Ohio and Harrison townships, but nowhere were they found in any great number.

The Knox silt loam covers rather hilly upland, more broken near the streams and more hilly as the Brown County line is approached. As a rule, a line drawn north and south through the east middle part of Jackson, Ohio, Harrison and Union townships divides the hilly region from the more level and undulating. East of this line the land is rolling to nearly level, gradually sloping to the southeast. West of the line the surface features are very irregular. hills and deep valleys occupying the greater part of the territory. Taylor's Hill, Dial Hill and Mt. Healthy are, as mentioned in the general description, some of the largest of these knobs and hills.

The land was once heavily timbered with poplar, beech, hickory, etc. Lumber was cheap at that time and much of the forests was cut and burned in order to make room for agricultural purposes. It is said that this land would be worth $200 an acre now if the original timber had been left or had been judiciously handled. As it is, many of the steep slopes which were once heavily wooded have been deprived of their thick growth and are now badly washed and gullied, the unproductive subsoil being exposed.

Corn, wheat and hay are the principal crops. Considerable of the rougher portions are devoted to pasturage. The soil is well adapted to fruit growing and the drainage and aeration could not be better. The only difficulty encountered in this industry is the poor facilities for transporting the product, but this obstacle is being overcome by the building of fine roads and pikes through the entire western part of the county.

The improvements on this type are the poorest in the county. Land is sold at prices ranging from $10 to $60 per acre, and some has been sold for even $8.

Very few of these farms are sold for cash, but are usually traded for farms in other parts of the county, or for town property. The low price of land and the inducements for fruit growing are attracting many new comers to these parts.

The following table gives the result of mechanical analysis of the Knox silt loam:

MECHANICAL ANALYSIS OF KNOX SILT LOAM.

Locality.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
Central part Sec. 20, T. 8 N., R. 4 E.	Soil....	.1	.3	3.5	5.7	10.0	64.5	14.9
	Subsoil.	.9	.0	5.6	11.8	18.5	32.7	30.4

Chemical Analysis of Knox Silt Loam.

Collector, Quinn.

Description	131–a
Reaction to litmus	Neutral
Moisture in air dried soil	1.31%
Total soil nitrogen	0.115%

Analysis of fine soil dried at 105° C.—

Volatile and organic	3.25%
Insoluble in 1.115 HCl	85.01%
Soluble silica (SiO_2)	0.44%
Ferric oxide (Fe_2O_3)	2.71%
Alumina (Al_2O_3)	7.48%
Phosphoric acid anhydride (P_2O_5)	0.39%
Sulphuric acid anhydride (SO_3)	0.03%
Calcium oxide (CaO)	0.25%
Magnesium oxide (MgO)	0.64
Potassium oxide (K_2O)	0.23%
Sodium oxide (Na_2O)	0.27%
Total	100.70%

SIOUX LOAM.

The Sioux loam, to a depth of 12 or 14 inches, is a dark brown sandy loam, containing a small per cent. of gravel. The subsoil, to a depth of three feet, is ordinarily a yellowish, gravelly sandy loam, containing a higher content of clay than the surface soil, and having a higher percentage of fine gravel and small rounded stones. The soil is very loose and mellow and is easily cultivated.

The type is found principally in German, Columbus and Flat Rock townships, and is usually included in what is known as the Haw Patch land. When this area was first cleared, it is said the patch became covered with a dense growth of hawthorn (Cratægus Oxyacantha), and the territory was named by the early settlers after this shrub. The soil is of glacial origin, having been derived from reworked glacial material, and represents a filled in valley or outwash plain where glacial waters once flowed.

The topography varies from level to slightly undulating. The drainage, because of the gravelly subsoil, is very good but often excessive. Crops often suffer during a dry season, but when climatic conditions are favorable and with an average amount of rainfall, no soil in the county will produce as well.

Commercial fertilizers are used to some extent, but as a rule are not necessary. The crops grown are corn, wheat, oats and timothy. Corn will average in a good year 50 bushels, wheat 25, oats 35, timothy 1½ tons per acre. Because of its good drainage and its loose character, the Sioux loam is an early soil and well suited to market and truck crops. Frequent cultivation is necessary, whether it is used for general crops or for special purposes, as by this means a greater amount of moisture is conserved which otherwise would not be available.

The improvements on this type are the best in the county. Fine houses and barns, good fences and good roads are found throughout the area. The interurban line connecting Indianapolis and Louisville runs through the western portion of this area, and the P., C., C. & St. L. Railroad through the eastern portion. Very few farms exchange hands in this locality, but the price usually asked is $125 to $200 per acre. The rent for this land is mostly on the share basis, one-half the grain being usually demanded.

The following table gives the result of mechanical analysis of the Sioux loam:

MECHANICAL ANALYSIS OF SIOUX LOAM.

LOCALITY.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
N. E. Cor. Sec. 13, T. 9 N., R. 5 E.	Soil....	5.5	1.3	12.7	21.5	12.0	30.1	16.7
	Subsoil.	2.1	2.7	16.5	23.2	13.2	20.9	20.5

COLOMA SAND.

The Coloma sand is found principally in Sand Creek Township and in the southeastern part of Columbus Township. There is also a narrow strip of this light soil extending in a northeastward direction, through Clay Township, as far north as the town of Nortonburg.

The surface soil, to a depth of eight or 10 inches, is a slightly loamy, brownish sand of rather fine texture. The subsoil, from 10 to 36 inches, is reddish brown sand of coarser material than the soil and also has less organic matter. In the lower lands and depressions, the soil becomes more loamy, has a higher organic matter content, and is more productive than that on the hills.

The Coloma sand is of glacial origin, having been formed from the residuary glacial till and subsequently modified and arranged by wind and water. The material which makes up this soil, when examined through a microscope, appears to be made up mostly of small, angular, and rounded quartz particles, each covered with smaller grains of silt and clay.

The surface features vary from gently rolling to hilly. Because of these irregular surface features and its light, porous nature, the soil is very susceptible to drought, and crops often suffer during a continued dry period. Addition of organic matter and frequent cultivation are to be recommended for these areas.

The crops usually grown are corn, wheat, oats and potatoes. In a favorable season, good average yields are obtained. This is probably the earliest soil in the county, even earlier than the Waukesha sandy loam in the northern part of the county.

Fertilizers are not used to any great extent. Considerable dependence is being placed on green manurial crops, especially soy beans and cowpeas. The effects of these crops help in a great measure to keep up the fertility of the soil.

Improvements on this type of soil are very good. The farmers are, as a rule, very prosperous, and are interested in all modern agricultural methods. Good roads abound through the area, and the interurban line running south from Columbus cuts the western portion of the type. Land sells at from $60 to $125 an acre.

The following table gives the result of mechanical analysis of the Coloma sand:

MECHANICAL ANALYSIS OF COLOMA SAND.

LOCALITY.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
S. central part Sec. 22, T. 8 N., R. 6 E.	Soil....	.5	.0	.7	32.1	43.7	10.8	12.1
	Subsoil.	.0	.0	1.1	41.9	47.1	3.9	5.9

Wabash Sandy Loam.

The alluvial soils of this county have all been classed in the Wabash series.

There is some variation in the soil of these bottom lands, but ordinarily a silty, sandy loam is found in the immediate vicinity of the streams, gradually becoming more sandy at a distance. Although the area was formerly subject to great overflow, especially along White River below Columbus, there has been less trouble along this line during recent years, and it is only after excessive spring rains that floods are common. Along the larger tributaries on both the east and west side of White River, considerable damage is often done to fields and crops by the spring freshets. To eliminate this destruction as much as possible, dikes and breakwaters have been constructed along the creeks, wherever the danger from this source is greatest.

The soil of the Wabash sandy loam is usually a dark, sandy, silty loam to a depth of 12 or 15 inches. The subsoil, from 15 to 36 inches, is a sticky, sand loam, at times containing a great deal of gravel. Gravel and water-worn pebbles are often found scattered over the surface soil. Where the silt content is high, as near the streams, little difference can be observed in the texture of the soil and subsoil, and the dark color is maintained throughout.

The topography of the type is generally quite level, although a few "swags," or depressions, are encountered near the river. Outside of these low-lying places, natural drainage is very good. On the second bottoms, where the silt is less in evidence and the sand and gravel content high, drainage is sometimes excessive and crops are apt to suffer from drought.

The soil is easily worked, and when spring floods do not interfere crops may be put in as early as on any other soil in the county. All crops grown in this part of the State do well on the bottoms. Corn, wheat, oats, clover and truck are grown extensively, but corn has always been the favorite crop. In the year 1910, Mr. Jesse Newsom, a farmer in Sand Creek Township owning considerable of this bottom land, raised 3,300 bushels of corn on 47 acres, making an average of over 70 bushels to the acre. Mr. Newsom says he has grown as high as 96 bushels to the acre on the well drained areas. An average of 75 bushels is a yield not out of the ordinary, on soil of this kind, providing weather conditions are favorable during the growing season.

Corn is grown continuously in some places, but where the floods no longer add their rich deposits of silt and organic matter it is plainly seen that this soil can become depleted as well as the clay uplands on either side. Wheat averages well, and is usually used in rotation with corn. Clover and alfalfa are grown on the bottoms and where drainage is good many fine stands are secured. Dr. J. H. Morrison of Hartsville has had excellent results with alfalfa on the bottom lands, along Clifty Creek. It should be remembered, however, that whenever the water level of the streams is high it is useless to undertake the growing of clover or alfalfa, as neither of these legumes can exist with a wet, cold subsoil.

Because of the danger from floods, very few buildings have been built on the bottom lands. Other improvements as fences, break-waters, roads, etc., are very good. The alluvial soils are considered among the best in the county and a high price is usually asked for them.

Miami Clay Loam.

The Miami clay loam occurs principally in the eastern and north-eastern townships. Excepting the Knox silt loam, which occupies most of the western part of the county, this is the most extensive type found in the territory.

This soil is generally a light brown or grayish brown silty loam extending to a depth of eight or 10 inches, underlain by a lighter colored silt loam, grading into a yellow, mottled, silty clay loam at a depth of 24 inches. The surface soil contains considerable fine sand in some places, its presence being particularly well marked after a hard rain.

The topography varies from gently rolling to hilly and broken near the streams. The surface features have been affected to a great extent by the underlying rocks, especially near Hartsville and Newbern, where the limestone formations are exposed. The soils in this vicinity and throughout the upland area are often spoken of as limestone soils, but the limestone rocks have contributed little to their formation.

The Miami clay loam represents the product of weathered glacial till, and throughout the area stones and rock fragments, both of local and foreign rocks are encountered. Numerous depressions, which very likely mark the site of lakes and ponds of the glacial epoch, are seen throughout the area, especially in the northern half of the territory.

Natural drainage is, as a rule, poorly developed, except where the surface features are uneven and the underlying rocks come close to the surface. In the flat and rolling tracts, the surface water has little chance to run off, and the impervious nature of the subsoil allows only little to pass through to the underground channels. Where such conditions exist, tile under-drainage is very necessary. In the depressions where the soil and subsoil are still more compact and heavy, due to the large amount of organic matter, tile drainage is of utmost importance, but often difficult to bring about, due to the nature of the surrounding uplands.

This soil, like the Knox silt loam, is adapted to the general crops, but the yields are much greater than on the Knox soil. Corn will average from 25 to 60 bushels per acre, wheat 12 to 25 bushels, and potatoes 50 to 150 bushels. The black soil of the depressions is unexcelled corn lands, and almost invariably is devoted to this crop. Oats and wheat have been grown, but some claim that such crops have a tendency to grow rank, having lots of straw but little if any grain. These dark soils should be liberally supplied with potash to make up for the deficiency which is usually indicated by such growth.

As a general thing, the Miami clay loam is considered a good all around soil. Crops often yield much better on this land than on the Haw Patch and river bottoms. It is not as susceptible to drought as the former, nor is it subject to overflow like the latter. Compared to the Knox silt loam it is far superior. Improvements in the way of roads, farm buildings, school houses, etc., are above the average.

The following table gives the result of mechanical analysis of the Miami clay loam:

MECHANICAL ANALYSIS OF MIAMI CLAY LOAM.

Locality.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
N. E. Cor. Sec. 18, T. 8 N., R. 7 E.	Soil....	1.5	.6	4.5	11.9	24.5	22.4	35.1
	Subsoil.	1.2	3.6	18.1	14.2	16.7	29.6	26.5

Soil Survey of the Boonville Area, Indiana.

By A. W. Mangum and N. P. Neill.
U. S. Bureau of Soils.

LOCATION AND BOUNDARIES OF THE AREA.

The Boonville area is located in the southwestern part of Indiana, bordering on the Ohio River. It is bounded on the east by the

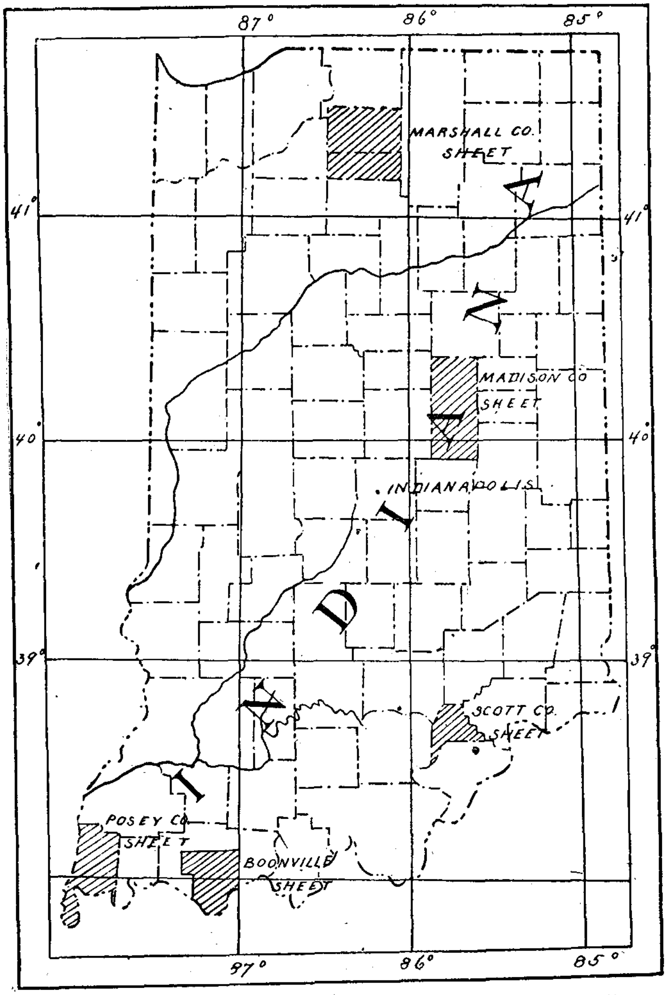


Fig. 1.—Sketch map showing location of the Boonville area, Indiana.

meridian of 87° west longitude and the Ohio River; on the north by a line drawn east and west through Tennyson; on the west by a line running 10$\frac{3}{4}$ miles north from the Ohio River to 1$\frac{3}{4}$ miles east of the village of Hatfield, thence west for a distance of 4$\frac{3}{4}$ miles, and then north to the northern boundary; and on the south by the Ohio River. This territory includes parts of Warrick and Spencer counties, and embraces 169,216 acres, or approximately 264 square miles.

The area is well adapted to agriculture, which, together with the coal industry, forms the leading occupation of the people.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

In 1803, John Sprinkle crossed the Ohio River from Kentucky and settled at Newburg, Warrick County, and in the same year a few other families followed him, taking up the adjoining lands. These first settlers were all known as "squatters," as the county was not surveyed until 1805, and it was some years after that date before these lands were put on sale by the Government. Four years after the settlement at Newburg the present town of Rockport was established by Daniel Grass, and as supplies for the settlement were easily obtained from Owensboro, Ky., its population rapidly increased. The settlement of the area was at first slow, on account of frequent trouble with hostile Indians, but after the battle of Tippecanoe, in 1811, which effectually destroyed all chance of future annoyance from that source, the population of both the inland section and that along the river increased very rapidly. Many settlers came in from Kentucky, Tennessee, Georgia, Virginia, and the Carolinas, as well as from the States to the east.

The development of the northern part of the area progressed more slowly than that of the section which bordered on the river, because there was no outlet for its products and communication with the outside world was much more difficult. All supplies were taken from the river to Boonville in wagons until the railroad reached that town in 1873.

At first the settlers cultivated only small areas of corn, grain and potatoes for home use, depending on the game in the surrounding forests for meat, and on trading with the boats which passed up and down the river for all other necessaries of life. The growing of tobacco began to attract attention soon after the area was settled, and later, when good markets for the product were established at Owensboro and Louisville, Ky., its production rapidly increased. Corn, tobacco, wheat, barley and oats soon began to be cultivated on a comparatively large scale, and gristmills were erected, so that the people no longer depended on Kentucky as a source of supplies.

About 1836 two agricultural societies were organized, one at Rockport and one at Boonville, for the purpose of encouraging the farmers of the area in stock raising and the cultivation of general farm products. County fairs and farmers' institutes were held yearly, where a small number of stock and a few other products of the surrounding country were exhibited; but no great interest was taken in these attempts until 1856, when a new organization was formed, which continued for years to be the most prosperous agricultural society in the State.

Corn and tobacco continue to be the leading product of the area. A tobacco market was established at Rockport in 1855. The high prices prevailing during the decade from 1860 to 1870 caused a great increase in the tobacco acreage. The supply from the Southern States was cut off during this period, and there was a great demand for tobacco at high prices. The acreage devoted to this crop increased so rapidly that tobacco was soon cultivated almost to the exclusion of all other crops. Spencer County alone is said to have produced as much as 10,000,000 pounds a year. In more recent years the production of tobacco has greatly decreased, but at the present time the prices offered at the neighboring markets of Owensboro and Louisville are causing renewed interest in its cultivation.

One of the most important factors in the development of the northern portion of the area was the advent of the Lake Erie, Evansville and Southwestern Railroad, which reached Boonville in 1873. This afforded adequate means of transporting the products of this section to both the local markets and those situated at a distance from the area. The coal deposits in the immediate neighborhood soon began to be developed, which caused a large increase in population and property values. It had been known for some time that there were coal beds in the hilly sections of the area, but owing to the lack of transportation facilities no attempt had been made to develop them. During the last ten years coal mining has attained considerable local importance, and coal is now being shipped to more distant markets.

The area at the present time is well developed agriculturally. It contains a number of towns and villages, of which Boonville and

Rockport are the largest, each having a population of about 3,000. They have a number of small factories and are the centers of trade for large and prosperous rural districts.

Climate.

The area surveyed is not subject to severe winters or to excessive heat during the summer months. The winters are not only mild, but of comparatively short duration. The growing season comprises about six months of the year, during which time crops are safe from damage by frosts. There is usually adequate rainfall for the crops grown, and injury from drought is very uncommon, even to crops maturing in the late summer.

During the early part of the spring excessive rains, occurring both in this State and those to the northeast, together with the melting of the snows farther north, cause the Ohio River to overflow. Large areas of the flat, low lands along its course are flooded, rendering them too wet for the early cultivation of crops.

The last killing frost in the spring usually occurs about April 9, and the first in fall about October 31.

The following table shows the normal monthly and annual temperature and precipitation as observed at Evansville, Ind., which is situated only a short distance southwest of the area:

Normal Monthly and Annual Temperature and Precipitation.

Month.	Evansville.		Month.	Evansville.	
	Temperature. Degrees F.	Precipitation. Inches.		Temperature. Degrees F.	Precipitation. Inches.
January	35.4	3.31	August	78.4	2.09
February	32.3	2.98	September	71.9	2.48
March	44.6	4.84	October	59.2	2.87
April	57.0	3.55	November	45.0	3.67
May	67.0	4.38	December	35.8	3.02
June	76.3	4.67			
July	79.6	3.54	Year	56.9	41.40

Physiography and Geology.

The physiographic features of the area are quite marked, varying from rolling uplands and small valleys to bottom lands or river flats. The rolling uplands vary considerably in height, but rarely exceed 500 feet above sea level. The coal knobs, located three and a half miles northwest of Rockport, have an elevation of 600 feet and are the highest hills in the area. The hilliest portions are found in the vicinity of Boonville, in the northwestern corner of the sheet, around Chrisney, in the northern and eastern portions of the area, and to the south and west of Rockport.

The hills in only a few instances have very steep slopes, but as a rule are characterized by their smooth, gently rounded forms, with intervening shallow depressions. At Rockport, where the hills extend to the river, they have a steep, precipitous bluff, 75 to 100 feet above the level of the river, for about two miles to the south of that town. Where the surface is undulating or less hilly the soil does not erode to any extent. It is only on the steep sides of some of the higher hills that erosion is very great.

The principal valleys of the area occur along the Cypress Creek Ditch and Little Pigeon Creek, which still flow in the same channels they occupied prior to the Glacial period.

The valley formed by the Cypress Creek ditch has an average width of one mile, and extends across the area from north to south immediately west of Boonville. The Little Pigeon Creek valley traverses the area in a northeast and southwest direction and occupies the territory between the Boonville hills on the west and the Chrisney hills on the east. It has an average width of four miles and is the largest valley in the area. Numerous other small valleys occur, especially in the hills, where small streams have cut their way through, but they are not of sufficient importance to warrant separate discussion. The streams usually overflow after heavy rains or long wet periods, and the soils found in the valleys are of a silty or clayey character.

The surface of the bottom lands or river flats in the southern part of the area, along the Ohio River, presents a flood plain, cut by these numerous small streams, old stream channels and bayous. These lands are flooded annually by the overflow of the river, and each year new channels and bayous are formed. A few small ridges occur over these bottoms and have an elevation of three to four feet above the surrounding surface. The elevation of this flood plain is from 340 to 360 feet above sea level.

Following the course of the Ohio River and bordering it is a sand ridge, averaging one-half mile in width, which is somewhat higher than the lands immediately back of it and is rarely overflowed. The soils found in the bottoms are of a stiff, clayey character, and owing to their low-lying position are exceedingly difficult to drain.

All the drainage of the Boonville area finds its way into the Ohio River; the streams flowing in a southerly direction and emptying directly into the river. The largest is Little Pigeon Creek, which drains over three-fourths of the area. It enters the area two miles east of Tennyson, flows in a southwesterly direction, and passes out about five miles west of Richland City. The Cypress Creek ditch, which flows in a southerly direction through the extreme portion of the area, drains the territory around Boonville and to the west of it. The remainder of the area is drained by smaller streams, which have their sources within the area and flow directly into the Ohio River.

The rocks forming the basal structure of the area belong to the Carboniferous system. The rocks of this system have played an important part in the economic geology of the area, and at present quite extensive coal mines are being developed. The rocks belonging to this period, which are more commonly exposed, consist of sandstone, shale, and shaly sandstone. Exposures may be seen in different parts of the area, especially in deep road cuts.

Inasmuch as the underlying rocks are everywhere covered by a thick mantle of loess, they have played only a minor part in the formation of the soils of the area. During early Quaternary times great ice sheets extended across Indiana some distance north of the area. As the ice melted and the glaciers began to recede it is believed that a part of the material which later formed the soils of the area was released and carried still farther south and deposited over broad flats by streams then issuing from the glacial front. It was later picked up by the winds and generally redeposited in the form of loess over the surface of the uplands, covering all older geological formations. The soils of the bottom lands are of recent alluvial origin, being made up of reworked loess material and very fine sand, and are generally underlain by alluvium of the Glacial age.

SOILS.

The soils of the area are divided naturally into two general groups—upland and bottom land. The several soils, in their typical occurrence, are quite distinct, each possessing its own physical peculiarities. Six types have been recognized in the area, the Miami silt loam and Miami fine sandy loam being found in the upland division; the Waverly silt loam, Waverly clay loam, Waverly clay, and Waverly fine sandy loam in the bottom-land division of the area.

The following table shows the actual and relative extent of each of the different types found in the area:

AREAS OF DIFFERENT SOILS.

Soil.	Acres.	Per Cent.
Miami silt loam	86,656	51.2
Waverly clay loam	30,208	17.9
Miami fine sandy loam	22,848	13.5
Waverly silt loam	17,280	10.2
Waverly clay	8,320	4.9
Waverly fine sandy loam	3,904	2.3
Total	169,216	....

MIAMI SILT LOAM.

The Miami silt loam is the most extensive type in the area surveyed. Its topographic features, ability to withstand drought, adaptability to a great diversity of crops, and its natural productiveness makes it the most valuable soil in the area for general farming purposes.

The soil is a silt loam averaging from 8 to 10 inches in depth, and varying in color from a light ashy-gray to light brown, according to the amount of organic matter present. It contains, in its typical form, a small percentage of fine sand, and when recently put under cultivation or in its virgin state carries a large amount of organic matter.

The subsoil, from 9 to 36 inches, consists of a silt loam containing a small proportion of very fine sand in the first few inches. It varies in color from dark red to yellow, and becomes heavier as the depth increases. At a depth of four or five feet the clay content is much larger and a very heavy silt loam occurs, which is usually of lighter color than that immediately underlying the soil. The material is very compact at a depth of from 25 to 36 inches, making a subsoil very retentive of moisture, while the fine silty texture of the soil prevents the surface from becoming baked, sun cracked, or difficult to cultivate.

The Miami silt loam, covering 51 per cent. of the entire survey, occurs in the uplands in all parts of the area. The largest unbroken body occurs in the northeastern part of the area and extends from near Rockport to the extreme northern boundary. Small tracts occupy the low ridges in the vicinity of the flat river bottoms. These differ slightly from the typical Miami silt loam, in that the soil is slightly heavier and the underlying subsoil has a larger clay content. These small areas have undoubtedly been submerged at times, and the soil has been slightly altered by material deposited by water, as well as by that washed down from the neighboring uplands.

The topography of the country occupied by this type is rolling. The hills are low and rounded, with gently sloping sides, and the intervening valleys are broad and shallow. This insures good drainage, and with proper attention the land is subject to but little injury from erosion. Artificial drainage is seldom necessary and is practiced in but few localities, the rolling topography being usually sufficient to drain the excess water into the numerous small streams.

The loess from which this soil is derived is of glacial origin. The material, which is supposed to have been transported by wind and water, was deposited as a mantle over the entire country to the southward. It shows no stratification, and has an average depth of from 8 to 10 feet in the more hilly section, although it often reaches a greater depth in the valleys or more level areas. The loess overlies beds of sandstone and shaly sandstone belonging to the Carboniferous system. These rocks, however, have not entered into the composition of the soil, except on an occasional steep slope where a thin layer of sandy shales has been exposed through the process of erosion, in which case they weather rapidly, and, becoming mixed with the silty material, cause a larger percentage of fine sand in the soil of the immediate vicinity.

Great care is necessary to keep the Miami silt loam in a high state of productiveness, and a rotation of crops is very essential in order to secure the best results. Where the soil is in a loose and thorough state of cultivation as is necessary when the crop is corn or potatoes, it suffers greatly from the effects of erosion, and large areas of the subsoil are exposed along the steeper slopes.

The Miami silt loam is well adapted to most of the general farm products of the area. Wheat and oats do especially well, and large yields of clover, timothy, and other grasses are always obtained. Very little tobacco is cultivated on this type, as the other soils of the area are considered better suited to the variety grown in this section. Wheat averages 15 bushels, oats about 30 bushels, and corn from 30 to 35 bushels per acre. Where the soil is well tilled and a good system of rotation practiced, much larger yields are frequently realized without the aid of commercial fertilizers. Clover and timothy average from one and a half to two tons per acre, two or more cuttings often being obtained. Apples, peaches, plums, and pears are all successfully grown in the more hilly sections. No attempt has been made to cultivate vegetables and truck crops, except on a limited scale for home use and for local markets, but excellent yields are generally realized from these crops.

The following table gives the mechanical analyses of typical samples of the Miami silt loam:

MECHANICAL ANALYSES OF MIAMI SILT LOAM.

No.	LOCALITY.	Description.	Gravel, 2 to 1 mm., Per Cent.	Coarse Sand, 1 to 0.5 mm., Per Cent.	Medium Sand, 0.5 to 0.25 mm., Per Cent.	Fine Sand, 0.25 to 0.1 mm., Per Cent.	Very Fine Sand, 0.1 to 0.05 mm., Per Cent.	Silt, 0.05 to 0.005 mm., Per Cent.	Clay, 0.005 to 0.0001 mm., Per Cent.
10796	1 mile E. of Pedigo Lake Mills.	Gray to Brown silty loam, 0 to 12 inches.	0.1	0.3	0.2	0.5	4.0	84.2	10.7
10798	¾ mile S. of Chrisney.	Yellow to brown silty loam, 0 to 10 inches.	.2	.8	.5	1.2	6.1	77.1	13.8
10797	Subsoil of 10796..	Heavy, silty loam, 12 to 36 inches.	.0	.2	.1	.3	8.7	68.2	22.4
10799	Subsoil of 10798..	Yellow, silty loam, 10 to 36 inches.	.2	.3	.4	.7	5.2	70.2	22.7

MIAMI FINE SANDY LOAM.

Third in extent and second in agricultural importance among the soil types of the Boonville area is the Miami fine sandy loam. The soil consists of a light to dark brown fine sandy loam, averaging about eight inches in depth. This sandy loam varies from fine to medium in texture, with the coarser material usually occurring in the upper portions of the soil. The sand content rapidly decreases with depth, and below 8 to 14 inches the subsoil is a heavy fine sandy loam, whose color varies from light red to yellow, generally becoming lighter in the deeper layers. The subsoil found from 20 to 36 inches below the surface is a light silt or clay loam, there being only a small percentage of sand present.

The type is practically uniform throughout the area, with the exception of a few minor variations in local spots. On some of the higher elevations a sandy phase occurs which consists of a very sandy loam in which the percentage of sand continues to be quite large throughout the entire 3-foot profile. At a lower depth, however, the sand content decreases rapidly, and at four or five feet below the surface the subsoil is the same as that found underlying the typical soil. The sandy loam of this phase, for a depth of from 20 to 30 inches is somewhat coarser than that of the typical soil, but grades rapidly into a sandy loam of finer texture at lower depths.

In low positions a somewhat heavier phase of the type is encountered which has been slightly modified by the action of water. The soil in this case is a fine sandy loam to a depth averaging eight inches, mixed with varying quantities of organic matter. The underlying subsoil is a heavy fine sandy loam which grades into a clay loam at about 15 to 20 inches below the surface. The color of both soil and subsoil varies from gray to brown, depending upon the amount of organic matter present. These variations occur only in limited areas over the main soil type, and are not of sufficient extent to be shown on a map of the scale used.

The Miami fine sandy loam occurs in one extensive body, reaching from the central part to the southwestern corner of the area. It embraces all the territory from a short distance south of Midway southwest to within three-fourths of a mile of the Ohio River. The eastern boundary of this area is formed by the rolling uplands of the Miami silt loam and the western by the bottoms of Little Pigeon Creek. Two small patches of this type are found a few miles northwest of Rockport, bordering the bottom lands of Lake Drain Creek. In the extreme western part of the area, northwest of Hatfield, two small areas are also found.

The topography of this soil is generally level or slightly undulating. Some portions, however, consist of low hills with shallow depressions intervening. The small hills or ridges trend in a northeast-southwest direction, the general slope being to the south and west.

Many small streams and drains flow across this type in a southwesterly to westerly direction, emptying either into Little Pigeon Creek or the Ohio River. In a few instances the streams have cut out wide depressions, and a heavier type of soil is usually found occurring along them. The type possesses good natural drainage. The streams which flow through it afford excellent outlets for all the drainage waters, and only in a very few instances has it been necessary to construct artificial drainage ditches. Occasionally, however, it has been found advisable to widen and deepen the streams in order to increase their capacity for carrying off the surplus water during times of heavy rains or long wet periods.

In addition to the good natural drainage which this soil type possesses, it also has the power to retain moisture, the underlying silt or clay loam subsoil forming an excellent medium for storage of the soil water, so that with the aid of proper cultivation crops suffer but little from the effects of drought.

Over the more elevated portions of the type, and where the sand content of the soil is above the average, natural drainage is apt to be too thorough for most crops. In this case great care should be exercised in the methods of cultivating, particular attention being paid to the preservation of a surface mulch in order to carry the crops safely through the dry seasons of July and August. The lower lying portions of this soil type require artificial drainage to secure the best crops. Ditching and tiling greatly improve the productivity of such areas, and a large part of these is being artificially drained at the present time.

The Miami fine sandy loam is of alluvial and glacial origin. The underlying silt and clay loam is undoubtedly reworked loess material washed down from the uplands, while part of the sand which goes to make up the sandy loam was deposited at an early date during times of exceptionally high water. The sand underlying the Miami silt loam bordering this type on the east has been washed over the surface of this soil and has entered into its composition.

The type is well adapted to almost all kinds of crops that will grow in this latitude, with the possible exception of timothy, which requires more moisture than this soil can retain during the dry season. Ordinarily wheat averages 20 bushels per acre. The yield of corn on the cob varies from 40 to 80 bushels per acre, depending upon the manner in which it is cultivated, and of oats only from 25 to 30 bushels, owing to the lack of sufficient moisture fully to mature the crop. Early potatoes yield from 75 to 175 bushels, while the late varieties produce from 100 to 125 bushels per acre.

The Miami fine sandy loam is one of the best soils in the area for the production of tobacco. It produces usually from 700 to 1,000 pounds per acre, although a much higher yield is often obtained. Tobacco is considered a sure crop, and often does well when corn, wheat, and other crops are a failure.

Apples and peaches are grown to some extent, but the apples do not keep as well as those grown on heavier types. Small fruits are cultivated to a limited extent, the quantity produced being scarcely sufficient for home consumption. The soil is well adapted to truck crops, but its distance from good markets renders their production unprofitable at the present time.

The following table gives mechanical analyses of typical samples of this type of soil:

MECHANICAL ANALYSES OF MIAMI FINE SANDY LOAM.

No.	LOCALITY.	Description.	Gravel, 2 to 1 mm., Per Cent.	Coarse Sand, 1 to 0.5 mm., Per Cent.	Medium Sand, 0.5 to 0.25 mm., Per Cent.	Fine Sand, 0.25 to 0.1 mm., Per Cent.	Very Fine Sand, 0.1 to 0.05 mm., Per Cent.	Silt, 0.05 to 0.005 mm., Per Cent.	Clay, 0.005 to 0.0001 mm., Per Cent.
10790	2 miles E. of Hatfield.	Brown fine sandy loam, 0 to 14 inches.	0.0	1.7	10.0	28.6	19.2	32.1	8.3
10788	1 mile E. of Richland City.	Brown to gray fine sandy loam, 0 to 12 inches.	.2	1.7	6.4	27.1	18.6	34.9	11.1
10791	Subsoil of 10790..	Heavy fine sandy loam, 14 to 36 inches.	.1	1.2	7.7	26.1	10.7	39.7	14.2
10789	Subsoil of 10788..	Yellow loam, 12 to 36 in...	.1	.8	3.0	17.3	14.2	40.3	24.4

WAVERLY SILT LOAM.

The Waverly silt loam covers a very limited part of the area surveyed, but agriculturally it is one of the most valuable soils. The soil has a depth of from 12 to 18 inches. It is a silt loam, slightly plastic when wet, gradually becoming heavier as the depth increases, and varying in color from gray to dark brown, according to the amount of organic matter present.

The subsoil is a light-yellow silt loam, containing a larger percentage of clay than the soil, and becoming heavier at a depth of 25 or 30 inches. In places the subsoil is a mottled, heavy, drab silt loam of a much stiffer nature than the soil, but still retaining its silty character.

The greater part of this type, as it exists in the area, contains a comparatively small amount of organic matter, but in the poorly drained places, where there has been a continual accumulation of humus, the percentage of organic matter is very high.

The Waverly silt loam occurs as narrow strips bordering most of the small streams in all sections of the area, but seldom extends back more than a quarter of a mile from the streams. The largest area, which lies along the Cypress Creek ditch west of Boonville, has an average width of one mile. A second extension occurs at the head of the Willow Pond ditch, northwest of Rockport, where the soil contains a very large amount of organic matter and is of much darker color than the greater proportion of the type. The Willow Pond area has only recently been drained and put under cultivation, and both soil and subsoil are of a slightly heavier nature than the typical Waverly silt loam.

In topography the type is level, with a gentle slope toward the small streams. It occupies the low depressions near the sources of streams and the narrow valleys between the rolling hills. The streams have usually cut their channels down several feet below the lands bordering them, but are generally insufficient to drain thoroughly the larger areas without artificial means. This soil is easily drained by straightening and deepening the small stream courses and cutting lateral ditches at frequent intervals through the wet areas. Tiles are used with excellent results, and at present the greater part of this soil is well drained. When ditched and tiled thoroughly it is very productive, and in several localities its value has been increased from $10 to $50 an acre by the installation of a good drainage system.

The Waverly silt loam is derived from material washed from the uplands at times of heavy rains and deposited in the depressions and shallow valleys, mixed with decaying vegetable matter. The remains of decomposed logs and other organic matter have been found in the soil at a depth of from 6 to 10 feet below the surface, indicating that the now shallow valleys have been gradually built up to this present level by the steady accumulation of material from the uplands.

Where the soil is well drained, corn averages from 50 to 70 bushels; wheat, 20 bushels; oats, 40 bushels; clover and timothy, about two tons, and tobacco from 1,000 to 1,200 pounds per acre. Large yields of potatoes and other vegetables are obtained. The soil seems best adapted to corn and tobacco. The corn crop is never a failure, and when well cultivated, larger yields than those above mentioned are obtained. Tobacco gives large yields per acre, and, as quantity rather than quality is what the growers strive for, much of this soil type is devoted to its production.

The following table gives the mechanical analyses of typical samples of the Waverly silt loam:

MECHANICAL ANALYSES OF WAVERLY SILT LOAM.

No.	LOCALITY.	Description.	Gravel, 2 to 1 mm., Per Cent.	Coarse Sand, 1 to 0.5 mm., Per Cent.	Medium Sand, 0.5 to 0.25 mm., Per Cent.	Fine Sand, 0.25 to 0.1 mm., Per Cent.	Very Fine Sand, 0.1 to 0.05 mm., Per Cent.	Silt, 0.05 to 0.005 mm., Per Cent.	Clay, 0.005 to 0.0001 mm., Per Cent.
10806	4 miles N. of Rockport.	Brown to yellow silty loam, 0 to 10 inches.	0.2	0.5	0.5	3.6	10.4	74.8	10.1
10804	2 miles E. of Boonville.	Yellow fine silty loam, 0 to 12 inches.	.2	.2	.1	.5	5.8	82.1	11.1
10805	Subsoil of 10804..	Yellow silty loam, 12 to 36 inches.	.3	.5	.3	.4	5.7	77.8	15.1
10807	Subsoil of 10806..	Yellow heavy silty loam, 10 to 36 inches.	.2	.5	.5	3.5	10.7	67.5	16.7

Waverly Clay Loam.

The soil of the Waverly clay loam consists of about six inches of heavy, light-brown to gray silt loam, often containing small iron concretions scattered over the surface and through the soil. The soil becomes heavier with depth and grades into a very heavy silt loam containing a large percentage of clay. At a depth of from 12 to 20 inches the subsoil is sticky, mottled clay, usually containing small iron concretions. It becomes stiffer and more tenacious as the depth increases, making the soil difficult to drain. When plowed and exposed to the air the subsoil becomes whitish in color and dries into hard crusts or clods very difficult to pulverize. There is apparently little organic matter in the soil, except in small swampy areas, and no attempt has been made to drain these areas or to put them under cultivation. In such places the soil is known locally as "glade" or "crawfish" land and is of little agricultural value.

The Waverly clay loam occupies small areas adjacent to many of the small streams, but in the north central part of the area there is one body of considerable extent. This occupies the low, flat country which extends along Little Pigeon Creek and other streams from near Tennyson to where Little Pigeon Creek leaves the area. There are a few ridges and shallow depressions in this area, but the greater part of the land is almost level. It is drained with great difficulty, on account of the compact nature of the soil, the level topography, and the slight elevation above the level of the streams.

Where this soil is ditched and tiled and a complete system of artificial drainage established, the least productive phases have been made to produce average crops. Where no system of drainage is practiced, these lands are either covered with a growth of scrub oak or are used exclusively for pasture.

A small area of the type situated about two and a half miles north of Rockport deserves special mention. It occupies an old terrace of the Ohio River, and has a more rolling topography than the typical areas. This, together with its elevation and nearness to the river, gives it better drainage and a higher crop value than this soil usually possesses. This area is of too small extent, and the soil occurring between the low ridges is too typical of the Waverly clay loam to classify it as a separate soil type.

The Waverly clay loam is derived from the same loess material as the Miami silt loam of the uplands, but its position in the low, flat valleys, only a few feet above the present level of the stream, has caused this material to undergo considerable change. The poor drainage, the addition of finer material washed down from the uplands, the effect of water which collects and spreads over the low areas in wet seasons, and the material deposited over these sections by former inundations, all combine to make this a much heavier soil than that formed from the loess on the well-drained uplands.

The yields of the various crops cultivated on this soil depend to a great extent on the thoroughness of the drainage and cultivation. With the methods usually practiced corn will average from 10 to 15 bushels and wheat from 10 to 12 bushels per acre. Wheat often gives larger yields in a favorable season if preceded by clover. Very little oats is grown on this type, and a yield of from 15 to 20 bushels per acre is estimated as an average crop.

Tobacco is grown quite extensively on this soil, a heavy, coarse-textured leaf being produced. This tobacco does not command so high a price as that grown on the more sandy soils, but the plants are larger and larger yields are obtained, the average being from 1,000 to 1,200 pounds per acre.

This soil seems best adapted to clover, timothy, and redtop, and a large amount of hay is harvested yearly from it. The hay crop averages from two to three tons per acre for each cutting, and the facilities for shipping this product to southern cities make it a profitable industry.

The Waverly clay loam varies considerably in agricultural value, according to its position, topography, and the methods used in its management. The greater part of it is considered a very poor soil for general farming purposes, but where it occupies the low ridges a few feet above the more level areas and is well drained very fair crop yields are usually obtained. Small areas frequently appear only a few rods apart where, on account of the local influences of topography and natural drainage, fair yields are produced on one field, while on the adjacent one, which is too wet and poorly drained, nothing except clover and grass can be successfully grown.

The following table gives mechanical analyses of this type:

MECHANICAL ANALYSES OF WAVERLY CLAY LOAM.

No.	LOCALITY.	Description.	Gravel, 2 to 1 mm., Per Cent.	Coarse Sand, 1 to 0.5 mm., Per Cent.	Medium Sand, 0.5 to 0.25 mm., Per Cent.	Fine Sand, 0.25 to 0.1 mm., Per Cent.	Very Fine Sand, 0.1 to 0.05 mm., Per Cent.	Silt, 0.05 to 0.005 mm., Per Cent.	Clay, 0.005 to 0.0001 mm., Per Cent.
10786	1½ miles N. E. of Richland City.	Heavy silty loam, 0 to 6 inches.	0.3	1.0	1.4	3.5	8.9	56.3	28.6
10784	3½ miles E. of Boonville.	Clay, 0 to 6 inches........	.3	1.0	.7	1.0	1.8	59.0	36.1
10787	Subsoil of 10786..	Gray clay, 6 to 36 inches...	.4	1.3	1.6	3.7	8.6	53.2	31.0
10785	Subsoil of 10784..	Yellow to gray heavy clay, 6 to 36 inches.	.2	.4	.3	.3	1.1	53.9	43.7

WAVERLY CLAY.

The Waverly clay is an alluvial soil found in the low bottom lands bordering the Ohio River. It extends uniformly over that section of the area which is subject to annual inundation during the spring floods.

The soil, to a depth of from 8 to 10 inches, consists of a light-brown clay loam, often containing a small amount of sand. The percentage of silt and clay is very large, and the soil rapidly becomes stiffer and more tenacious with depth, grading into a heavy tenacious clay subsoil of a brown or drab color, which is often mottled in the lower depressions. A few small iron concretions are frequently seen in the more swampy areas, both in the soil and subsoil.

This type of soil is overflowed annually, and when the water recedes the lands, on drying, become baked and sun cracked, making its cultivation difficult.

The Waverly clay occurs in a large area in the extreme southern part of Spencer County and embraces the greater part of the lands lying within the great bend of the Ohio River, southwest of Rockport. It also extends in narrow strips a short distance up the valleys of some of the small streams which flow through this section of the area. These lands are comparatively level, but are traversed by numerous narrow sloughs and shallow, swampy depressions with low ridges intervening.

The type as a whole occupies a basinlike depression, surrounded on three sides by the sand ridge which extends along the banks of the Ohio River and on the north by the rolling uplands. The small streams which flow through it have cut their channels several feet below the surface of the greater portion of the area, and as soon as the floods subside the water covering the lowlands finds its way back to the river through these outlets. Drainage is difficult over a large proportion of the type, but ditching and tiling greatly increase its agricultural value.

The material from which this soil is formed is brought down by the Ohio River at times of high water and is deposited over the areas flooded. During the annual spring floods the river water backs up through the openings which the small streams have cut in the sandy ridge and spreads out over the low flat country of the interior. The fine particles of silt and clay held in suspension are gradually deposited over the bottom lands, while the sand and coarser particles are deposited nearer the main current of the stream. This annual addition of new material to the soil tends to maintain its productiveness, and when the crops are not damaged by overflow large yields are obtained. Along some of the narrow depressions, where the current of the stream is strongest during the overflow, the surface soil has been eroded and the stiff clay subsoil exposed. Crops planted in such places are either a total failure or give very low yields.

The Waverly clay is cultivated almost exclusively to corn, which averages about 40 bushels per acre. During favorable seasons and where the land is well drained and cultivated as much as 60 bushels is often produced. Wheat yields from 18 to 20 bushels per acre, although the crop is sometimes destroyed or greatly damaged by the floods. It is estimated that about one wheat crop in three is harvested from this soil. Wheat is often sown in the fall, and if the crop is destroyed by the overflow it is followed by corn planted in the late spring. Oats are grown to a very small extent, as they suffer from the same disadvantages as wheat; but when not damaged by floods 40 bushels per acre may be produced. Tobacco is grown to a limited extent, and about the same grade of the dark export type is obtained as that grown on the Waverly clay loam. The yield is about 1,000 pounds per acre. Clover, timothy, and other grasses give yields of from two to three tons per acre.

This type, however, is best adapted to the production of corn. The soil is usually in condition to cultivate by the latter part of April, and often at an earlier date, and as the corn crop is planted in May it is very seldom damaged by overflow, and large and profitable yields are thus almost always assured.

The following table gives mechanical analyses of typical samples of the Waverly clay:

MECHANICAL ANALYSES OF WAVERLY CLAY.

No.	LOCALITY.	Description.	Gravel, 2 to 1 mm., Per Cent.	Coarse Sand, 1 to 0.5 mm., Per Cent.	Medium Sand, 0.5 to 0.25 mm., Per Cent.	Fine Sand, 0.25 to 0.1 mm., Per Cent.	Very Fine Sand, 0.1 to 0.05 mm., Per Cent.	Silt, 0.05 to 0.005 mm., Per Cent.	Clay, 0.005 to 0.0001 mm., Per Cent.
10808	7½ miles S. W. of Rockport.	Heavy clay loam, 0 to 8 inches.	0.3	1.1	0.7	1.8	3.0	58.2	34.8
10810	7½ miles S. W. of Rockport.	Brown heavy clay loam, 0 to 10 inches.	.1	.2	.3	1.1	1.5	55.5	41.2
10809	Subsoil of 10808..	Stiff clay, 8 to 36 inches ...	.7	2.2	1.2	2.9	4.7	51.6	36 6
10811	Subsoil of 10810..	Brown to gray heavy clay, 10 to 36 inches.	.1	.3	.5	1.5	1.8	46.8	49.0

WAVERLY FINE SANDY LOAM.

The Waverly fine sandy loam is a type of minor importance in the area on account of its limited extent. It is well adapted to a variety of crops, and, owing to its elevation above the flood plain, the crops are seldom seriously injured by the overflows of the Ohio River.

The soil to a depth of 15 inches is a light-brown to gray fine sandy loam, the sand content being usually large and of the finer grades. As the depth increases the soil becomes heavier, and at from 15 to 20 inches passes into a brown fine sandy loam, containing a larger percentage of clay. The sand content, depth of soil, and size of the sand particles often vary according to location. That portion of the type lying nearest the river is of a coarser texture and is often deeper than that immediately bordering the Waverly clay.

The Waverly fine sandy loam occupies a narrow ridge extending along the whole course of the Ohio River, where it forms the southern boundary of the area, except where the Rockport hills reach to the water's edge. This ridge slopes gently toward the low inland basin occupied by the Waverly clay, but its slope toward the river is more abrupt and ends in the steep banks which extend to the water's edge. Its elevation above the river and the neighboring lowlands, together with the sandy nature of the soil itself, gives to this type excellent drainage. Ditching and tiling are never necessary, as only a very small proportion of the type is subject to overflow.

This sandy ridge was formed before the river had cut its channel down to its present level. During times of overflow the water, spreading over the more level sections, deposited the coarser material near the banks of the river. The coarser sands were deposited near the main current, while the finer grades were carried farther inland and laid down near the deposits of silt and clay. As the river gradually deepened its channels, and as more material was annually deposited along its banks, a natural levee was soon formed, consisting of a sand ridge several feet above the flood plain of the river. Small quantities of silt, clay, and organic matter, becoming mixed with the sand, formed a soil which is not only productive, but easily cultivated.

During a very dry season the crop yields are small, but with an average amount of rainfall large yields of oats, corn, wheat, potatoes, melons, and navy beans are secured. Corn averages from 40 to 50 bushels, wheat from 15 to 20 bushels, and oats from 25 to 30 bushels per acre. Tobacco is also grown on this soil and averages about 700 pounds per acre. The yield is not so large as that obtained on the heavier soils, but the leaf grown usually brings a higher price. All vegetables do well on this soil. A large acreage is devoted to navy beans. It is also excellently adapted to alfalfa, while a large yield of clover is always obtained. The type is best adapted to corn, melons, alfalfa, and early vegetables, the latter being grown for local markets.

The following table gives mechanical analyses of typical samples of the Waverly fine sandy loam:

MECHANICAL ANALYSES OF WAVERLY FINE SANDY LOAM.

No.	LOCALITY.	Description.	Gravel, 2 to 1 mm., Per Cent.	Coarse Sand, 1 to 0.5 mm., Per Cent.	Medium Sand, 0.5 to 0.25 mm., Per Cent.	Fine Sand, 0.25 to 0.1 mm., Per Cent.	Very Fine Sand, 0.1 to 0.05 mm., Per Cent.	Silt, 0.05 to 0.005 mm., Per Cent.	Clay, 0.005 to 0.0001 mm., Per Cent.
10802	3 miles S. of Rockport.	Brown fine sandy loam, 0 to 12 inches.	0.1	0.4	0.6	23.1	34.7	31.0	9.9
10800	6 miles S. of Rockport.	Gray to brown heavy fine sandy loam, 0 to 15 inches.	.1	.3	.3	9.7	37.6	38.9	13.1
10803	Subsoil of 10802..	Heavy fine sandy loam, 12 to 36 inches.	.1	.1	.4	18.0	32.8	32.4	16.0
10801	Subsoil of 10800..	Brown loam, 15 to 36 inches.	.1	.2	.2	8.0	32.9	41.2	17.5

AGRICULTURAL METHODS.

To obtain the best results on the soils of the area very careful methods of cultivation are necessary.

When the Miami silt loam is constantly kept in the loose condition required for the successful cultivation of corn, the upper soil soon becomes eroded and its productivity is greatly lessened. The underlying subsoil becomes exposed on the surface and the land often fails to give sufficient yields to make its cultivation profitable. The usual method employed to restore these lands to their former state of productiveness is to seed them down to clover. A fair stand of clover is usually obtained, except on a few small areas where erosion has been greatest. The lands are heavily fertilized with stable manure or commercial fertilizer and the fields are pastured to sheep or other live stock. By this method much of the worn-out land in the area has been reclaimed and profitably cultivated to all crops adapted to the soil.

Where a rotation of crops is practiced the upland soils suffer very little from erosion and profitable yields are continuously obtained without the aid of commercial fertilizers. Some system of crop rotation is in use in all sections of the area and on all the soil types, with the exception of the Waverly clay, but crop rotation is of the greatest importance on the Miami silt loam and the Miami fine sandy loam. The soils occupying the river flats and low upland valleys are not so easily eroded, and are annually enriched by the addition of new material washed down from the surrounding uplands or deposited by water.

Drainage is the most important factor in the management of the soils occupying the lower and more level sections of the area. The agricultural value of a large proportion of the Waverly silt loam and of the Miami fine sandy loam has been greatly increased where a good system of artificial drainage has been established. The Waverly clay loam, on account of its level topography and slight elevation above the level of the streams, is the most difficult soil of the area to drain, but where ditching and tiling are practicable good results are always obtained. Where tile drainage is used the tiles are laid at a depth of two and a half to three feet and are placed 30 or 35 yards apart. These open into the main drainage ditch, which leads to the neighboring stream. This system is adequate to drain the greater part of the upland valleys and low depressions occupied by the Waverly silt loam and the Waverly clay loam, but the topography of some of the small swampy areas occupied by the latter makes thorough drainage almost impossible.

When preparing the soil for the cultivation of wheat the field is plowed about the 1st of August. It is then dragged, harrowed, and rolled three or four times. The wheat is usually drilled in during the first week in September and is harvested early in July. The preparation of the land for oats is about the same as for wheat, except that the land is seldom worked more than twice before the crop is drilled in. Oats are sown during March and April, and the crop is harvested during the latter part of July.

For corn the soil is plowed in the early part of April or as soon as the season permits. It is then dragged or harrowed until it is in a loose and thoroughly cultivated condition. The crop is planted from the 10th to the 20th of May, and should be cultivated once each week until it becomes too large.

Tobacco seeds are first sown in beds located on the sunny hillsides, which afford them a natural protection. The tobacco beds are covered with a thin canvas or cheesecloth. The plants are set out during the latter part of June and the crop matures in September. It is then cut and hung on low scaffolds in the fields until the leaves begin to turn yellow. Great care is taken to protect it during rainy weather while in the field. After a short interval of time it is removed to open well-ventilated barns, stripped from the stalks, and suspended from scaffolds. It is alternately dried and softened, as the climatic conditions vary from dry to damp, and when thoroughly cured is assorted and put on the market. No curing by means of artificial heat in especially constructed barns is practiced at present in the area.

Agricultural Conditions.

The agricultural interests of the area are centered in the production of corn, wheat, and tobacco. A limited acreage is devoted to the production of oats, hay, and vegetables, but the climatic conditions, soils, and facilities for marketing all tend to make the area particularly well adapted to the three staples first named. The farmers of the area are intelligent and energetic, and the majority of them are prosperous and free from debt. Large yields of all crops grown, together with the prevailing good prices, have placed the farmers in all sections of the area in excellent financial condition. Great interest is manifested in farmers' institutes, agricultural societies, and all kinds of local organizations which tend to advance the interests of the rural population.

The average farm dwelling consists of a neatly painted two-story frame building, while the barns and other outbuildings are modern and well kept. These are always large enough to store the crops, to shelter the small number of stock which each farmer invariably owns, and to protect the farm machinery during the winter months.

About three-fourths of the farmers own the lands they cultivate, the remainder being tenants on the farms of the larger landholders. Lands are usually rented on a share basis, but a few tenants in the upland sections pay cash. When rented on shares the landowner receives from one-fourth to one-third of the crop produced. The tenant furnishes the seed, work animals, farm machinery, fertilizers, and labor, receiving from two-thirds to three-fourths of the crop made. From $3 to $4 an acre is the usual cash rent for farms in the Miami silt loam or Miami fine sandy loam, but a higher rate is obtained for well-drained lands in the Waverly silt loam. The Waverly clay loam and Waverly clay types of soil are never rented for cash, the uncertainty of a profitable yield, on account of the liability of crops on these areas to damage or destruction by floods, droughts, or unfavorable seasons causing the share system to be preferred by the tenant.

The largest farms in the area are situated along the Ohio River on the low, flat areas of Waverly clay. They average from 150 to 300 acres each, and, owing to the annual flooding of this section during the early spring months, they are cultivated almost exclusively to corn. There are comparatively few dwellings or farm buildings in this part of the area, as the farmers cultivating these lands live on the neighboring uplands or on the sandy ridge bordering the river. On the Miami silt loam of the uplands and on the Miami fine sandy loam the farms have an average size of from 100 to 125 acres, and a very large proportion of the land is under cultivation. No large tracts are being cultivated on the Waverly clay loam. Although some farmers own from 150 to 200 acres of this type, much of it is either used for pasturage or is covered with a growth of hardwood timber.

The average tenant in the area farms from 40 to 75 acres. As a general rule farm labor is plentiful throughout the year, the supply often exceeding the demand, so that many of the farm laborers are compelled at certain seasons to seek employment in the towns or neighboring counties. During harvest there is always a demand for experienced farm hands at good prices, and it is often difficult to obtain them at this season. The labor employed in the area is of a very efficient character. When hired by the month, from $14 to $20, including board, is paid for farm hands, but during harvest from 75 cents to $1 a day is the usual rate.

Corn, wheat, and tobacco are the principal products, each being grown on every variety of soil found in the area. A failure of the corn crop on many of the soil types is very rare, and during a favorable season an excellent crop is always obtained. This crop can not be grown continuously on the rolling uplands without involving damage to the soil from erosion. As the soil becomes loose and friable when frequently cultivated, much of it is washed from the surface of the rolling hills to the neighboring valleys. However, when a rotation of crops is practiced large yields are continuously obtained and the general productiveness of the soil remains unchanged.

A number of varieties of wheat are grown in the area, the most important being the Pool, the Red Wonder, the Russian Red, and the New Columbia. The Pool is the variety most widely grown, but the Red Wonder seems better adapted to the more sandy soils.

The greater part of the tobacco produced in the area is of the dark export type, but on some of the lighter soils a small amount of Burley is grown. The Pryor and One-sucker are the varieties of dark tobacco most widely cultivated, and a vigorous growth of these is always obtained on the heavier soils. The leaf is heavy and oily, varying in color from a light brown to a dark reddish brown. While a comparatively small quantity of Burley tobacco has been grown in the area, the present good prices are causing the production of this variety to increase rapidly. When the difference in the market prices is not very great the farmers prefer to grow the dark export type, as larger yields per acre are produced and it requires much less attention, both while the crop is in the field and while it is being cured. Only a small part of the tobacco grown in the area is consumed in the United States, the greater proportion being exported to foreign markets, where the dark, heavy types of this product are in greater demand.

In connection with the foreging discussion of the agricultural products of the area it seems advisable to point out again the relation between these products and the several soils. The Waverly clay and the Waverly fine sandy loam are well adapted to corn. The Waverly silt loam is also excellently adapted to this crop, and when well drained it produces larger yields than any other type in the area. The Miami silt loam is best adapted to wheat. Large yields of wheat are also harvested annually from the Miami fine sandy loam, and while there is no great difference between these types in the yield per acre, that produced on the silt loam of the uplands is of a higher grade and, as a rule, commands better prices on the markets. Large yields of wheat are obtained on the Waverly clay when the crop is not destroyed by floods. The Waverly clay loam, when properly drained, is well adapted to the production of the dark-leaf tobacco, and yields of from 1,000 to 1,200 pounds per acre are realized. This soil, however, is best adapted to clover and timothy, a large part of the hay produced in the area being grown on it.

The Waverly fine sandy loam and the Miami fine sandy loam are well adapted to melons, and the heavier, poorly drained phases of these types produce large yields of oats. Burley tobacco is also grown on these sandy loams, and with proper care in its cultivation, cutting, and curing a very fair grade is often obtained. Tomatoes, small fruits, and early vegetables are well suited to these sandy soils, and limited experiments have demonstrated that alfalfa does well, especially on the Waverly fine sandy loam which borders the Ohio River.

The transportation facilities of the area are excellent. Two branches of the Southern Railroad traverse the area, one of which terminates at Rockport, an important local shipping point on the Ohio River. The facilities afforded by both the river and the railroads cause Rockport to receive a large amount of produce from the surrounding country on the way to more distant markets.

A large number of well-kept county roads connect Boonville, Rockport, Chrisney, and other smaller towns with all sections of the surrounding country. The streams are all well bridged, and the more important county roads are macadamized for some miles out from the leading towns.

Several landings are situated at short intervals along the Ohio River, where the products of the neighboring farms are loaded on the small river steamers and transported direct to Louisville, Owensboro, or other large markets. An electric car line is now being constructed to connect some of the smaller towns with Evansville, Rockport, and other importaint local markets. This will greatly facilitate traffic, and will enable the farmers in certain sections of the area to market their produce with more dispatch and at much less expense that at present.

Owensboro, Ky., is the market for almost the entire corn crop of the area. The large distilleries located there create a constant demand for this product. The greater part of the wheat and tobacco is shipped to Louisville, Ky. A small portion of the tobacco crop is marketed at Owensboro, and a still smaller proportion is shipped direct from the area to foreign markets. Very few farmers own more than a few head of stock. No cattle are raised for other than the local markets, but a large number of hogs are raised and marketed at Louisville and Cincinnati. A few farmers in the area have made a specialty of this industry, and as good prices are obtained it has proved very profitable.

The diversity of crops grown, the natural productiveness of the land, the transportation facilities afforded by the river and the railroads, and the nearness to large markets all tend to make the area surveyed one of the most prosperous sections of the State.

Soil Survey of Scott County, Indiana.

BY A. W. MANGUM AND N. P. NEILL.
U. S. Bureau of Soils.

LOCATION AND BOUNDARIES OF THE AREA.

The extreme dimensions of Scott County are 17 miles from east to west and 15 miles from north to south. The county is bounded on the north by Jackson and Jennings counties, being separated

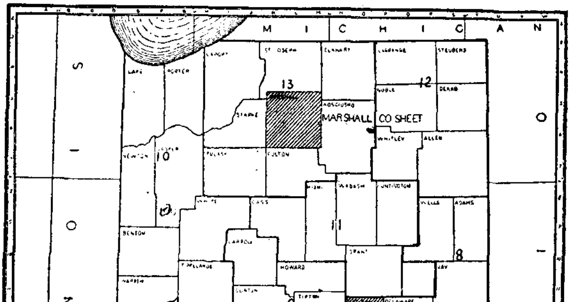


FIG. 1.—Sketch map showing location of the Scott County area, Indiana.

from them by the Muscatatuck River; on the east by Jefferson County; on the south by Clark and Washington counties, and on the west by Washington and Jackson counties. The total area included within these boundaries is 126,336 acres, or approximately 197 square miles.

Scottsburg, the county seat, is situated on the main line of the Pennsylvania Railroad, which runs between Chicago and Louisville, and affords an excellent shipping point to some of the large cities. The population of Scottsburg is about 1,200. Prior to 1885, lumbering was the chief occupation, but since that date agriculture has become the leading pursuit of the people.

History of Settlement and Agricultural Development.

Few events of any importance in the history of Scott County transpired before the War of 1812. Several attempts had been made prior to that time to establish settlements in this part of Indiana, but they were generally unsuccessful on account of trouble with the hostile Indians. The Pigeon Roost settlement, which was established in the southern part of the area in 1809, was probably the first settlement of any importance in the county, but this was attacked in 1812 by Indians, most of its inhabitants massacred and the village completely destroyed. The Indians, however, were soon defeated and driven from this part of the State, and settlement then progressed more rapidly. A few foreigners, chiefly Irish, Scotch and Germans, were among these early settlers, but the majority came from Kentucky, Tennessee, North Carolina and Virginia. Scott County was organized in 1817. The county seat was at first located at Lexington, but was later transferred to Scottsburg.

Considering the length of time the county has been settled, its agricultural development has been very slow. The early settlers cultivated small tracts of land to corn, wheat, potatoes, and other general farm crops for home use, but they depended on the timber of the surrounding forests as their main source of income. Larger areas were put under cultivation and more interest was taken in tilling the soil as the land became cleared and the lumber industry declined. About 1850 a railroad, now a part of the Pennsylvania system, was built through the county, and fourteen years later the Baltimore and Ohio Southwestern was constructed. Later on these roads aided materially in the development of the county, as they afforded excellent facilities for transporting its products to eastern markets.

The eastern part of the area was the first to develop agriculturally. The timber in this part of the county was of much lighter growth than was found on the low, flat valleys farther west. The soil was productive and easily cultivated, and its topography rendered it better adapted to general farming purposes than the rough, broken country of the southwestern part of the area.

About 1880 the lumber industry began to fail, and by 1885 it had become of minor importance. This marked the beginning of the real agricultural progress of the county, and farming soon became the leading occupation of the people. The agricultural wealth of the county is estimated to have increased fully 50 per cent. during the last twelve years. Corn, wheat, oats, clover, timothy, and vegetables are now successfully grown on almost every type of soil in the county, and the rough and hilly sections seem well adapted to orchards and vineyards. Within the last few years tomato growing has developed into a very important industry, and a large acreage is annually devoted to the production of this crop. There have been established in the county a number of canning factories, which afford a ready market for all the tomatoes grown, and the specialization of this crop is proving very profitable.

Great interest is manifested in the county agricultural organizations and in the subject of good roads. Within the last twelve years considerable attention has been paid to road construction, and most of the streams are now spanned by durable iron bridges.

Although there was practically no increase in the population of Scott County during the twenty years from 1880 to 1900, the general progress during the last fifteen years has been very rapid. A telephone system connects the rural districts with the cities, and the rural free delivery of mail has been established. Tile drainage, more thorough cultivation of the soils, and more modern methods of farming are rapidly coming into use, and the county as a whole is in a very prosperous condition.

Climate.

The following table, compiled from Weather Bureau records, shows the normal monthly and annual temperature and precipitation taken at Scottsburg, within the county; at Madison, in Jefferson County, just east of the area surveyed, and at Salem, in Washington County, just west of the area.

Normal Monthly and Annual Temperature and Precipitations.

Month.	Scottsburg.		Madison.		Salem.	
	Temperature, ° F.	Precipitation, Inches.	Temperature, ° F.	Precipitation, Inches.	Temperature, ° F.	Precipitation, Inches.
January	32.9	3.28	34.2	4.15	29.2	3.35
February	31.0	2.60	31.5	2.85	30.6	3.57
March	43.2	4.44	43.9	4.86	41.9	3.83
April	52.3	2.31	55.6	3.01	52.4	3.05
May	65.0	3.70	65.3	4.44	63.5	3.22
June	74.4	4.30	74.9	4.14	71.2	4.52
July	78.0	3.02	77.9	3.13	77.2	2.89
August	76.4	2.90	76.3	3.40	74.6	3.50
September	69.1	2.38	70.2	2.33	68.1	2.58
October	57.5	2.13	58.1	2.06	56.4	2.66
November	44.5	3.43	44.8	3.29	44.5	3.94
December	36.3	3.25	35.1	3.30	32.4	3.32
Year	55.1	37.74	55.7	40.96	53.5	40.43

These three places are practically in the same latitude, but it will be noticed from the above table that the precipitation is somewhat greater at Madison and Salem than it is at Scottsburg, while the annual temperature is about the same.

Physiography and Geology.

There have been two controlling factors in the physiographic development of Scott County—the limestone, sandstone, and arenaceous shale of the Knobstone group and the black, slaty shale of the New Albany series. The upper strata of the Knobstone group, which cap the hills in the southwestern part of the county, have resisted the agencies of erosion better than the softer underlying shale, and the surface of this section is very broken and hilly. The shales belonging to the New Albany series, which underlie the soils of the eastern two-thirds of the county, have given rise to a rolling topography.

The Knobstone hills of the southwestern part of the area have an elevation of from 200 to 400 feet above the drainage level of the country north and east of them, and present the most prominent topographic features of the area. These hills have been cut by numerous northward-flowing streams, which have formed deep, narrow, V-shaped valleys, varying in length from one to five miles. As the streams approach the more rolling country the valleys become much broader and the slope of the hills is more gentle. The surface of these broader valleys was once much lower than it is now, as there has been a silting up of the stream beds since the formation of the valleys until the material deposited is estimated in many cases to exceed a depth of 20 feet.

The level upland parts of the county are best developed west of Scottsburg and in the vicinity of Austin. Here the surface is comparatively level, although it is traversed by many small streams and shallow valleys. The streams flow across these uplands in a general northerly direction, and the shallow valleys vary in width from a few rods to about one mile.

As already pointed out, the topography of the eastern two-thirds of the area is of a gently rolling character. The summits of the rounded hills are comparatively level, and the hillsides slope gently toward the small streams which flow through the broad, intervening valleys. Along the lower stretches of the streams the valleys have been gradually filled up with sediment, and the neighboring hills are lower and more gently undulating. This characteristic is especially well developed just east of Scottsburg and along Stuckers Fork and its larger tributaries, where material has been deposited to a depth of many feet.

In the extreme northern part of the county the topography retains its rolling or undulating character, but the general elevation is much less than it is farther south. The land bordering the Muscatatuck River, in the northwestern part of the area, is low and flat, but marked by many old stream channels, bayous, narrow sloughs, and low, sandy ridges. It has only a slight elevation above the level of the stream, and is subject to frequent overflow during the heavy spring rains. A narrow, sandy ridge, generally a few feet higher than the greater part of this flood plain, extends along the immediate banks of the river, and is not so much subject to overflow as the lower lands farther back from the stream.

However, most of the area has good natural drainage. The rough and hilly country in the southwestern part of the county is drained by the Big Ox Fork and its tributaries. This stream flows across the county in a general northward direction, and empties into the Muscatatuck River. Pigeon Roost Creek, which also has its source in the Knobstone hills, traverses the south central part of the area and empties into Stuckers Fork. The latter stream and its main tributaries, Kimberlins Creek and Big Hog Creek, drain the greater part of the rolling uplands in the eastern and central parts of the area.

The Muscatatuck River, which forms part of the northern and northwestern boundaries of the county, is the principal stream of the area, and receives the drainage waters of almost the entire county.

The approximate glacial boundary of southern Indiana takes in the northeastern two-thirds of Scott County. It is difficult to determine its exact limit, but the ice-sheet is thought to have extended to the Knobstone hills. Although it is believed that a considerable proportion of the surface material covering the greater part of the county is of glacial origin, it is very probable that the material was mainly of local derivation, as no glacial bowlders or fragments of igneous rocks are encountered in the soil.

The geological formations which underlie the area are frequently exposed on the steeper slopes and are seldom at any great depth below the surface. The shales weather rapidly on exposure, and have undoubtedly entered largely into the composition of the various types of soil. The eastern part of the area, including the territory covered by the Volusia silt loam, is underlain by the New Albany black shale, and small, partially decomposed fragments of this rock are frequently encountered in the lower part of the soil section and in the subsoil. These shales, which here form the highest member of the Devonian age, are, in the extreme eastern part of the area, only a few feet thick. They have, however, a general dip to the southwest, and at Scottsburg, in the central part of the county, they attain an estimated thickness of over 120 feet.

A thin layer of limestone, known as the Rockford goniatite limestone, which forms the lowest member of the Lower Carboniferous, sometimes occurs overlying the New Albany black shales, but it has had little, if any, influence on the composition of the soils. Above this layer of limestone, or where the stratum is absent, lying upon the New Albany shales, is a series composed of argillaceous and arenaceous shales and thin layers of sandstone, which belongs to the Knobstone group of the Lower Carboniferous.

The new Providence shales, which occur at the bottom of this group, consist of a soft clay shale of greenish or bluish color. They are estimated to be about 50 feet thick at the southern boundary of the county, but gradually become thinner toward the north. In the northern part of the area it is difficult to distinguish these shales from those occurring just above them. They weather rapidly on exposure and have probably entered into the composition of the soil, though not to so great an extent as the series overlying them.

The Upper Knobstone shales occur just above the New Providence series. They are of a light-gray or greenish color, and grade from a soft argillaceous shale at the bottom to a sandy shale and impure, fine-grained sandstone at the top. Above these shales and forming the upper series of the Knobstone group are alternate layers of more or less pure sandstone and sandy shales. This series is known as the Knobstone sandstone and varies in thickness from about 75 to 100 feet. It occurs capping the higher elevations in the southwestern part of the county, and does not weather so rapidly as the softer shales of the lower series. Embedded in the strata are considerable quantities of iron concretions, which impart a reddish color to the derived soils.

The surface material of the area is, in the main, so similar to that formed by the disintegration of the underlying geological formations that it is difficult to determine what proportion of the soils is derived from material reworked by glacial agencies and what proportion has been derived directly from the decomposition of the rocks.

SOILS.

Four types of soil occur in Scott County. Of these, three are derived from the weathering of the underlying geological formations and glacial deposits. The fourth, occurring in the low, flat bottom lands, is derived from material deposited by the streams, together with that which has been washed down from the surrounding uplands. The following table shows the extent of each of the four types:

AREAS OF DIFFERENT SOILS.

Soil.	Acres.	Per Cent.
Volusia silt loam	46,912	37.1
Scottsburg silt loam	37,184	29.4
Dekalb silt loam	22,080	17.5
Waverly silt loam	20,160	16.0
Total	126,336	....

SCOTTSBURG SILT LOAM.

The Scottsburg silt loam consists of a light to very light ashy gray silt loam, having an average depth of 8 or 10 inches. Small iron concretions are scattered over the surface and through the soil. There is frequently a considerable amount of fine and very fine sand mixed with the silt, which causes the soil to have many of the characteristics of a fine sandy loam. At 10 or 12 inches the soil grades into a light-yellow or slightly mottled silt loam. This becomes gradually heavier and more compact as the depth increases, and at 30 to 36 inches consists of a heavy silt loam of a drab or gray color, slightly mottled with yellow iron stains and usually containing small iron concretions. This soil resembles the Miami silt loam, but the color is lighter.

This type of soil occurs in areas of greater or less extent in almost all parts of the county. A large area is found just west of the town of Scottsburg, occupying that part of the uplands lying between the hills of the southwestern section and the rolling uplands of the eastern part of the area. In the eastern and northeastern sections of the county the areas gradually become smaller, and finally occupy only the small level areas capping the summits of the rolling hills, many of which do not exceed a few acres in extent.

The entire area embraced by this type has the general appearance of having once been a level upland plateau, but it is now intersected by many small streams with wide, shallow valleys. The topography of the broad areas between these streams is flat or very gently rolling, and the slope toward the small watercourses is seldom steep enough to cause the lands to suffer to any great extent from erosion. The topography of the small areas occupying the summits of the rolling hills east and north of Scottsburg is also comparatively level, as the steeper slopes of the rounded hills are usually occupied by the Volusia silt loam.

The numerous small streams that traverse these sections of the area are adequate to carry off the excess water at times of heavy rains, and the type, as a whole, is fairly well drained. Tile drains are seldom used, but a good system of underdrainage has proved of great benefit to this soil wherever it has been established, both in wet and dry seasons. The crops cultivated on this soil are often considerably damaged by droughts, and the better results are nearly always obtained during seasons when the rainfall is greatest.

The areas included in this soil type are underlain by the soft argillaceous and sand shale of the Knobstone series. However, as this section of the area is thought to be within that part of Indiana which was at one time covered by glaciers, it is very probable that a considerable part of the material from which this soil has been formed was deposited through glacial action. As no bowlders or igneous rocks occur in these areas, this glacial material would seem to be chiefly of local origin. The soft underlying shales disintegrate very rapidly wherever they have become exposed, and also have undoubtedly entered largely into the composition of the soil.

Very careful management is necessary to keep this soil in a productive state, and some system of crop rotation is very important, as the continued cultivation of any one crop soon decreases the yields. In order continually to obtain good results, the turning under at least once in every two or three years of clover or some other crop that adds considerable humus to the soil is very essential.

The Scottsburg silt loam is cultivated to corn, wheat, oats, clover, timothy, and tomatoes, and often produces yields equal to those obtained on any other soil type in the area; but when no rotation is practiced and the land has been poorly cultivated, small yields are secured. When properly cultivated, corn yields about 30 bushels per acre. Wheat will average 12 to 15 bushels per acre. Oats, when sown in the spring, average about 25 to 30 bushels, but when put in during the fall months much larger yields are obtained, provided the crop escapes winter killing. Clover and timothy produce about one and one-half tons of hay per acre, while the yield of clover seed ranges from one and one-half to three bushels per acre.

This type of soil seems best adapted to tomatoes, small fruits, vegetables and all early-maturing crops adapted to the climatic conditions of the area. The constant cultivation of the soil necessary in the growing of tomatoes seems to benefit these lands, but if cultivated when in a wet condition the soil dries out rapidly and bakes into clods, and it is difficult to reduce these again to a state of good tilth.

Alfalfa has been successfully grown on limited areas, and experiments have proved that a very fair grade of tobacco can also be produced on this type.

The table following gives the results of mechanical analyses of samples of this soil:

MECHANICAL ANALYSES OF SCOTTSBURG SILT LOAM.

No.	LOCALITY.	Description.	Fine Gravel, 2 to 1 mm., Per Cent.	Coarse Sand, 1 to 0.5 mm., Per Cent.	Medium Sand, 0.5 to 0.25 mm., Per Cent.	Fine Sand, 0.25 to 0.1 mm., Per Cent.	Very Fine Sand, 0.1 to 0.05 mm., Per Cent.	Silt, 0.05 to 0.005 mm., Per Cent.	Clay, 0.005 to 0.0001 mm., Per Cent.
11003	3½ miles N. E. Scottsburg.	Silty loam, 0 to 12 inches..	0.9	3.3	4.1	9.3	9.7	61.8	10.8
11011	2 miles W. of Scottsburg.	Silty loam, 0 to 12 inches..	1.5	2.2	1.7	3.3	6.2	72.7	11.9
11009	1 mile W. of Austin.	Silty loam, 0 to 14 inches..	1.9	4.9	3.8	6.7	8.8	57.6	16.4
11010	Subsoil of 11009..	Silty loam, 14 to 36 inches.	1.6	3.6	3.1	5.6	8.3	59.6	17.9
11012	Subsoil of 11011..	Silty loam, 12 to 36 inches.	.3	1.0	.9	2.2	8.4	69.4	18.0
11004	Subsoil of 11003..	Gray silty loam, 12 to 36 inches.	.8	2.1	2.5	5.9	7.4	59.4	21.8

Dekalb Silt Loam.

The Dekalb silt loam, to a depth of 10 inches, is a silty loam of a gray to light-brown color, becoming light red or yellow at greater depths. The soil is easily eroded and the texture varies slightly according to the steepness of the slopes and the consequent degree of erosion that has taken place. On the steeper hillsides much of the finer material has been washed down to the lower levels and the underlying yellow or red heavy silty loam has become mixed with the coarser material, forming a soil of a more pronounced red to brown color, containing less fine sand.

The subsoil is a heavy reddish to yellow silt loam containing a small proportion of fine sand. It rapidly becomes heavier as the depth increases, and at 30 to 36 inches is a very heavy silt or clay loam, still containing some fine sand, but of a stiff, tenacious character.

Small fragments of chert, limestone, and sandstone are frequently encountered, both on the surface and in the soil. These are the remains of the upper strata of the Knobstone group, which once extended over this part of the area.

The Dekalb silt loam occurs in one large, unbroken area, embracing the whole of the extreme southwestern portion of the county, and extending for some distance along its southern boundary. The topography of the country occupied by this soil is rough and broken. The small streams have cut rapidly through the soft shale, forming deep, narrow valleys. The upper strata of the Knobstone shale and sandstone have not weathered so rapidly as the softer shale beds, and still cap the higher elevations, making the general topographic features consist of a series of isolated knobs and irregular ridges, separated by deep, narrow ravines. The stream valleys widen out as they approach the more level country to the north and east, and the steep, precipitous banks disappear as the adjoining hills become low and more rounded.

Pigeon Creek and Ox Fork have their sources in this part of the area, and these, together with their many small tributaries, furnish the natural drainage system for the surrounding uplands. The land is often excessively drained, and in order to obtain the best results methods for conserving the soil moisture and for protecting the lands against erosion must be used.

Glaciation is thought to have extended to the foothills of the rough and broken country occupied by the greater part of this soil type, and it is very probable that there was a deposition of the finer glacial material over a considerable part of this section of the county. A large precentage of the material from which this soil is formed is derived, however, from the disintegration of the Knobstone shale. As already stated, small fragments of limestone, chert, and sandy shale are often encountered, scattered on the surface and mixed with the soil; and the soft blue argillaceous shale, containing numerous layers of impure chert and flat, oblong, cherty concretions, is frequently found at a very slight depth below the surface. Thin layers of hard brown ferruginous shale, such as form the outer layers of the embedded geodes and ironstone concretions, frequently occur associated with the softer shale or scattered in small fragments on the surface. The characteristic red or yellow color of the soil is due to the oxidation of the large amount of iron contained in the material from which it is formed.

Many of the hillsides, where the topography is most broken, are too steep to be profitably cultivated, and as a whole less of this type of soil has been developed agriculturally than any other soil in the area; but the greater part of these cultivated lands produces very fair yields of corn, oats, wheat, rye, timothy, clover, and tomatoes.

Crops maturing in the late summer often suffer from drought, but under careful cultivation the average yields per acre will compare favorably with those obtained from any of the upland soils. Corn produces, on an average, 25 bushels; wheat, 10 to 15 bushels; and oats, about 20 bushels per acre. Clover and timothy yield from one and one-half to three tons per acre, and a large quantity of clover seed is thrashed each season, the crop averaging about two bushels per acre. Tomatoes are extensively cultivated and yield an average of six tons per acre. The less hilly areas occupied by this type of soil are well adapted to wheat, clover, oats, tomatoes, and timothy, while the rough and hilly sections are well suited to fruit. Large yields of peaches and apples have been continually realized from the small orchards situated on these lands, but many of the trees have recently been injured by disease—a form of leaf blight—which has lessened the crop yields considerably. The thriving condition of a few small vineyards indicates that this soil is excellently adapted to grapes and might be profitably employed for their production on a commercial scale.

The following table gives the results of mechanical analyses of the fine earth of samples of this soil:

MECHANICAL ANALYSES OF DEKALB SILT LOAM.

No.	LOCALITY.	Description.	Gravel, 2 to 1 mm., Per Cent.	Coarse Sand, 1 to 0.5 mm., Per Cent.	Medium Sand, 0.5 to 0.25 mm., Per Cent.	Fine Sand, 0.25 to 0.1 mm., Per Cent.	Very Fine Sand, 0.1 to 0.05 mm., Per Cent.	Silt, 0.05 to 0.005 mm., Per Cent.	Clay, 0.005 to 0.0001 mm., Per Cent.
10983	2 miles S. W. of Leota.	Silty loam, 0 to 12 inches..	0.9	2.9	3.7	13.0	12.1	54.2	13.1
10981	Sec. 13, T. 2 N., R. 6 E.	Silty loam, 0 to 18 inches..	.7	2.8	3.6	7.6	7.2	63.4	14.7
10985	1 mile W. of Leota.	Silty loam, 0 to 14 inches..	.3	1.1	1.3	3.0	4.2	66.5	23.5
10984	Subsoil of 10983..	Loam, 12 to 36 inches......	1.5	3.8	4.8	16.1	12.3	37.9	23.6
10982	Subsoil of 10981..	Heavy silty loam, 18 to 36 inches.	1.2	2.3	7.3	9.9	7.7	47.3	24.2
10983	Subsoil of 10985..	Silty loam, 14 to 36 inches.	.2	1.6	1.4	3.2	5.2	62.8	24.8

WAVERLY SILT LOAM.

The soil of the Waverly silt loam has an average depth of 8 to 10 inches and consists of a gray to light-brown silty loam, which becomes slightly heavier as the depth increases. It contains varying amounts of medium to fine sand and a large quantity of small iron concretions mixed with the soil and scattered over the surface. The soil grades into a heavy silty subsoil of a drab color, usually mottled with yellow iron stains. The sand content of the subsoil decreases with depth and at 36 inches the material is a heavy mottled silty or clay loam, containing a small amount of sand and a large quantity of small rounded iron concretions.

While a typical section of this soil as it occurs over the greater part of the low bottom lands will show a gray to light-brown silty loam containing varying amounts of sand, the texture of the soil is often modified to a considerable extent by local conditions. The areas extending along the smaller streams are influenced by the different geological formations through which the streams have cut their channels and by material washed from the surrounding uplands. Areas of this phase of the soil, such as the one found at the junction of Stuckers Fork and Hog Creek, are usually better drained than much of the type and are not so subject to overflow as the greater part of the bottom lands. The sand content often varies considerably, the texture of the surface soil frequently ranging from sandy to silty within areas less than an acre in extent. These local variations, occurring along the smaller streams in the more rolling parts of the county, are not of sufficient extent to permit the classification of each modification as a separate soil type.

The largest areas of the Waverly silt loam form what is known locally as "The Flats," an area bordering the Muscatatuck River. The type also extends in strips of varied width up the shallow valleys of the other principal streams and their tributaries.

These low flat areas have a very gently rolling or level topography. Occasionally a narrow ridge extends along the immediate banks of the river, and this has an elevation a few feet higher than that of the greater portion of the flat bottoms, while small sandy areas, usually less than an acre in extent, are frequently encountered along the stream. Numerous sloughs, narrow ponds or bayous, old stream beds, and swampy depressions are found scattered over this part of the county. The soil found in these depressions forms the heavier phase of the Waverly silt loam. On drying the surface becomes baked and sun-cracked, causing the soil to be more difficult to cultivate properly than the higher and more sandy areas.

The low-lying position which the Waverly silt loam occupies and the many basin-like depressions lying between the streams and the rolling uplands make the natural drainage very poor. The streams which traverse this type have a very slight fall, and during the heavy spring rains they leave their channels and spread out over the adjoining bottoms. These streams have cut their channels to a sufficient depth below the level of the lands bordering them to admit of ditching and tile draining, and where this is done the lands are in a condition to cultivate soon after the spring floods have subsided. Many of the lower depressions and narrow sloughs would be difficult to drain, but a good system of tile drainage would greatly enhance the agricultural value of the greater portion of this type.

The Waverly silt loam has been formed from material deposited by the streams at times of overflow, mingled in places with material washed down from the surrounding uplands. The coarser material held in suspension by the streams is deposited during overflows near the banks of the main channels, while the silt, clay, and finer sand particles are laid down where the current is more sluggish. The sandy texture of the low ridges that occur near the streams is due to the sorting of the material by currents of varying velocities; but those areas lying nearer the rolling uplands owe their sandy character to material washed down from the neighboring hills. The areas of this type occupying the narrow valleys nearer the sources of the small streams are not as frequently overflowed as the broad, flat valleys near the river, and the soil here owes its origin more to the erosion of the steeper hillsides than to material laid down by the streams during times of overflow.

The agricultural value of these bottom lands depends to a marked degree on the thoroughness of the drainage. The better drained areas along the river and those occupying the valleys in the rolling uplands produce excellent yields of all crops cultivated, while the poorly drained areas in the low depressions, when cultivated at all, are devoted to the production of timothy and other grasses. Where the soil is well drained and properly cultivated, corn produces an average yield of 45 bushels per acre, and 50 to 60 bushels is not an uncommon yield during a favorable season. Wheat produces from 18 to 20 bushels per acre, but is not extensively sown, owing to the liability of the crop to destruction during the spring floods. Twenty-five bushels per acre is the estimated average yield of oats, but owing to the usually wet condition of these lands during the early spring months, oats are seldom grown. Tomatoes on the better-drained areas yield about six tons per acre. Timothy produces two and one-half to three tons of hay per acre, and clover also does well, especially on the low ridges.

The soil is well adapted to corn and timothy. The corn crop is usually planted after the annual spring floods have subsided, and is seldom a failure. Timothy always produces a profitable yield of hay, and is successfully grown on the poorly drained areas. A comparatively large proportion of these flat bottom lands is still covered with a heavy growth of hardwood timber—oak, hickory, and beech.

The straightening of the channels of many of the small streams, a more extensive use of tile drains, and the removal of driftwood and other obstructions from the channels of the larger streams would greatly improve the conditions over much of this soil and increase its value for general agricultural purposes.

The following table gives the results of mechanical analyses of typical samples of the soil and subsoil of the Waverly silt loam.

Mechanical Analyses of Waverly Silt Loam.

No.	Locality.	Description.	Gravel, 2 to 1 mm., Per Cent.	Coarse Sand, 1 to 0.5 mm., Per Cent.	Medium Sand, 0.5 to 0.25 mm., Per Cent.	Fine Sand, 0.25 to 0.1 mm., Per Cent.	Very Fine Sand, 0.1 to 0.05 mm., Per Cent.	Silt, 0.05 to 0.005 mm., Per Cent.	Clay, 0.005 to 0.0001 mm., Per Cent.
10999	Sec. 13, T. 4 N., R. 6 E.	Silt loam, 0 to 8 inches.....	1.2	2.2	1.1	3.4	5.6	67.6	18.5
10997	Sec. 7, T. 4 N., R. 7 E.	Silt loam, 0 to 10 inches....	.2	.6	.4	3.2	7.0	70.0	18.7
10995	2 miles E. of Scottsburg.	Heavy clay loam, 0 to 8 inches.	.4	1.3	1.0	3.2	5.2	51.5	37.4
10998	Subsoil of 10997..	Heavy silty loam, 10 to 36 inches.	.4	.8	.5	2.2	11.2	66.8	17.9
11000	Subsoil of 10999..	Heavy silty loam, 8 to 36 inches.	1.1	2.6	1.3	3.0	4.3	66.9	20.7
10996	Subsoil of 10995..	Gray clay loam, 8 to 36 inches.	.5	1.0	.7	2.5	6.9	54.1	34.1

Volusia Silt Loam.

The Volusia silt loam is the most important upland soil in the area. It covers the greatest extent of territory and is recognized as well adapted to general farming purposes. The best developed and most profitable farms in the area are situated on this type.

The soil is a light-brown silty loam, often containing considerable fine sand. When dry the surface has a gray appearance, but the color changes to light brown or red as the subsoil is approached. The soil has an average depth of 8 to 10 inches, and the texture becomes slightly heavier with increased depth. Small iron concretions occur both on the surface and throughout the soil. The soil grades into a subsoil of light-red to yellow heavy silt loam, containing a small percentage of sand and rapidly becoming heavier and stiffer as the depth increases, until in the lower 10 or 12 inches of the profile is found a heavy silt loam, stiff and compact, but seldom containing a sufficient amount of clay to give it a sticky or tenacious character. As the underlying shale is approached the material becomes yet more stiff and compact, and at from four to five feet below the surface it is a very heavy silt or clay loam, with a very low sand content.

The Volusia silt loam covers the greater proportion of the eastern part of the county. Approached from the west, it first appears as narrow areas extending along the steeper slopes of the rounded hills, but these areas rapidly broaden out and finally cover the entire rolling upland, except where the Scottsburg silt loam occurs capping the higher elevations.

The topography of this type of soil is quite rolling. The hills are low and rounded and slope gently to the broad, shallow stream valleys. In the extreme eastern and northeastern sections the surface is slightly more broken, the hillsides are steeper, and the intervening valleys become more narrow and V-shaped. These steeper slopes suffer greatly from erosion, and the red or yellow silt loam of the upper subsoil is frequently exposed on the surface, or has been washed down and mixed with the soils occupying the lower levels, giving the latter a red to brown tinge.

These lands are very well drained by the natural drainage system furnished by the rolling topography and numerous small streams—are frequently too well drained, in fact, for the successful cultivation of many crops.

It is generally believed by geologists who have made a study of this area that the glacier once covered the section of Scott County occupied by the Volusia silt loam, and that a deposit of glacial drift was laid down over the older geological formations. The material composing this soil contains no glacial bowlders or other evidence of having been transported from other localities by glacial agencies, and the drift seems to be mainly of local origin. The black shale, which is encountered at a depth of from 3 to 30 feet below the surface, forms by disintegration a light-brown to red silty material similar to that found in the overlying soil. This shale is frequently exposed in cuts and along the steeper hillsides, and has entered largely into the composition of the soil. The shale has embedded in it a large quantity of rounded iron concretions, and it is probably to the weathering of these that the derived material owes its red or yellow color.

In the central part of the county the Volusia silt loam is found along the steeper hillsides, where the erosion has been greatest and where outcrops of the underlying shale are frequently encountered.

During a season of average rainfall and where the soil has not suffered from the effects of erosion, profitable yields of corn, wheat, oats, clover, timothy, and tomatoes are produced. Corn yields from 30 to 35 bushels; wheat, 15 to 20 bushels; oats, about 25 bushels, and clover, one to two tons of hay and about two and one-half bushels of seed per acre. Timothy is not as extensively grown on this soil as on some of the other upland types, but will yield about one and one-half tons of hay per acre. The yield of tomatoes is about six tons per acre.

There are a few farms on this soil which give larger yields than the above year after year. The difference is due to more thorough cultivation, a rotation of crops, and more careful soil management generally. Potatoes and other vegetables are grown on this soil to a limited extent for the local markets, and excellent yields are obtained. In general, the soil of this type is well adapted to general farming, and all crops cultivated in the area can be successfully grown upon it.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

MECHANICAL ANALYSES OF VOLUSIA SILT LOAM.

No.	LOCALITY.	Description.	Gravel, 2 to 1 mm., Per Cent.	Coarse Sand, 1 to 0.5 mm., Per Cent.	Medium Sand, 0.5 to 0.25 mm., Per Cent.	Fine Sand, 0.25 to 0.1 mm., Per Cent.	Very Fine Sand, 0.1 to 0.05 mm., Per Cent.	Silt, 0.05 to 0.005 mm., Per Cent.	Clay, 0.005 to 0.0001 mm., Per Cent.
10993	2½ miles S. of Lexington.	Brown silty loam, 0 to 12 inches.	0.5	2.8	7.0	6.3	4.2	67.5	11.6
10989	4½ miles E. of Scottsburg.	Brown silty loam, 0 to 18 inches.	1.9	3.5	3.4	7.3	8.2	60.2	14.9
10991	2 miles N. E. of Lexington.	Silty loam, 0 to 10 inches..	.5	2.1	3.0	7.4	6.7	62.6	17.7
10990	Subsoil of 10989..	Heavy silty loam, 18 to 36 inches.	1.7	3.4	2.6	5.3	6.4	60.5	20.1
10994	Subsoil of 10993..	Heavy silty loam, 12 to 36 inches.	.3	1.8	2.8	3.3	4.3	63.5	23.8
10992	Subsoil of 10991..	Clay loam, 10 to 36 inches	.6	2.3	3.0	7.1	8.5	50.9	27 5

AGRICULTURAL METHODS.

A large amount of commercial fertilizer is applied annually to the soils of Scott County, but where modern and improved methods of farming are in use the soils retain their productivity and profitable yields are continuously obtained with the application of a minimum amount of fertilizer.

Some system of crop rotation is necessary on all the soils of the area in order to obtain good results, and rotation, which has been practiced for some time by the more successful farmers, is now coming into general use. The wheat lands are usually plowed in the late summer or early fall and are rolled and harrowed from three to four times before the wheat is drilled in. The crop is sown during September or October and is harvested about July 1. Oats are often cultivated in much the same manner, but when drilled in during the fall months a profitable yield is very uncertain. If the winter is unusually mild, larger yields are often obtained from the winter oats than from those drilled in during the spring months, but the uncertainty involved in this method causes it to be seldom practiced. The oats crop is put in as early in the spring as the usual wet condition of the soil permits. The lands are given a rather shallow plowing, and then harrowed and dragged. After the seed is put in the fields are again harrowed.

In growing corn and tomatoes, level cultivation is not generally practiced, but where this method has been used on the upland the best results have been obtained, as the soils retain a larger amount of moisture and the crops suffer less from the effects of the summer drought. The lands cultivated to corn are plowed as early as the season permits. The fields are then harrowed and dragged till the clods are broken up and the soil is in a thoroughly pulverized condition. The fields are usually "checked off" by shallow furrows crossing each other at right angles, so that the crop may be cultivated both ways. Corn is planted from the latter part of April to the first of June and is harvested in September. The soil is prepared for the tomato crop in much the same way as for corn. The tomato seed is first sown in beds about the last of March, and the young plants are taken up and set out by hand during the latter part of May or early in June. Level cultivation for this crop, especially where grown on the Scottsburg silt loam, has been very successfully practiced.

The agricultural value of the poorly drained areas occupying the flat lowlands along the more important streams has in many places been greatly increased by the establishment of a good system of tile drainage. The greater part of these lands has a sufficient elevation above the level of the streams to permit tile to be laid from three to four feet below the surface and still have a sufficient fall to the stream to insure good drainage. The average cost per acre for tiling these lowlands is estimated at about $18.

Clover is extensively cultivated on the steeper hillsides of the rolling uplands as a means of checking the excessive erosion to which these soils are subject. Where the greater part of the upper soil has been washed down to the lower levels, leaving the subsoil exposed on the surface, an application of barnyard manure is often necessary in order to get a stand.

Agricultural Conditions.

As pointed out in the paragraphs devoted to the history of the county, its agricultural development has progressed very slowly, and it is only in recent years that the cultivation of the land has received the whole attention of the farming class. The area was originally covered by a heavy growth of timber, and the principal occupation of the rural population was the cutting of timber for crossties and staves. As the lands were cleared and the timber became less plentiful more interest was taken in farming, and within the last fifteen or twenty years the condition of the farming class has steadily improved and the value of cleared lands has greatly increased. Few of the farmers in the area are wealthy, but the majority are practically free from debt, and as a whole are in a very prosperous condition. The introduction of crop rotation and other improved methods of farming, together with a demand for the general farm products at good prices, have been the principal causes of the present favorable status of the agricultural class, which is most marked in the eastern part of the county, where the lands have been longer under cultivation and the people have depended for a longer period on the products of the farm rather than on those of the forest as their principal source of income.

About 64 per cent. of the farms in Scott County are operated by the owners. The remainder are rented, either for a share of the products or for cash. The owners of the farms on the low river flats also own and cultivate small areas in the neighboring uplands, where they make their homes. The swampy condition of the lowlands and the fact that they are subject to annual overflow make it undesirable to live in this section of the area.

There are a few large landholders in the county who cultivate farms of several hundred acres, but the average size of the farms is approximately 89 acres. The total area in farms is about 113,578 acres, over half of which is at present improved.

Aside from those owning land, the farmers of Scott County are either renters or "tenants" on the farms of the larger landholders. The "tenant" receives a fixed sum, usually about $25 a month, and is entitled to no part of the crop produced. The landowner furnishes the land, farm buildings, work animals, farming machinery, seed, and fertilizers, and receives the entire crop yield. Lands are seldom rented on a cash basis except in small tracts for the production of tomatoes, in which case the rate varies from $3 to $10 an acre. When rented on shares the owner furnishes only the land and farm buildings and receives one-third to one-half of the corn, wheat, and oats, and three-fifths of the clover and timothy produced.

An excellent class of white labor was once abundant throughout the county, but in recent years, as the agricultural interests of the county have rapidly developed, the demand for intelligent farm hands has greatly increased, and efficient labor is often scarce during harvest. The wages paid during the harvest season range from $1 to $1.50 a day, but when employed by the month or for longer periods the average farm laborer receives about $20 a month and board.

The principal products of Scott County are corn, wheat, oats, timothy, clover, and tomatoes. A small acreage is also cultivated to potatoes and other vegetables. In 1900 the total corn crop was estimated at 407,920 bushels, being an average yield of about 23 bushels per acre for the entire acreage in that crop. The corn crop is seldom a failure, either on the uplands or river flats, and where a good system of rotation is practiced a very profitable yield is always obtained on any of the soil types of the area. Wheat is extensively cultivated over the entire upland section of the county, and, although the acreage devoted to this crop has decreased in the last three years, it is still more widely cultivated than any other crop produced in the area, with the exception of corn. In many localities the wheat crop during the past two or three seasons has been almost a total failure. This has been due to the damage done by the Hessian fly and rust. The result has been a decrease in the acreage devoted to wheat and an increase in the acreage of oats and rye.

Both clover and timothy are successfully grown in all sections of the county, each yielding annually from 5,000 to 7,000 tons of hay. Clover is always included in the crop rotation practiced on the rolling uplands, as it aids materially in checking the excessive erosion common to this portion of the area, and in restoring the lands to their former state of productiveness.

The growing of tomatoes has become one of the most important special industries of the county, and the number of acres cultivated to this crop is yearly increasing. In the county there are six canning factories, which are supplied by the surrounding country. The annual output of each factory is estimated at about 400,000 cans.

A large number of hogs are raised in the county, and a few farmers own a sufficient number to enable them to ship carload lots to the more distant markets. Very few cattle, however, are raised for shipment, and the small shipments sent to the larger markets are usually gathered from all parts of the county. The raising of poultry for shipment to the eastern cities is at present a very profitable industry throughout the county, and large quantities of both chickens and eggs are annually sent out.

The Waverly silt loam is the principal corn soil of the county, as, owing to its annual flooded condition, a profitable yield of any of the other staple crops is very uncertain. The corn crop is planted late in the spring and is less liable to damage by floods than wheat or oats. The annual deposition of new material over these lands during periods of inundation, together with that washed from the surrounding hills, causes them to suffer very little if any from the continuous cultivation of one crop.

Wheat, oats, rye, and clover are well adapted to the Volusia silt loam, and if properly cultivated produce large and profitable yields. These crops are also successfully grown on the more rolling sections of the Dekalb silt loam, and in a wet season or on small areas where the drainage is not excessive they will produce yields equal to those obtained on any other soil type of the area. The rougher and more broken sections of the Dekalb silt loam is best suited to apples, peaches, and grapes. There are at present a few small vineyards in this part of the county, and there has been a ready market for their products. The small orchards have received very little attention, and although large yields are annually obtained, no attempts have been made to raise fruit for other than the local market.

Timothy is extensively grown on the poorly drained areas of the Waverly silt loam and produces larger yields than are obtained on the uplands.

The tomato seems best suited to the Scottsburg silt loam. While the growth of the plant is not as vigorous as on some of the lowland soils, a larger yield per acre is always realized.

Alfalfa has been successfully grown, both on the level uplands and stream bottoms, but no attempts have been made to cultivate more than a few small isolated areas to this crop. Sorghum cane has also been grown as a forage crop on some of the soils and excellent results have been realized.

A small amount of tobacco, chiefly of the heavy export type, has been raised in the county, and the yield and price obtained for the crop indicate that its production could be made a very profitable industry in the area.

Two railroads enter the county, one traversing the west-central and the other the eastern part. These furnish a means of rapidly transporting the products of the county to markets situated at a distance. No section of the county is more than six to eight miles distant from a local shipping point on one or the other of these railroads.

A well-kept system of public roads extends over the county, connecting Scottsburg, Austin, and Lexington, the most important shipping points, with all sections of the surrounding country. Many of these roads are constructed from the hard black shale and limestone which underlie the eastern part of the county, and traffic over them is seldom impeded even during the worst seasons of the year. Iron bridges have also been constructed over the small streams on every important county road.

Scottsburg and Lexington are the local markets for most of the products of the county. The corn not consumed by the local hominy factories is marketed at Cincinnati or Indianapolis, while the wheat and other products exported are shipped to Cincinnati, Chicago, Louisville, and Indianapolis. The entire crop of tomatoes is taken by the local canning factories.

The situation of the area near many of the largest markets and the shipping facilities afforded by the railroads permit those products of the area that are not consumed at home to be placed on the markets in the larger cities in a short time and at a very small cost, and this fact favors the extension of other special crops, such, for instance, as the fruits already indicated as suited to certain soil conditions, but at present produced only on a small scale.

Soil Survey of Posey County, Indiana.

By Herbert W. Marean.
U. S. Bureau of Soils.

LOCATION AND BOUNDARIES OF THE AREA.

Posey County is situated in the extreme southwestern corner of the State of Indiana. It is bounded on the south by the Ohio River, on the east by Vanderburgh County, on the north by Gibson

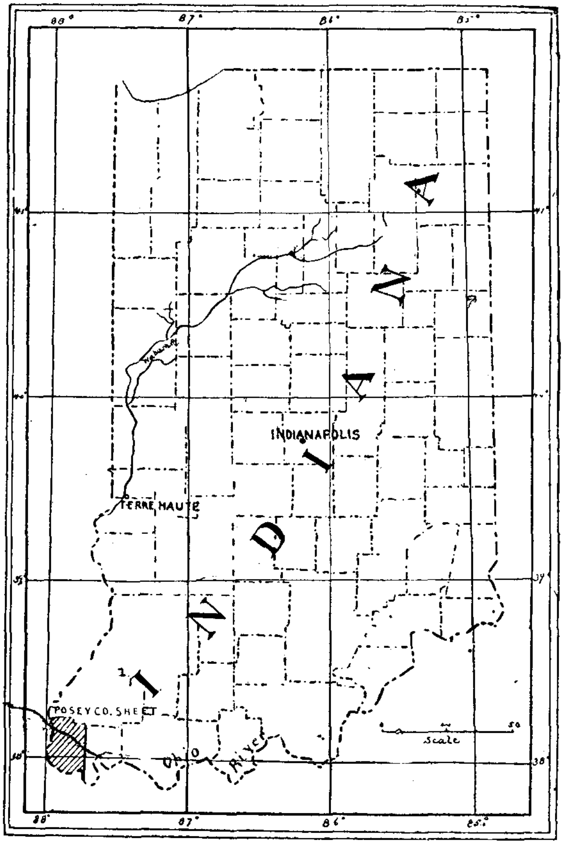


Fig. 12.—Sketch map showing area surveyed in Indiana.

County, and along its entire western border flows the Wabash River. The county has a population of about 23,000, composed mostly of whites, though there is a small colored population along the southern boundary. Mount Vernon, the county seat, is situated in the middle southern part of the county, on the Ohio River. It has a population of about 5,000. New Harmony and Poseyville rank next in size and importance. Good transportation facilities are afforded by the three lines of railroad which cross the county, while the Ohio River furnishes easy means of traffic by water.

History of Settlement and Agricultural Development.

Little is known of the conditions existing in this part of the country previously to the advent of the white settlers. There are evidences, however, that point to the fact that the territory was held by the Pottawatomi and Wea Indians. The first settlers came from North Carolina and Tennessee in the year 1809. A number of German families from Pennsylvania also settled in the county, and today the German element constitutes a thrifty and prosperous community in the eastern part of the county. These pioneer farmers established their homes on the sandhills and ridges, where springs afforded an adequate supply of water, above the unhealthful influences of the swampy lowlands. Agriculture at this early day was necessarily primitive and conducted upon a small scale. A few acres of cleared land sufficed for the needs of the family, and rude log huts were their dwellings. Crude implements were employed in the cultivation of meager crops of corn and wheat. These were the principal products, with small quantities of cotton and hemp which served to furnish their clothing. Some of the best lands of the county were then in a swampy condition and have more recently been developed by improved methods of drainage. Conditions gradually improved, and through a recognition of the fertility of the soil and the advantages derived from reclaiming swamp lands, agriculture in the county was given an impetus which has lasted to the present time, and today Posey County is one of the richest farming districts in Indiana. At least two-thirds of the county has been cleared and put under cultivation since 1860. Prominent among those who took an active part in the development of the county and the administration of its affairs were the Rapps, the Owens, and Thomas Posey. The last mentioned was Governor of the Territory of Indiana previously to its admission as a State, and Posey County was named in his honor. The county was organized in September, 1814, when by an act of the Legislature, Posey County was formed from parts of Gibson and Warrick counties. In December, 1818, Vanderburgh was formed from parts of Gibson, Warrick, and Posey, when the present boundaries of the county were permanently fixed.

CLIMATE.

Mount Vernon, situated on the Ohio River, is the only station of the Weather Bureau in Posey County, but the records of temperature and rainfall kept by that station are quite fragmentary and no normals have been established. The nearest stations outside the county for which normals have been established are Evansville, situated on the Ohio River and in about the same latitude as Mount Vernon, though 20 miles farther east, and Princeton, the county seat of Gibson County, the next county to Posey on the north, and about 15 miles north of the county line. The table given below contains data drawn from the records of these two stations. It is believed that they fairly represent the conditions of the area surveyed.

Normal Monthly and Annual Temperature and Precipitation.

	Evansville.		Princeton.	
	Temperature.	Precipitation.	Temperature.	Precipitation.
January	35.4	3.41	30.7	2.96
February	32.3	2.98	32.9	3.23
March	44.6	4.84	42.3	4.33
April	57.0	3.55	54.7	3.37
May	67.0	4.38	64.1	3.67
June	76.3	4.67	74.6	4.35
July	79.6	3.54	76.9	2.83
August	78.4	2.09	75.1	2.64
September	71.9	2.48	68.2	3.16
October	59.2	2.87	55.4	2.16
November	45.0	3.67	42.9	3.82
December	35.8	3.02	35.3	3.15
Year	56.8	41.50	54.4	39.67

The frost records kept by the station at Mount Vernon are more complete. The occurrences of the last killing frost in spring and first in fall during the last nine years are given in the following table:

Dates of Killing Frosts.

Year.	Last in Spring.	First in Fall.
1893	March 29	October 29
1894	May 19	....
1895	May 14	October 1
1896	April 4	October 19
1897	April 20	October 29
1898	April 7	October 27
1899	April 10	Sept'ber 27
1900	April 12	Nov'ber 8
1901	April 21	October 17
Average date	April 17	October 20

From the above table it appears that, at least along the Ohio River, there is an average period of one hundred and eighty-six days during which tender vegetation is safe from damage by freezing. This period is probably subject to local variation, due to differences of elevation or other physiographic features.

Physiography and Geology.

Posey County lies in the point between the Ohio and Wabash rivers at their confluence, and these streams form the natural boundaries of the county, as well as of the State, on the south and west. The flood plains of these two rivers form together one of the two main physical divisions into which the county naturally divides itself. The width of the river bottoms varies from a few rods to four or five miles. The topography of these bottoms is generally level; sometimes very gently undulating, with depressions or sloughs alternating with low ridges that are apt to be sandy in nature. Two or three low but distinct terraces can be observed in crossing from the banks of the stream to the bluff which separates the river bottoms from the upland. These terraces mark successive stages in the erosion of the river valley, and a change of soil type is likely to be encountered as one passes from a lower to higher flood plain. Thus in Point Township the lower plain along the Ohio and Wabash rivers is occupied by the Yazoo clay, while in ascending a bluff 10 or 15 feet high we come upon the Guthrie clay, occupying an older flood plain formed by the combined action of the two rivers. So also in the region east of Mount Vernon the lower bottom is occupied by recent sediments, while rising 25 feet above this is a level area which is now covered by Waverly silt loam, but wnich was once formed as an alluvial plain of the Ohio. The original soil of this older bottom can be seen in deep stream cuts underlying the deposit of loess, from which, by weathering, the present soil has been derived.

The rise from the river bottoms to the uplands varies greatly in abruptness. Along the Wabash, especially where the bottom is narrow, the ascent takes the character of a steep bluff, rising in some instances to an altitude of 150 feet above the river. In the south, however, along the Ohio River, the slope from the bottoms to the upland is more gradual. Again, in the eastern border of the county a bold bluff separates the two physiographic features of the county.

The general character of the surface in the upland may be described as undulating. Low, rolling hills, descending with symmetrical curves to the broad stream valleys, with here and there a wooded slope, combine to form a scene most pleasing to the eye. The general slope of the country is toward the southwest. A large part of the upland is drained by Big Creek and its tributaries, emptying into the Wabash west of Upton. The Black River drains a narrow belt on the north, and in its lower course, where it joins with the broad Wabash Valley, it has cut off a portion of the upland which rises in an isolated mesa-like plateau 50 or 75 feet above the surrounding valley. A few minor streams in the south empty directly into the Ohio River.

Underlying the soils of the whole county are found rocks belonging to the Carboniferous or coal-bearing group. These rocks, which are usually shales or shaly sandstones, are met at an average depth of 20 feet. Deep road cuts sometimes reveal the disintegrating shale with loess lying unconformably above it. Along the river bluffs, near the eastern border of the county, outcrops of an impure limestone are to be found. Inasmuch as all these rocks are covered by a deep coating, either of loess or river sediment, they have had no direct influence upon the formation of the soils. But there is an intimate relation between the soils of the county and Pleistocene geology. The invasion of the ice-sheet which took place in the beginning of the Quaternary era reached to the southern part of Indiana, and traces of it are to be found in the northwestern corner of Posey County. Wells dug in the neighborhood of Poseyville pass through a stratum of granitic gravel which is unmistakably of glacial origin, and in other places in Robb and Harmony townships glacial till underlies the deposit of loess. Evidences of glacial action are also to be seen in the physiography of this section. The level-topped plateau previously mentioned, which lies just north of Griffin, is plainly a "glacial bench" formed by the glacier as it passed over this hill and planed off the overlying softer beds, leaving the nearly level surface of the harder strata to form an isolated tableland. Throughout the valley of the Black River, and to a less extent in the Wabash bottom, granitic and other crystalline gravels are found, indicating that these recent sediments may be composed largely of reworked glacial material.

SOILS.

The soils of Posey County present many interesting problems to the student of agriculture. Though not differing greatly in native fertility, they show an unusual degree of variation in their physical properties. In a limited area are to be found five or six distinct types and phases of soil, each with its own peculiar relation to the quality and quantity of crops.

The soils naturally divide themselves, according to the two main physiographic features, into the upland types and the river-bottom types. There are four upland types; Miami silt loam, Waverly silt loam, Miami sand, and Memphis silt loam. The river-bottom types, including soils occurring on the level flood plains of the Ohio, Wabash, and Black rivers, are seven in number: Yazoo clay, Guthrie clay, Yazoo loam, Miami fine sandy loam, Yazoo sand loam, Miami sandy loam, and Griffin clay.

The following table shows the extent of each of the several soil types:

Soil.	Acres.	Per Cent.
Miami silt loam	149,376	60.3
Yazoo clay	30,720	12.4
Waverly silt loam	16,384	6.6
Guthrie clay	14,592	5.9
Memphis silt loam	9,408	3.8
Yazoo loam	8,320	3.4
Miami sand	7,680	3.1
Miami sandy loam	3,584	1.4
Miami fine sandy loam	3,456	1.4
Yazoo sandy loam	2,752	1.1
Griffin clay	1,600	.6
Total	247,872	

Miami Silt Loam.

This is a soil of remarkable uniformity. Over the large area which it covers it maintains a nearly constant character with only minor variations due to the physical features of the land. The soil is typical of a silt loam. Fine sand is present to a considerable degree, but the percentage of coarse sand is very small. When wet it possesses a certain degree of plasticity, but when dry it is open and friable, crumbling into a loamy mass under cultivation. The surface soil is a light gray or reddish yellow. The more open portion of the soil, which constitutes the soil proper, extends to a depth of about nine inches. Lying below this is found a more plastic silt loam of a light-red or yellow color, and this is in turn underlain at 14 to 15 inches by rather heavy, tenacious silt loam of a claylike nature. This heavier subsoil contains more clay particles and less of the fine sand groups, but, as will be seen by the accompanying mechanical analysis, silt still predominates. The subsoil in some cases descends with little variation to a depth of 10 or 20 feet, but as a rule deep cuts reveal a change occurring at about five feet below the surface. At this depth the red claylike material grades into an incoherent yellow silt, which in some cases shows traces of stratification.

The Miami silt loam is by far the most extensive soil in Posey County, covering more than half the total area. It is found in every part of the upland region, where it occupies all the various features of topography. In general, however, the country over which it extends presents a moderately rolling surface. Little or none can be called rough or broken, although along the eastern border the aspect of the country approaches this condition. In some localities the soil lies almost perfectly level, and here is found a phase varying somewhat from the type. The surface is light gray, and mixed with the soil are small nodules of concretionary iron oxide. The soil in these places is deeper than on the ridges, and the subsoil is generally lighter in shade, indicating a lower degree of oxidation of the iron salts.

In the southwestern part of the county, where this type borders the Guthries clay, and also in the region west of Mount Vernon, a phase of the Miami silt loam is found which is deserving of attention. The soil here is rather mixed; small, sandy patches are found occupying low ridges or knolls, and where they are sufficiently extensive are indicated on the soil map as areas of another type. Other patches are found occupying little depressions, and here the soil is of a whitish color with a mottled clay-like subsoil. The phase has arisen as a result of wet conditions that have prevailed, consequent upon the low-lying, level position of the soil.

The origin of the Miami silt loam explains its uniformity of character and its wide distribution. It is composed of material known to geologists as loess. This material is supposed to be of glacial origin, brought down by the ice-sheet in the great Ice Age of North America. Though there is little difference of opinion as to its origin, the manner in which it was deposited is still a matter of controversy. Some believe it to have been deposited in the shallow waters of a great inland sea, which they suppose to have covered a vast area in the Mississippi Valley at that period. Others think the deposits should be attributed to aeolian agencies; that the winds blowing across the ice covered with earthly debris and over the deposits of till, unprotected by vegetation, bore away the finer particles of dust and dropped them over the region farther south.

It is easy to see that a soil derived from so wide a source will possess much of the natural fertility that we find in alluvial soils. It is not apt to lack any of the essential ingredients of plant food, and in its physical properties it will be well adapted to widely varying agricultural products. Such is the case with the Miami silt loam. Wherever found it is a fertile soil, producing good yields of wheat, corn, and clover, and timothy hay—the staple products—together with some fruits and garden vegetables that are raised for home use. The average yield of wheat is 20 bushels per acre and of corn 35 or 40 bushels, while in favorable seasons 25 or 30 bushels of wheat and 50 bushels of corn are produced per acre. Some strawberries and other small fruits are grown in the vicinity of the larger towns and yield good returns. A number of Kiefer pear orchards are found on this soil, but apples seem to be the fruit best of all suited to the soil and climatic conditions.

The following table gives mechanical analyses of the soil and subsoil of this type:

MECHANICAL ANALYSES OF MIAMI SILT LOAM.

No.	Locality.	Description.	Organic Matter, Per Cent.	Gravel, 2 to 1 mm., Per Cent.	Coarse Sand, 1 to 0.5 mm., Per Cent.	Medium Sand, 0.5 to 0.25 mm., Per Cent.	Fine Sand, 0.25 to 0.1 mm., Per Cent.	Very Fine Sand, 0.1 to 0.05 mm., Per Cent.	Silt, 0.05 to 0.005 mm., Per Cent.	Clay, 0.005 to 0.0001 mm., Per Cent.
7122	3 miles W. of Mt. Vernon.	Silty loam, 0 to 8 inches	1.49	0.00	0.44	0.40	0.78	3.76	85.20	8.62
7120	1 mile N. of Mt. Vernon.	Coarse silty loam, 0 to 8 inches.	2.47	.00	.14	.08	.36	3.86	81.82	13.68
7124	7 miles E. of Mt. Vernon.	Silty loam, 0 to 7 inches	1.90	.56	2.10	1.56	4.30	10.90	62.28	17.36
7121	Subsoil of 7120.	Heavy silty loam 8 to 36 inches.	.34	.00	.10	.12	.50	5.92	84.16	9.10
7123	Subsoil of 7122.	Heavy silty loam 8 to 36 inches.	.49	Tr.	.32	.18	.42	5.78	70.34	22.26
7125	Subsoil of 7124.	Heavy silty loam 7 to 36 inches.	.47	.30	1.58	1.12	2.46	6.20	54.68	33.30

WAVERLY SILT LOAM.

The Waverly silt loam is the soil locally known as the "black bottoms." The soil is a mellow, black loam, plastic when wet but loamy and easily tilled. It becomes heavier at a depth of seven or eight inches, and the black loam is underlain at a depth of from 10 to 20 inches by a yellowish or drab clay loam, plastic and tenacious. This subsoil contains more silt than true clay, but it possesses the characteristics of a clay loam. The black color of the soil is due to the presence of organic matter, which also gives the soil a very desirable tilth when cultivated. In some instances there is little change in the appearance of the soil to a depth of 20 inches or more.

The total area of Waverly silt loam is comparatively small, but it ranks third in agricultural importance. It covers in all about 25.6 square miles, or 16,384 acres. It occurs in nearly all parts of the county, but the principal areas occur in the neighborhood of Poseyville, at the northern border of the county, and in the vicinity of Mount Vernon in the south. Small, scattering areas occur throughout the upland region, and there are a few patches along the bottoms of the Wabash and Black rivers. In the Poseyville and Mount Vernon areas, where it is most typically developed, the soil occupies level or gently sloping topography. Along the Wabash bottoms it is sometimes found as a gently sloping talus at the foot of the river bluffs, and here it is more sandy than the typical soil. In other localities it occurs in minor depressions, where the poor drainage has given rise to marshy conditions and allowed considerable amounts of humus to accumulate. A small area in the valley of the Black River differs from the type in being of a heavier and more claylike character. This phase possesses a very heavy, tenacious, drab clay subsoil and is commonly characterized by a slight admixture of coarse sand and rounded gravel in the soil.

There is an intimate relation between the origin, physiography and drainage of the Waverly silt loam. With the possible exception of the small area found in the Black River valley, which may be in part alluvial, the soil is of loess material. In the Poseyville area it lies in the broad, level upland valleys that resemble old lake floors. The material forming the mineral portion of the soil was deposited at the same time and probably in the same manner as the loess of the surrounding uplands. But the low-lying areas, now occupied by the black soil, were covered by shallow, stagnant water, or by bogs and swamps, and fallen limbs and leaves of trees and decaying swamp vegetation added to the soil the supply of humus which gives it the black color and loamy tilth which it now posesses. Silt was also sifted in by washing from the uplands while this swampy condition prevailed, for the organic matter did not accumulate as a layer of peat, but was thoroughly mixed with soil particles. Subsequently, through natural process of erosion and by artificial means, these lands have been drained and today form one of the most highly valued soils of the area.

Considerable ditching and tile drainage is practiced in areas of this soil, and always with good results.

In the southern part of the area, east of Mount Vernon, the soil also occupies a level position. Here it lies upon an old Ohio River terrace, where a coating of loess covers the clay loam of the ancient river flood plain to a depth of 20 feet or more. The southern boundary of this area is a bluff with a descent of 25 to 30 feet to the present river bottom. As there is no barrier which might have held back the surface water from draining into the Ohio River, the imperfect drainage which produced marshy conditions must have been due to level topography and the texture of the soil. Upon this old terrace the soil grades by degrees into the Miami silt loam, and no sharply defined boundary between the two types is found.

In agricultural importance the Waverly silt loam stands next to the Yazoo clay. It is well adapted to all the crops now grown in the county. The average yield of corn is 50 bushels per acre;

of wheat, 25 bushels; while clover crops yielding from one-half to two tons of hay per acre are cut, with a second cutting of seed. Some fruit and vegetables are grown, but only on a limited scale and for home consumption. The soil is well adapted to the production of timothy hay, and yields of from one to one and one-half tons per acre are average crops.

The texture of this soil is shown by the mechanical analyses given in the following table:

MECHANICAL ANALYSES OF WAVERLY SILT LOAM.

No.	LOCALITY.	Description.	Organic Matter, Per Cent.	Gravel, 2 to 1 mm., Per Cent.	Coarse Sand, 1 to 0.5 mm., Per Cent.	Medium Sand, 0.5 to 0.25 mm., Per Cent.	Fine Sand, 0.25 to 0.1 mm., Per Cent.	Very Fine Sand, 0.1 to 0.05 mm., Per Cent.	Silt, 0.05 to 0.005 mm., Per Cent.	Clay, 0.005 to 0.0001 mm., Per Cent.
7132	2 miles E. of Mt. Vernon.	Silty loam, 0 to 10 inches.	3.56	0.10	0.44	0.24	2.10	10.68	74.78	11.48
7134	4 miles E. of Mt. Vernon.	Loam, 0 to 12 inches...	2.77	.20	.50	.24	1.14	5.78	78.44	13.68
7133	Subsoil of 7132.	Sticky silty loam, 10 to 36 inches.	1.61	.12	.52	1.00	4.18	8.56	71.28	14.30
7135	Subsoil of 7134.	Clay loam, 12 to 36 inches.	1.35	.40	.60	.30	.88	4.98	78.38	14.36

MEMPHIS SILT LOAM.

The Memphis silt loam is an upland type, sometimes called the "gray bottom," or made land. The soil is a brown or yellowish-gray silt loam 10 or 12 inches in depth, underlain by silt of a mealy texture. It differs in texture from the other silt soils of the area in that it lacks the plasticity that they usually possess, resembling in this respect very fine sand. As a rule, the soil varies but little in texture to a depth of three or four feet, although the upper foot is usually of a more loamy nature, due to the effects of cultivation.

This soil is found occupying the narrower stream valleys in the upland portion of Posey County. No large areas of it occur, but it extends in narrow strips, from 200 to 500 yards wide, along the edges of the upland streams. The most extensive of these belts is that along the Big Creek bottoms in the eastern part of the county. Other narrower belts are found throughout the territory occupied by Miami silt loam, and occasionally these extend for a short distance into the river lowlands.

The soil lies in a nearly level position, forming the flood plain of the stream to whose agency it owes its origin. These flood plains are subject to frequent overflow, and the land is generally inclined to be wet and in need of drainage. Where the bottom is narrow, a common method of drainage is employed in which the stream channel is deepened and straightened. If the flood plain is broader, a more adequate method is to lead lateral lines of tile into this central ditch.

As we should expect, this soil, derived by stream sedimentation from fertile upland soils, is a strong and productive type. Corn is the crop chiefly grown and the one to which the conditions are best adapted. The yields average about 50 bushels per acre. The low-lying position of the soil and its favorable texture give to it the desirable property of resisting drought. In a country where late droughts are liable to reduce the corn yield this characteristic greatly enhances the value of the soil. The Memphis silt loam is also an excellent grass soil, and wheat does fairly well upon it. Sorghum is raised, but only to a limited extent, for the production of sirup for domestic use, and though it does well on this and other soils, it can not compete with corn and grass.

MIAMI SAND.

The Miami sand is found almost exclusively in the northern and western parts of Posey County. It usually lies in strips from a quarter of a mile to a mile broad along the bluffs facing the Black and Wabash rivers. The foot of the bluff almost invariably forms one boundary, and the type is here bordered by the Yazoo loam, Yazoo sandy loam, or some other river-bottom type. The upland boundary, however, is less distinctly marked. As a rule the soil grades into the Miami silt loam of the upland by slow degrees, and shows no abrupt change of character to mark a definite boundary. In the district just north of Poseyville it extends down and off the bluff into the valley, where it occupies gently undulating topography. But at this point bluff and valley are not as distinct as they are along the Wabash lower down, and the change is little more than a gradual descent from high, rolling upland to low, undulating valley.

The character of the soil is somewhat variable. In typical areas it is found to be a medium sand, somewhat loamy, though containing little silt and clay in the soil. This sand is of a dark reddish-brown color, or light gray where it lies more level and has been bleached by the action of the elements. The particles are composed chiefly of rounded quartz grains showing the action of water. There is considerable admixture of heavier material in the subsoil, which becomes somewhat sticky at a depth of from 12 to 14 inches and which at three feet is a sticky orange sand, sufficiently mixed with clay to give it a plastic character.

In some localities this soil assumes the character of a sandy loam of finer texture and more coherency than the typical soil. On the other hand, a few areas occur where to a depth of five or six feet at least the soil is an orange-red sand, and in places where a road cut affords a view of the deep subsoil, traces of an irregular stratification are seen.

The soil is well drained. It is so perfectly drained in many cases as to be ill adapted to general farm crops.

It is difficult to say just what has been the origin and method of formation of the Miami sand. It is thought by some to be of loess origin, i. e., to have been transported to its present position at the same time and by similar means as the loess soils of the upland lying to the east and south of it. The roundness of its particles, as well as the lines of stratification in the subsoil, would lead to the conclusion that this material was deposited in water. Others believe it to be wind-blown sand and to be of a later geological age than the loess.

Miami sand is the chief watermelon soil of the county. Its open, leachy texture makes it unreliable for general farm crops, and until melon production was introduced this land was considered very inferior and could be purchased at a low price. But the recognition of its adaptability to melon production has greatly enhanced its value. Watermelons and cantaloupes are raised in large quantities and with good profit. Wheat does very well when it follows melons, but corn, which matures late, is apt to suffer from dry weather. Stock peas often find a place in the system of rotation, and are better adapted to the sandy condition than clover, while they perform a similar office of fertilization. Alfalfa might be profitably introduced on this soil. It is suggested that peaches, which are profitably grown on a similar soil in Michigan, might do well on the Miami sand.

The following analyses show the texture of the Miami sand:

MECHANICAL ANALYSES OF MIAMI SAND.

No.	LOCALITY.	Description.	Organic Matter, Per Cent.	Gravel, 2 to 1 mm., Per Cent.	Coarse Sand, 1 to 0.5 mm., Per Cent.	Medium Sand, 0.5 to 0.25 mm., Per Cent.	Fine Sand, 0.25 to 0.1 mm., Per Cent.	Very Fine Sand, 0.1 to 0.05 mm., Per Cent.	Silt, 0.05 to 0.005 mm., Per Cent.	Clay, 0.005 to 0.0001 mm., Per Cent.
7128	3 miles N. W. of Poseyville	Medium sand, 0 to 8 inches.	1.08	0.00	2.34	23.04	52.60	8.60	8.88	3.68
7126	4 miles W. of Mt. Vernon.	Medium sandy loam, 0 to 7 inches.	.60	.00	2.54	20.50	61.54	4.78	6.82	4.12
7127	Subsoil of 7126.	Medium sand, 7 to 36 inches.	.22	.00	2.04	25.70	50.54	3.78	13.78	4.10
7129	Subsoil of 7128.	Medium sand, 8 to 36 inches.	.52	.14	2.74	21.32	54.70	7.36	8.84	4.74

MIAMI SANDY LOAM.

The Miami sandy loam is of limited extent, and consequently of small agricultural importance. It possesses some characteristics, however, which distinguish it as a separate type and give it special adaptability to certain products. The soil varies from a light-brown to black sandy loam, composed of well-rounded, medium sand mixed with heavier material, which gives it considerable coherency. Even where the percentage of clay is small, the soil possesses a high degree of compactness, which is one of its characteristic features. The soil becomes heavier at a depth of about 10 inches, and, as is the case with most of the Wabash bottom soils, there is considerable fine, rounded gravel present in the subsoil. The sandy nature of the soil prevails to a depth of about three feet, but below this the deep subsoil differs little from the subsoil of the Yazoo loam, being a rather heavy clay loam mixed with gravel.

The total area of this type is about 0.6 square mile, most of which lies in the Wabash and the Black River bottoms. The principal areas of it occur in tracts of from 400 or 500 to 1,000 acres each. Several of these areas are found on the river flat west of Mount Vernon; others are found north of New Harmony and on Cutoff Island, and still another is found bordering the Black River, just on the northern edge of the county.

Although the land lies almost perfectly level, the soil is generally well drained. In fact, where the sand content exceeds the average the soil is apt to be too well drained for most crops. Its location and physiography, as well as its composition, indicate that the derivation is alluvial. It is hard to say just what cause should be assigned to the peculiar black color which it usually possesses, but this is probably due to the admixture of organic material with the heavier portion of the soil, for the sand grains seem to be largely of quartz.

In its crop relations the Miami sandy loam shows a great deal of diversity, and it is hard to assign the reasons for this variation. In some localities where it is devoted to wheat and corn it gives large yields of these crops. Again, the productiveness may fall far below the average for the county. There seems to be little difference in the physical properties of the soil in these two cases, although the more fertile areas contain a slightly larger percentage of clay. In a few cases melons are grown on this soil, and it is thought that larger areas might well be devoted to this industry, especially where the general farm crops do not thrive.

The texture of this soil is shown by the following mechanical analyses:

MECHANICAL ANALYSES OF MIAMI SANDY LOAM.

No.	LOCALITY.	Description.	Organic Matter, Per Cent.	Gravel, 2 to 1 mm., Per Cent.	Coarse Sand, 1 to 0.5 mm., Per Cent.	Medium Sand, 0.5 to 0.25 mm., Per Cent.	Fine Sand, 0.25 to 0.1 mm., Per Cent.	Very Fine Sand, 0.1 to 0.05 mm., Per Cent.	Silt, 0.05 to 0.005 mm., Per Cent.	Clay, 0.005 to 0.0001 mm., Per Cent.
7112	2½ miles N. E. of N. Harmony.	Black sandy loam, 0 to 10 inches.	1.54	0.00	1.82	10.80	36.86	12.32	26.74	11.24
7113	Subsoil of 7112.	Medium sand and clay, 10 to 36 inches.	1.42	.01	1.47	11.78	41.30	12.04	20.58	12.84

MIAMI FINE SANDY LOAM.

Miami fine sandy loam is the name given to one of the river-bottom soils. It is a red-brown or yellowish sandy loam of medium texture, but varies considerably in the percentage of clay it contains. A typical profile shows a mellow sandy loam, 10 inches in depth, overlying red sand of medium texture. Sometimes clay loam is met at a depth varying from one to four feet. Often the soil is a loose, incoherent sand, resembling beach sand, and in this phase is at times devoid of vegetation.

The soil occurs in low ridges, usually very narrow, immediately bordering upon the Ohio and Wabash rivers. Other patches of it occur throughout the river lowlands, and bordering the lower course of the Black River there is an area of considerable extent. In this locality the soil varies considerably and departs somewhat from the typical section. A single sample is less uniform in texture; there is some coarse sand and fine gravel, and the soil itself possesses a degree of compactness not usually found in this type.

The areas of this type are as a rule higher than the soils which lie adjacent to them. These sands are the product of alluvial deposition and have been laid down during the inundations which frequently occur. As long as the swollen stream is confined within its narrow channel the flow is so swift that the coarse particles are held in suspension, but as soon as the overflow takes place and the water, spreading out over the broad, level bottoms, is retarded in its rate of flow, the sediment is dropped, the sand being the first to be laid down. Farther from the banks, where the flow is still more sluggish, silt and clay particles are deposited, forming the clay-loam soils.

Nearly all of this soil is under cultivation, although there are some areas of nearly pure sand upon which no crops are grown. Corn is the principal crop, and where there is a considerable proportion of clay in the soil, an average yield of from 40 to 45 bushels per acre is secured. Watermelons are also successfully grown on many small patches too sandy for other crops. Fair yields of wheat are secured where the soil lies above high-water mark, and garden vegetables, though not extensively grown, are successful crops on this type of soil.

The texture of typical samples of the soil and subsoil of this soil type is shown in the following table:

MECHANICAL ANALYSES OF MIAMI FINE SANDY LOAM.

No.	LOCALITY.	Description.	Organic Matter, Per Cent.	Gravel, 2 to 1 mm., Per Cent.	Coarse Sand, 1 to 0.5 mm., Per Cent.	Medium Sand, 0.5 to 0.25 mm., Per Cent.	Fine Sand, 0.25 to 0.1 mm., Per Cent.	Very Fine Sand, 0.1 to 0.05 mm., Per Cent.	Silt, 0.05 to 0.005 mm., Per Cent.	Clay, 0.005 to 0.0001 mm., Per Cent.
7130	7 miles E. of Mt. Vernon.	Medium sandy loam, 0 to 7 inches.	0.93	0.00	0.24	0.34	41.24	35.72	14.82	7.78
7131	Subsoil of 7130.	Medium fine sandy loam, 7 to 36 inches..	1.10	.00	.20	.14	31.34	31.42	25.32	11.22

YAZOO SANDY LOAM.

The Yazoo sandy loam is an important type of soil, covering in all nearly five square miles, or 2,752 acres. It is found chiefly in the higher parts of the Wabash River bottoms near New Harmony. As a rule, the type occurs at the foot of the sandy bluffs, from which it is often separated by a narrow talus of Waverly silt loam. Its derivation is somewhat obscure, but it is probably composed of material washed down from the sandy bluffs above and mingled with finer material of the bottoms. It occupies higher ground than the Yazoo loam, which it usually borders on the riverward side, and as a rule it is separated from this type by a low terrace.

This soil is a fine sandy loam, resembling the Yazoo loam in surface appearance. The texture varies somewhat. In some cases it is a medium sandy soil with little coherency and with a subsoil of fine yellow sand, but typically the soil to a depth of 12 inches is a fine sandy loam, becoming more cohesive and sticky with silt and clay in the subsoil. At a depth of about three feet the clay predominates, giving the soil a desirable moisture-holding character.

For corn and wheat, the crops generally grown, this soil is less valuable than the Yazoo loam. The more sandy portions are, however, very well adapted to melon culture and are beginning to be used for this industry. A patch of watermelons was seen which produced about four carloads of melons and yielded a money return of about $40 per acre. More of this soil might profitably be devoted to this paying industry.

The texture of this soil type is shown by the following mechanical analyses:

MECHANICAL ANALYSES OF YAZOO SANDY LOAM.

No.	LOCALITY.	Description.	Organic Matter, Per Cent.	Gravel, 2 to 1 mm., Per Cent.	Coarse Sand, 1 to 0.5 mm., Per Cent.	Medium Sand, 0.5 to 0.25 mm., Per Cent.	Fine Sand, 0.25 to 0.1 mm., Per Cent.	Very Fine Sand, 0.1 to 0.05 mm., Per Cent.	Silt, 0.05 to 0.005 mm., Per Cent.	Clay, 0.005 to 0.0001 mm., Per Cent.
7116	2 miles E. of N. Harmony.	Fine sandy loam, 0 to 8 inches.	1.59	0.14	1.48	2.46	10.76	7.86	71.76	5.52
7118	1 mile E. of N. Harmony.	Fine sandy loam, 0 to 8 inches.	2.34	1.28	10.04	14.76	20.02	5.60	36.84	11.12
7117	Subsoil of 7116.	Sand and clay, 8 to 36 inches.	.73	.14	1.12	1.64	6.34	5.76	72.86	12.10
7119	Subsoil of 7118.	Fine sand and clay, 8 to 36 inches.	.84	.60	7.96	14.02	17.12	4.54	38.38	17.38

Yazoo Loam.

The Yazoo loam is one of the Wabash River bottom soils. The soil is a brown loam, composed of a mixture of fine sand, silt, and clay. The surface appearance varies considerably, and this variation indicates different phases of the soil. In some localities it is light gray, almost white, when dry. This phase often contains some medium-sized, rounded gravel. The soil here is inferior in fertility to the other phases. In the other extreme the soil presents a dark-brown or black appearance. These black areas occur as small patches within the district over which the type extends, and but for their limited extent might have been recognized as a distinct soil type. This phase occupies minor depressions and owes its peculiar characteristics to the wet conditions which at one time existed in these places. It is generally true that where a soil occupies low land and is continually wet it is found to be of a heavier type and to contain more humus than the soil about it, although it may originally have been derived from the same source. Such is the case with this phase of the Yazoo loam.

A typical profile of the soil and subsoil of the Yazoo loam shows a brown loam containing a good deal of fine sand, with an average depth of 8 inches. Lying below this is a loam, somewhat heavier and of a light-brown or orange-yellow color, which contains some coarse sand and waterworn gravel. This, at a depth of about 15 inches, is underlain by a heavier clay loam to a depth of 36 inches or more. Gravel is sometimes present to the amount of 10 or 15 per cent. of the entire soil, and in one or two instances stream cuts show a stratum of gravel occurring at a depth of 10 or 15 feet. Those who have engaged in well digging in the neighborhood say that it is quite common to find this layer of gravel in the deep subsoil. This stratum has an important effect on the drainage of the soil, furnishing a natural outlet for the surplus ground waters.

The Yazoo loam is of comparatively limited extent, but of considerable agricutural importance. It covers a total area of 8,320 acres, lying wholly within the Wabash and Lower Black River valleys. It occupies the nearly level flood plain of these streams, to whose agency it owes its origin. The presence of granite and other crystalline pebbles in the soil suggests that the material of which it is formed may be in part reworked glacial drift.

The Yazoo loam is the principal wheat soil of the Wabash bottoms. It is eminently adapted to the growing of wheat, producing grain of excellent quality, with an average yield of 25 bushels per acre and occasional yields of 40 bushels on limited areas where the soil is black and rich. Corn varies a good deal in yield, being more dependent upon the season than wheat, but the average yield is good. Clover and timothy are the hay crops generally raised, and these about complete the list of products at present grown on the Yazoo loam.

The following table of mechanical analyses shows the texture of this soil:

MECHANICAL ANALYSES OF YAZOO LOAM.

No.	LOCALITY.	Description.	Organic Matter, Per Cent.	Gravel, 2 to 1 mm., Per Cent.	Coarse Sand, 1 to 0.5 mm., Per Cent.	Medium Sand, 0.5 to 0.25 mm., Per Cent.	Fine Sand, 0.25 to 0.1 mm., Per Cent.	Very Fine Sand, 0.1 to 0.05 mm., Per Cent.	Silt, 0.05 to 0.005 mm., Per Cent.	Clay, 0.005 to 0.0001 mm., Per Cent.
7114	1½ miles S. W. of Griffin.	Sandy loam, 0 to 8 inches.	1.49	1.02	8.04	10.78	10.50	4.86	50.98	13.40
7115	Subsoil of 7114.	Clay loam with sand and gravel, 8 to 36 inches.	.75	.74	6.92	8.80	8.58	3.78	44.52	26.66

YAZOO CLAY.

Next in extent and importance to the Miami silt loam comes the Yazoo clay. The soil to a depth of seven or eight inches is a brown clay loam, fairly friable when not too moist and usually containing a small amount of sand, which, together with the intermingled organic material, gives it a desirable tilth. The subsoil differs little from the soil except that it has a more compact structure. This clay is often underlain, at a depth varying all the way from 5 to 20 feet, by sand or sandy clay.

This soil forms the principal alluvial soil of the Wabash and Ohio River valleys. Belts of it are found stretching all along the river boundaries of the county, with occasional breaks where the upland bluffs approach near to the rivers. The belts of Yazoo clay are from a few rods to three or four miles broad, and where there are other types of soil upon the flats this type occupies the lowest position, forming a flood plain that is in most cases subject to annual overflow. The physiography is that which usually characterizes a river flood plain. The land lies nearly level, with a gentle inclination in the landward direction. There are numerous depressions, bayous, sloughs, and narrow ponds running in a direction generally parallel to the course of the river. Along the bluff that separates the lower bottoms from the upland or from a higher terrace it is usual to find a marshy strip of land or cypress bayou. Occasionally the Yazoo clay is found occupying these higher terraces above the reach of all but the highest floods. Such an area is found along the Wabash River west of the town of Upton. Here the soil departs somewhat from a strict conformity to the typical character. Slight depressions running up and down the valley give the land a gently rolling appearance. In these depressions the soil is black from the presence of humus, while on the low, narrow ridges that separate these depressions is often found a coating of coarse sand 12 inches or more in thickness. These sandy areas are not indicated on the soil map, because they are so limited in extent that they could not be accurately drawn on so small a scale.

As already stated, this soil is a product of alluvial deposition. The forces that have operated in its formation are still active. Much of it is subject to annual overflow, and each flood leaves a coating of sediment or washes away a part of that already deposited, and so the surface soil is constantly renewed and altered. Thus is formed a strong, fertile soil capable of producing good yields of various crops. On account of the danger from overflow, however, it is planted almost exclusively to corn. For the most part the land is owned or rented by farmers having farms in the upland district, who remain on the bottoms only long enough to cultivate and harvest this crop. In those areas where Yazoo clay occupies a higher terrace or "second bottom," winter wheat and other crops are planted, and do remarkably well. Timothy grass and clover average one and a half to two tons per acre, and a yield of from 25 to 30 bushels of wheat is commonly obtained. Corn on the lower bottoms produces with comparatively regularity, a fair average yield being 45 bushels per acre. From its physiographic position and its natural water-holding property the soil is able to resist drought better than the less favored soils. Corn planted late in the sloughs and draws in which the overflow water remains longest will mature and gives a generous yield, while late corn on the upland is almost sure to suffer from the summer drought. The pecan is a natural forest growth of this soil, and many of the nuts are annually gathered for the market. Several carefully kept orchards were seen which yield good returns to their owners.

The texture of the soil and subsoil of this type is shown by the following mechanical analyses:

MECHANICAL ANALYSES OF YAZOO CLAY.

No.	LOCALITY.	Description.	Organic Matter, Per Cent.	Gravel, 2 to 1 mm., Per Cent.	Coarse Sand, 1 to 0.5 mm., Per Cent.	Medium Sand, 0.5 to 0.25 mm., Per Cent.	Fine Sand, 0.25 to 0.1 mm., Per Cent.	Very Fine Sand, 0.1 to 0.05 mm., Per Cent.	Silt, 0.05 to 0.005 mm., Per Cent.	Clay, 0.005 to 0.0001 mm., Per Cent.
7106	1 mile E. of Mt. Vernon.	Clay loam, 0 to 7 inches	2.42	0.00	0.00	0.02	0.30	4.50	66.76	28.42
7108	1½ miles E. of Mt. Vernon.	Clay loam, 0 to 7 inches	2.60	.00	.02	.02	.06	1.50	70.04	28.46
7107	Subsoil of 7108.	Clay loam, 7 to 36 inches.	2.27	.00	.01	.02	.14	3.06	66.44	30.32
7109	Subsoil of 7108.	Clay loam, 7 to 36 inches.	2.27	.00	.01	.02	.04	.98	67.32	30.90

GRIFFIN CLAY.

This is an unimportant soil type that occupies an area of only about 1,600 acres in the valley of the Black River, on the northern edge of the county. Larger areas are supposed to occur in the county adjoining this one to the north. It is entriely different in character from any of the other soils occurring in this area. In its virgin state it is found to be a very compact soil, composed of a mixture of medium to fine gravel, coarse sand, rounded by water action, and clay. The clay is dark brown or mottled in color, very stiff and waxy, and difficult to work. In some areas the gravel is entirely absent, and where this is the case we have a very heavy clay of a tough and waxy character. Taking the whole area into consideration, there is an average gravel content of about 10 per cent., while at times it is as high as 40 per cent.

This soil occupies the broad, level floor of the Black River valley, forming a part of the river flood plain. Occupying as it does the lowest portions of the river valley and being of a close, impervious nature, it would seem to be poorly drained. While this is to a certain extent true, and drainage where employed is beneficial, still most of that which is at present under cultivation is undrained, except for occasional open ditches. The explanation of this may be found in the fact that the soil is generally underlain by a stratum of gravel at a depth of from 5 to 10 feet, which forms a natural drain.

The soil is alluvial in its origin, and the presence of so much gravel may be due to the reworking of glacial material. Pebbles of granite and other foreign rocks point to a glacial origin for the deposits along the river banks.

A large portion of this soil is covered by forest growth, but these are being rapidly cleared and the country is being opened up to cultivation. Corn is the chief product, and considerable wheat and some oats are grown. Large yields are reported. Wheat produced in the season of 1902 in one instance 38 bushels per acre, though this is above the average. Corn will yield from 50 to 60 bushels per acre. It is thus easily seen that though the soil is at first exceedingly difficult to cultivate, still when good cultural methods have been employed for a few years and the soil has become more friable and loamy, large returns may be realized.

The following table gives mechanical analyses of typical samples of this soil:

MECHANICAL ANALYSES OF GRIFFIN CLAY.

(Fine Earth.)

No.	LOCALITY.	Description.	Organic Matter, Per Cent.	Gravel, 2 to 1 mm., Per Cent.	Coarse Sand, 1 to 0.5 mm., Per Cent.	Medium Sand, 0.5 to 0.25 mm., Per Cent.	Fine Sand, 0.25 to 0.1 mm., Per Cent.	Very Fine Sand, 0.1 to 0.05 mm., Per Cent.	Silt, 0.05 to 0.005 mm., Per Cent.	Clay, 0.005 to 0.0001 mm., Per Cent.
7110	3 miles N. E. of Griffin.	Compact gravelly clay, 0 to 6 inches.	2.17	1.92	12.34	18.62	12.94	3.76	25.46	24.64
7111	Subsoil of 7110.	Gravelly clay and coarse sand 6 to 36 inches.	.90	1.14	14.68	21.20	13.32	3.18	20.24	26.28

GUTHRIE CLAY.

The Guthrie clay is a soil of somewhat variable texture. A typical profile shows a light-gray or whitish silty loam, five or six inches deep, underlain by a stiff clay subsoil usually mottled with yellow and white. The surface presents a whitish or ashy appearance and when dry is very hard and compact, though the soil itself is not very plastic or tenacious when wet. Silt forms the largest part of the material, and mixed with it are varying amounts of coarse sand and iron concretions about the size of buckshot or larger. In areas bordering the Wabash River some coarse sand and fine rounded gravel is present, but not in sufficient quantities to affect, in any marked degree, the agricultural value of the soil.

The Guthrie clay occurs in but one locality. It is found in the southwestern corner of the county, between the Wabash and Ohio rivers, where it occupies an area of 22.8 square miles, most of which lies in Point Township. In this area are found small, isolated patches of Miami sandy loam, Yazoo sandy loam, and Miami silt loam, but the Guthrie clay itself is never met in small detached areas. Its surface appearance is one of the characteristic features of this soil, from which it has derived the local designation of "the woods flats." The land lies almost perfectly level and is for the most part covered with forest. A few low ridges occur, but these are usually occupied by some other type of soil. From the topography it is evident that the soil occupies an old Ohio-Wabash flood plain that the deeper cutting of the stream valley has left above ordinary high water. From the present river-flood plains, which are occupied by the Yazoo clay, this older terrace is separated by a low bluff from 10 to 20 feet in height. At times of very high water, which may occur once in ten or fifteen years, the river floods rise above this bluff and cover the broad area of the Guthrie clay, leaving only the ridges above water. Such inundations have left their marks in scattered patches of sand and water-washed gravel. It was at first thought that the origin of the soil was by deposition from these flood waters, but on closer study it was found that although the soil has been considerably added to and altered in character by these inundations, yet it is not strictly an alluvial soil. It is supposed that the soil was derived, like the Miami silt loam, from the loess, and that its present character is due to physical and chemical changes that have taken place since its accumulation ages ago. The changes are those which commonly result from low-lying, level topography, prevailingly poor drainage, and consequent wet conditions.

The soil is one of the least valuable of all the Posey County types, and this fact seems to be chiefly due to its poor drainage. Only in very dry seasons does it produce a fair yield of corn. Wheat produces well only in favorable seasons. Some underdrainage has been done, with good results, but the present need is for large outlet ditches into which smaller ditches and tile lines might be led. The larger portion of this soil is now wooded, but with a good system of ditches and tile drainage there is reason to suppose that much of the area may be converted into productive land, adapted to grain and grass. Application of lime, it is thought, would improve the tilth and increase the productiveness of this soil.

At present grass and small grain are the crops to which the soil is best adapted. Wheat averages about 15 bushels per acre, and timothy hay from a ton to a ton and a half. Clover is said to do well and to produce an especially good crop of seed. These yields, of course, refer to those parts of the area that have been under cultivation for some time and have lost to some degree the unfavorable character of the soil in its original state.

Mechanical analyses of this soil are given in the following table:

MECHANICAL ANALYSES OF GUTHRIE CLAY.

No.	LOCALITY.	Description.	Organic Matter, Per Cent.	Gravel, 2 to 1 mm., Per Cent.	Coarse Sand, 1 to 0.5 mm., Per Cent.	Medium Sand, 0.5 to 0.25 mm., Per Cent.	Fine Sand, 0.25 to 0.1 mm., Per Cent.	Very Fine Sand, 0.1 to 0.05 mm., Per Cent.	Silt, 0.05 to 0.005 mm., Per Cent.	Clay, 0.005 to 0.0001 mm., Per Cent.
7136	Point Township	Clay, 0 to 7 inches.....	1.73	0.90	2.78	1.48	6.46	7.78	54.20	25.86
7138	7 miles S. W. of Mt. Vernon.	Clay, 0 to 7 inches.....	2.13	1.76	3.50	1.96	2.42	2.58	51.74	36.16
7137	Subsoil of 7136.	Clay, 7 to 36 inches....	.89	1.24	2.22	.96	5.12	5.82	55.50	29.18
7139	Subsoil of 7138.	Clay, 7 to 36 inehcs....	.92	2.80	3.44	1.72	2.02	2.40	48.46	38.48

AGRICULTURAL CONDITIONS.

Posey County is a prosperous agricultural community. On the whole, the farming classes are a progressive people. This is evident from the appearance of homes, farms, and farm equipments throughout the county. There is a general recognition of the fact that well-constructed barns and sheds for the protection of farming implements pay in the end, and farmers make an effort to have as substantial a shelter for their stock as possible. The typical dwelling is a two-story frame building. Many of the dwellings have modern conveniences and comforts, and in a large number of cases windmills furnish an adequate water supply for house and stable purposes.

The county is divided according to the rectangular system, and the roads conform in general to section lines. The farms vary in size from only a few acres to as many as 3,000; the average being about 65 acres. As the price of land varies according to location and character of the soil, a correct estimate could hardly be made of the value of the land in the county, but much of it can not be bought for less than $100 per acre. In general, the farms are managed by the owners. Proprietors of larger tracts sometimes subdivide their lands and rent small holdings to tenants, who pay rent in a share of the produce, or less frequently in money.

White labor is employed exclusively, and this is of an efficient character. In many cases where the farms are small, no regular hired hands are employed except at times of special pressure, such as wheat harvesting, etc. At other times the farmer is able with the help of his boys to carry on the regular work of the farm.

The staple crops of the county are corn, wheat, hay, and melons. The upland, which is best adapted to the cultivation of wheat, yields an average of 20 bushels per acre, and of corn about 35 bushels, while from one and a half to three tons of clover and timothy hay are cut to the acre. By far the greater amount of corn is grown on the soils of the Ohio and Wabash bottoms, and in some cases they average as much as 65 bushels to the acre. Soils admirably adapted to the production of wheat and grass are to be found among these river-bottom types. The sandy hills and ridges which extend in a semi-circle about the county are made use of for melon growing. The melon industry is one for which the county is famous. The quality of the watermelons grown on the sandy soils is very superior, and they find a ready market in Cleveland, Indianapolis, Chicago, and even as far east as Pittsburg and Buffalo. Later in the season shipments are made to New Orleans. Poseyville is the principal shipping point, and 300 or 400 carloads are shipped annually from this place to all points in the Middle West. Cantaloupes also thrive on the sandy soils, and their cultivation is a very profitable industry, although they are not so easily handled as the watermelons. Melon growing has been carried on in this region for many years. The first shipments were made about forty years ago. But though not a new one, the industry is still growing and is capable of much more extensive development. The Miami sand and many areas of the Miami sandy loam and Yazoo sandy loam are well adapted to the production of an excellent grade of melons. Outside the melon industry, fruit culture is carried on only to a limited extent. Enough is grown, however, to make it evident that many varieties would do well. Practically none is shipped outside the county, the greater proportion being utilized for home purposes. Apples, peaches, pears, plums and grapes all do very well, and few farms are without an orchard or grape arbor.

There is a general recognition of adaptation of soil to crops, evidences of which can be observed in any part of the county, as, for instance, the silt soil of the upland for wheat; melons on the sand hills and ridges; corn along the upland stream bottoms and river flats, etc.

As far as soil and climatic conditions are concerned, Posey County is eminently adapted to the production of tobacco of the heavy export type. A soil survey was made in Union County, Ky., just previous to this survey, and all the tobacco soils found there occur also in Posey County. There is an erroneous idea among farmers of Posey County that their soil is not as well adapted to tobacco culture as are the soils in Henderson and Union counties, immediately across the river; but the Miami silt loam and the Waverly silt loam, the two chief tobacco soils of this part of Kentucky, are found in Posey County, with the same properties and subject to the same climatic influences. The growing of this crop, however, requires considerable skill and experience, and a lack of this is probably the cause of failure on the part of the Indiana farmers to produce a crop of tobacco equal to the Kentucky crops. And so the advisability of introducing tobacco into this locality is a debatable question, and yet it is well for the farmer to know that this is one of the many crops to which this soil is adapted.

No commercial fertilizers are used, barnyard manure and decayed wheat straw furnishing a good supply of soil-enriching material. More care might well be taken, however, to preserve and utilize this store of fertilizer. Experience demonstrates that the work and expense of conserving and applying barnyard manure to the soil is sure to pay in the end.

Posey County has a favorable location with respect to markets for her produce. Three railroads, the Illinois Central, Louisville and Nashville, and Evansville and Terre Haute, traverse the area, affording transportation facilities to Chicago, St. Louis, Indianapolis, Louisville, Cincinnati and Nashville, while the waterway afforded by the Ohio River makes traffic by steamboat practicable for the river towns. The county is furnished with a good system of wagon roads, making internal communication convenient. These roads are now being greatly improved by the construction of macadam roadbeds of broken limestone.

Soil Survey of Greene County, Indiana.

By W. E. Tharp and Charles J. Mann.
U. S. Bureau of Soils.

DESCRIPTION OF THE AREA.

Greene County is located in the southwestern part of Indiana. It is bounded on the north by Clay and Owen counties; on the east by Monroe and Lawrence; on the south by Knox, Daviess, and

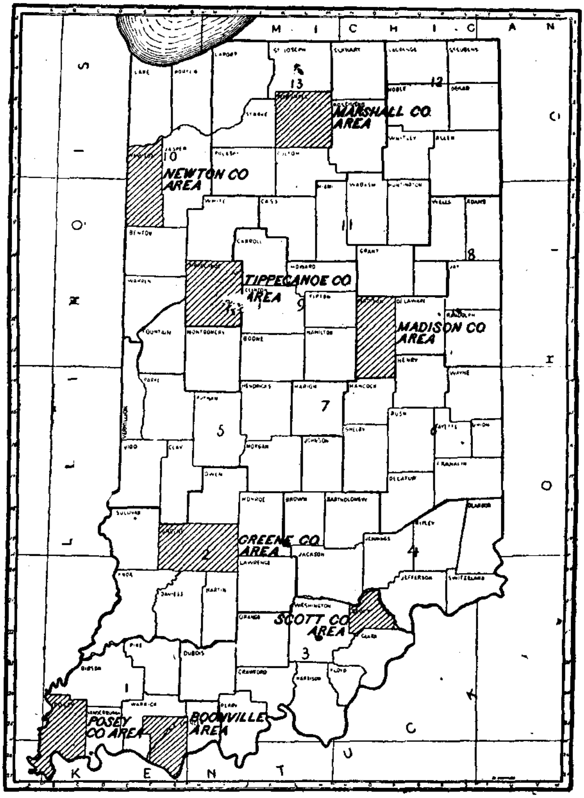


Fig. 1.—Sketch map showing location of the Greene County area, Indiana.

Martin; and on the west by Sullivan County. The parallel of 39° north latitude and the meridian 87° west from Greenwich cross the county, intersecting a few miles southwest of Bloomfield. The area is 342,000 acres, or 535 square miles.

All this area, excepting several sections of land in the southeastern corner which are tributary to Indian Creek, is drained by the West Fork of White River. This stream crosses the northern boundary about three miles east of the middle and follows a southern and southwestern course, dividing the county into two nearly equal parts. Its valley varies in width from one mile to several miles. On the eastern side it is bounded by hills which rise abruptly from the flood plain. Most of them are steep, but generally admit of cultivation. From Worthington orthward, and also opposite Bloomfield, the uplands decline rather sharply to the western side of the valley.

Between Worthington and the lower part of Lattas Creek there is a level area about one mile in width, formerly known as the Worthington Marsh. It is connected on the north with the valley of Eel River and also opens upon White River a short distance below Worthington. Its surface lies several feet above the highwater mark of these streams and it drains southward into Lattas Creek. It is bounded on the west by high hills—an old bluff—too steep in some places to be of much agricultural value. On the east, between it and the river, a ridge rises gradually from the marsh to a height of more than 100 feet and then drops abruptly to the flood plain of the river.

The level areas in the southern part of the county west of the river resemble the one just described, and have the same general relationship to the valley proper and to the higher land adjoining. While they may be considered an expansion of the valley of White River, they are separated from it by irregular shaped areas of upland which rise nearly to the height of the land several miles back from the stream. The Goose Pond and Beehunter marshes are valleys of old tributaries now filled much above their former levels by comparatively recent sedimentation. The uplands rise more than 200 feet above the level of these areas.

The surface of the northwestern townships presents considerable variation and is characterized by long, gradual slopes and broad, evenly rounded ridges. Lattas Creek drains most of this section of the county. An area of about 40 square miles on the northern boundary is drained by the Howesville and Lemon Creek ditches, which empty into Eel River.

The eastern half of the county is rough and broken. Richland Creek, which is the largest eastern tributary, enters the county near the northeastern corner and empties into White River below

Bloomfield. Plummer and Doans creeks lie south of Richland Creek, and are much inferior in size and length. Several small streams which empty into White River drain the northern part of this section.

The valleys of all these creeks are narrow. Along Richland and Plummer creeks they occasionally widen to one-half mile, but in general are less than a quarter of a mile in width. All of them, even the narrow ones, are characterized by low, flat-topped terraces, conspicuous by reason of the whiteness of the soil—the Waverly silt loam.

The interstream areas in this part of the county are everywhere deeply dissected by secondary tributaries. The hillsides and ridges which lead up to the crests of the major divides present every degree of slope and variety of form. The relief is so varied that no general description will apply to all of it. Between the drift boundary and the river much of the surface is rolling, with the very rough land confined for the most part to the neighborhood of the creeks, but east of the limit of glaciation there are many bold outcrops of limestone and of the harder strata of the Mansfield sandstone. Some of the broader divides afford considerable arable land, but they invariably decline on each side to short, narrow ridges, separated by deep ravines.

Greene County was organized in 1820, the year after the Indians vacated this part of the State. The first settlement was made in 1817 in Fairplay Township. In the next few years many immigrants arrived and settlements were made in other parts of the county. Only a few of these pioneers selected lands in the river bottoms, most of them preferring the uplands.

The majority of the early settlers came from the eastern counties of Indiana and from Ohio. Each of the older northern States seems to have been represented, but a considerable number of people from Kentucky, eastern Tennessee, and the Carolinas settled in the eastern townships. Very few foreigners have come to the county, and the present population is chiefly the descendants of many generations of native-born citizens.

Bloomfield, the county seat, and Worthington each have about 2,000 population. Linton and Jasonville are larger towns, located in the coal fields, and are good local markets for much of the farm produce grown in their vicinity.

The county roads radiating from these towns are well constructed and most of them graveled. The roads in the western townships are easily traveled. Those in the eastern part of the county are generally located on the ridges, and thereby avoid many steep hills. Most of the county is well served by rural delivery of mails and local telephone lines.

The shipping facilities of the middle and western parts of the county are excellent. The Evansville and Terre Haute, the Indianapolis and Vincennes, and the Southern Indiana railroads cross this part from north to south. There is also a branch of the Chicago, Indianapolis and Louisville—the Monon route—extending from Switz City southeast to Bedford. The recently completed Indianapolis Southern, which crosses the county from east to west, will give the eastern townships much better shipping facilities than they have had heretofore.

Climate.

The climate of this area presents no marked extremes in either temperature or precipitation. During the summer months there are many hot days, but there is usually a wind movement which tempers the heat and confines the oppressive effect to the narrow valleys or to locations to the leeward of high ridges.

The winters are usually mild and the snowfall light. The depth to which the ground freezes is variable. It seldom remains frozen longer than a few weeks, and a February thaw is always expected. The surface, if unprotected, invariably freezes and thaws to a depth of several inches a number of times during the latter part of the winter.

The following tables, compiled from the Weather Bureau records at Worthington, Greene County, and Washington, Daviess County, show the temperature and rainfall and the dates of killing frosts:

Normal Monthly and Annual Temperature and Precipitation.

Month.	Worthington.		Washington.	
	Temperature. ° F.	Precipitation. Inches.	Temperature. ° F.	Precipitation. Inches.
January	....	....	34.2	3.29
February	31.6	3.61	30.6	2.19
March	41.2	3.76	47.4	5.28
April	54.3	3.52	53.5	2.76
May	62.8	3.78	66.0	3.43
June	72.4	4.58	74.1	4.90
July	75.2	3.55	78.8	3.42
August	73.3	3.68	77.0	3.51
September	66.6	3.14	70.1	3.77
October	55.3	2.59	59.6	2.65
November	42.2	4.15	47.3	3.98
December	33.0	3.07	34.0	3.14
Year	....	....	56.0	42.32

DATES OF FIRST AND LAST KILLING FROST.

YEAR.	Worthington.		Washington.	
	Last in Spring.	First in Fall.	Last in Spring.	First in Fall.
1897	Apr. 10	Sept. 21	Apr. 21	Nov. 6
1898	Apr. 7	Oct. 15	Apr. 7	Oct. 23
1899	Apr. 16	Sept. 27	Apr. 9	Sept. 27
1900	May 10	Oct. 18	Apr. 13	Nov. 8
1901	Apr. 21	Sept. 18	Apr. 21	Oct. 5
1902	Apr. 15	Sept. 14	Apr. 14	Oct. 14
1903	May 4	Sept. 17	May 2	Oct. 18
1904	Apr. 21	Oct. 23	Apr. 21	Oct. 26
Average	Apr. 20	Sept. 30	Apr. 17	Oct. 20

The frost record at Worthington is not a correct indication of the range of temperature for the entire county. This station is located in a peculiar angle of the river valley, where the air drainage is poor. A record for the adjacent uplands would doubtless show a somewhat longer growing period for fruits and vegetables.

AGRICULTURE.

All the county, except the so-called marshes and Four-mile Prairie, was originally forested. During the four or five decades following the first settlements the agricultural development was slow. In 1850 not more than 10 per cent. of the arable land was cleared. In the absence of a market, the finest of walnut, yellow poplar, ash, and hard maple trees were felled and burned in heaps. Even so late as thirty years ago land was cleared of less valuable varieties in the same way.

The settlers produced most of the food they and their families consumed. Corn was usually the first and most important crop, and preceded the general cultivation of wheat. The clearings were protected by "stake-and-rider" fences, and the cattle and hogs supported themselves in the woods.

For many years Vincennes, Terre Haute, and Louisville, Ky., were the nearest trading points. Wheat and tobacco were hauled by ox teams, and the live stock driven to those markets. The completion of the Wabash and Erie Canal, about 1849, provided other markets. The first railroad, the Indianapolis and Vincennes, was not in operation through the county until 1864.

Those settlers from the mountainous sections of the South influenced the character of the agriculture in the eastern part of the county. They were generally content with small farms and methods which required a rather limited use of labor-saving implements. They introduced the culture of tobacco, which about forty years ago was grown on more than 100 acres in the neighborhood of Solsberry and Newark. This industry, though never extensively developed, brought considerable money into the section, the cured product, which was of fine quality, finding ready sale at Louisville, Ky.

The usual farm crops have always received more attention than any special industries. Stock raising and fruit growing have not been of great importance, and dairying has been entirely neglected. During the last forty years agriculture in the three eastern townships has suffered a decline. A steadily increasing number of the younger men have been attracted to the better and more easily farmed lands elsewhere or have sought employment in the mines.

In the western half of the county corn, wheat, and oats have been the principal crops. For many years their acreage increased only as the uplands and the river bottom were cleared. About twenty-five years ago the drainage of the "marsh land" began, and the yields of grain, especially corn, from these fertile tracts have greatly increased the total production of the cereals in this county. In character of improvements and adaptability to economical methods of tillage, the reclaimed lands are superior to the uplands. During the last twenty-five years the acreage of oats has materially increased, being now in the neighborhood of 15,000 acres. The average yield is about 25 bushels per acre. During the same period the acreage devoted to wheat has varied greatly from year to year, but has suffered a decrease from a maximum of about 45,000 acres to 16,000 acres. The highest average yield recorded for the entire county is 16 bushels per acre, but in favorable seasons some types of soil have averaged twice this quantity. There has been a marked increase in the acreage of corn. In 1895 48,130 acres produced 1,748,720 bushels. In 1884 39,000 acres yielded 1,122,910 bushels. The returns from the two years selected are quite near the average for the group of five years preceding each. According to the census of 1900, the acreage in corn was 58,645 acres, and the total yield was 1,926,550 bushels. There has probably been a decline in two or three of the eastern townships. The reclaimed marsh land, which has been devoted almost exclusively to corn, accounts in large measure for the increase in the production for the county as a whole, but there has been a tendency everywhere to extend the area devoted to this cereal.

Some of the soils are persistently planted to corn, to the exclusion of other crops to which they are better adapted. This is especially the case with some of the peaty lands and the Waverly silt loam, which produce heavy crops of timothy and only occasionally good yields of corn. Orchards have generally been planted on the Miami soils. Tobacco and truck crops have been confined to the type most favorable to their production. The adaptability of certain soils to different crops is quite well recognized, but not generally practiced. The same is true in a large measure with regard to rotation. The change of crops on every type is governed more by the convenience of the farmer or probable future prices than by the requirements of the soil.

During the last five years the general high price of grain and the decline in profits derived from cattle feeding have stimulated the production of the cereals and discouraged the raising of cattle and, to some extent, all other live stock. The tame grasses therefore have not been particularly profitable crops, even with those farmers who live on their own land and keep some live stock, while offering very little inducement to tenant farmers, who have little stock except their work teams. Neither class think they can afford to grow clover to be turned under for the benefit of a succeeding crop of corn.

Neither oats nor wheat give large returns over the cost of production, but are indispensable in affording a change for the land and an opportunity for seeding to grass.

Such industries as dairying and fruit growing, or special crops, such as broom corn, potatoes, and truck, have not received the attention they might have, on account of the cost of farm labor. The farmers are almost in direct competition for labor with the coal mine and stone quarry companies of this and adjoining counties. The usual wages given for a farm hand are $20 a month and board. Many of the small landowners employ but little hired help, and many of the owners of large farms either rent the land they can not cultivate themselves or furnish a house and garden lot to married men, whom they employ at $1 or $1.25 a day.

The average size of farms is 94 acres. Those in the eastern part of the county are generally small, while the holdings in the river bottom and in the western section of the county are larger. There are a few estates containing more than 1,200 acres each.

The assessed value of farm lands in 1895 was $5,872,988, and of the improvements thereon $1,575,816. These figures represent about one-half the actual value of the farms in the county. The census of 1900 gives the value of the farm lands, including farm buildings, as $8,119,230. Land adapted to corn has advanced in value during the last few years, while that only suitable for grass or pasture has declined.

All the light-colored soils are in need of organic matter. Many old fields are in such bad physical condition that only by leaving them in grass for a number of years or by the application of large quantities of manure or by the use of green manuring crops can they be restored to their former state of productiveness. It would seem that stock raising or dairying, alone or combined with fruit growing, offers the most practicable method for handling such lands.

In this connection due consideration is given the fact that the present high prices for corn, the cost of farm labor, and the uncertainty of profits which has attended the feeding of cattle have encouraged the production of grain, and that landlords invariably demand such terms of their tenants that the latter have no alternative, but must grow corn and keep but a few head of cattle or hogs.

SOILS.

The soils of Greene County have been formed from deposits of Pleistocene or later geological age. The underlying rocks belong to the Carboniferous, but these have contributed only indirectly to the formation of the soil, as they are covered almost everywhere by later deposits of Glacial age. The western two-thirds of Greene County was covered by the great continental ice sheet, whose eastern limit corresponds approximately with a line drawn through Newark and Scotland. Between this line and the White River the glaciation was apparently feeble, as the old topography has not been greatly changed, while west of this stream the inequalities of the surface were greatly reduced. East of the White River the drift is thin, and is composed largely of sand and gravel. West of the river it is considerably thicker, and consists largely of silt and clay, with comparatively little sand and gravel, and only a few small bowlders. On most of the long slopes and low divides of the northwestern townships the drift forms the deep subsoil overlain almost everywhere by the loess. Its direct influence upon the soils is therefore small, although it has doubtless contributed considerable material to the formation of some of the alluvial types.

The loess is the most important soil-forming deposit in the county. It forms a thin but almost unbroken mantle, seldom exceeding 10 feet in thickness, over both the glaciated and unglaciated parts of the uplands. In general, it is thickest on the summits of the ridges, thinnest on the flanks, and seems to become thicker again near the foot of the slopes. This is probably due to the greater amount of erosion that has taken place on these slopes. In the hilly sections of the county its average depth is five feet. The loess consists very largely of silt, and represents material ground up by the ice, assorted by water, and distributed by the wind. The weathering of this silty layer has given rise to the most extensive soil type in the area—the Miami silt loam. The loess material, however, has entered more or less into the formation of nearly every type in the area.

Upon the uplands bordering the White River valley and usually overlying the loess, occur areas of sand which were probably deposited in the valleys by the river when swollen from the melting of the later advances of the ice and then drifted upon the adjoining hills by the winds. This sandy material has given rise to lighter textured soils.

The advance in the ice caused some marked changes in the course of the streams. The Eel River and probably the White formerly flowed along the channel now occupied by Dead Creek Ditch. The White River also swung west almost to Switz City, Lyons and Marco. These old valleys were partially filled with glacial material more or less reworked by water. The coarse water-laid sand and gravel underlying Worthington Marsh and Four-mile Prairie were deposited at this time. The character of the surface material also indicates that it is from the same source, but deposited in comparatively quiet water. In fact, it is very probable that the marsh areas represent former lake beds. The light-colored soils along the border of these old valleys are composed principally of recent sediments derived from the uplands to the north and west. This deposition of local material is still in progress. Its influence has not reached the dark-colored soils, and since the larger areas of these soils lie a little too high to be affected by the rivers, they remain very much the same in texture as when laid down. The poorly drained condition has resulted in an accumulation of large amounts of organic matter in the soil, while in some places Peat has been formed. These dark-colored, reworked glacial soils have been included in the Clyde series.

Since the final retreat of the ice the streams have been lowering their channels; the energies of the White River being confined to the eastern side of the major valley. This stream has removed or greatly modified the older alluvium, and the present flood plain consists of reworked loess mingled with other material brought by the river from the upper parts of its course. The soils of recent alluvial origin may be divided into two series, according to differences in the character of the material. Where the material is entirely of local origin the soils are deficient in organic matter, very light in color, and low in productiveness, while those composed of material partly of foreign origin contain more organic matter; are yellowish-brown in color, and are quite productive. The former have been placed in the Waverly series and the latter in the Huntington series.

The soils of Greene County vary in texture from sand to clay, but the large predominance of silt and the finer grades of sand confine most of them to those classes designated as silt loams and fine sandy loams. While a rather close relationship exists in respect to texture, the soils differ widely in other respects. According to the similarity in other characteristics except texture, the soils have been arranged in four principal series—Miami, Waverly, Clyde, and Huntington—with single representatives of other series. The following table gives the name and area of each soil type found in Greene County:

AREAS OF DIFFERENT SOILS.

Soil.	Acres.	Per Cent.	Soil.	Acres.	Per Cent.
Miami silt loam	224,512	65.6	Marco clay loam	3,200	0.9
Waverly silt loam	25,152	7.4	Marshall silt loam	2,688	.8
Rough stony land	18,432	5.4	Peat	2,624	.8
Huntington silt loam	16,512	4.8	Waverly fine sandy loam	2,560	.7
Huntington fine sandy loam	13,696	4.0	Miami sand	512	.1
Clyde Sandy loam	11,712	3.4	Riverwash	192	.0
Bloomfield sandy loam	10,944	3.2	Sioux sandy loam	128	.0
Clyde clay	6,144	1.8			
Marco fine sandy loam	3,392	1.0	Total	342,400	....

MIAMI SAND.

The texture of the Miami sand ranges from medium to coarse, with a small amount of fine gravel. The surface is a dull or dirty gray. The moist sand below is generally a dark, reddish-brown, changing to a lighter brown with depth. There is some fine material present, but seldom enough to cause the wet sand to cohere. At a depth which varies greatly within very short distances, a substratum of sticky, clayey sand is found, similar to the subsoil of the Bloomfield sandy loam. This forms a moisture reservoir, but in most of the areas mapped as Miami sand it lies at a greater depth than three feet. In the depressions the soil is more loamy and darker colored.

Two small areas of Miami sand are found west of White River. The largest lies northwest of Bloomfield and the other is located about one and a half miles southeast of Worthington. The latter has a general north and south trend and is practically a low, narrow sandhill lying between the river valley and the second bottom. The area north of Bloomfield occupies a rather high hill which overlooks the river valley. The irregularities of the surface are pronounced and several deep ravines intersect it.

Wheat and clover may be grown successfully on this type. In wet seasons corn will give a fair return. Melons, sweet potatoes, and other early garden truck do well. A small acreage of melons is grown near Bloomfield for the local markets.

The following table shows the composition of a sample of this soil:

MECHANICAL ANALYSES OF MIAMI SAND.

NUMBER.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
15375..............	Soil...............	0.6	22.0	35.2	24.9	1.4	11.7	4.2

BLOOMFIELD SANDY LOAM.

The soil of the Bloomfield sandy loam is a medium to fine reddish-brown sand, containing a small percentage of silt and clay. The texture becomes coarser to a depth of 15 to 20 inches, where there is an appreciable increase in the silt and clay content, which continues to a depth of several feet. In cultivated fields the surface bleaches to a dull-gray or slightly reddish-gray, and while everywhere loose and on some of the ridges quite incoherent, it maintains fair moisture conditions. In the northern part of the area the texture of the soil is somewhat finer than elsewhere.

The subsoil is a medium to coarse sand or sandy loam darker in color than the soil. At a depth usually less than three feet it grades into a stiff, compact, sandy, silty loam. This heavy substratum contains a sufficient quantity of clay to render it somewhat sticky when moist, and very hard and compact when brought to the surface and allowed to dry.

Sometimes the subsoil changes again to a loose, light-gray sand, which is usually dry, much coarser than any of the material above it, and presents a greater variety in the composition of its grains. This stratum is seldom present along the margins of the areas of Bloomfield sandy loam farthest from the river. In the latter places the finer grades of sand form the soil, which overlies the loess.

It is probable that the sand was derived from sediments laid down in the river valley and drifted to the present position by the wind. Some low areas which have much coarse material may be ascribed to the agency of water, but the variable depth, erratic distribution, and the great topographic range of most of the type indicate wind action as the chief formative agency.

Most of the surface material consists of iron-stained quartz sand, but the deeper strata exhibit considerable variety in the character of the grains, indicating a derivation from crystalline rocks rather than the local sandstone.

The largest areas of this type occur on the bluffs overlooking White River. A few of them extend back upon the upland and gradually pass into a closely associated type, the Miami silt loam. Some of them, however, end very abruptly and are separated from the Miami silt loam by a narrow ravine. Both slopes of the ravine invariably consist of typical loess, indicating that the heavier material was deposited first.

The topography varies from gently rolling hills to a "hummocky" surface consisting of small mounds and narrow ridges of low relief. The intervening depressions are very irregular in size and outline. Not many of them are entirely inclosed, but generally open upon the lower areas of the adjoining types. Several conspicuous elevations near Worthington are capped with sand which averages finer in texture than most of the type found between Bloomfield and Newberry.

All of this type was originally forested. Some of the low, dune-like areas in the marshes are yet covered with oak, and on the river bluffs ash, poplar, sugar maple, and even walnut, attain a good size. Most of the timber, however, has been removed.

The crop value is determined largely by the character of the subsoil which constitutes the moisture reservoir. Where it is deep, good crops of corn and wheat may be secured. Clover is grown successfully and a few small fields of alfalfa have been sown. The limited acreage of rye in this county is almost entirely confined to the Bloomfield sandy loam. Melons and tomatoes, as well as early garden crops, give good yields. All the varieties of fruit trees adapted to this section make a satisfactory growth. Cherries do especially well, and some small orchards of apples and peaches present a promising appearance. On all the upland areas the air drainage is good. There is such a variety of slope and also of moisture conditions, due to the variable nature of the subsoil, that good sites for orchards abound. The annual crops are likely to suffer from continued drought, and the yields depend largely on the rainfall during the growing season.

This type is easily cultivated and does not wash badly, except on the steepest slopes. By frequent changes to clover some farmers are maintaining a dark, loamy appearance of their fields, and they usually secure good returns of wheat and corn. The organic matter, whether it consists of clover, stubble, or barnyard manure, soon burns out, and a continuous supply is a matter of prime importance. The surface of this sand should be exposed to the direct rays of the sun as little as possible. A cover crop of some kind is especially beneficial during the fall. Early plowing for wheat, which leaves the soil exposed for a number of weeks, is believed to be detrimental, in that it hastens the disappearance of the organic matter.

Much of this type is included in farms which have other types of soil, so that its value can hardly be stated. Most of it is devoted to the usual farm crops, and only where considerable areas of the deepest sand occur is it estimated at a lower value than adjoining areas of silt loam and fine sandy loam.

Sioux Sandy Loam.

The soil of the Sioux sandy loam consists of a dark reddish-brown sandy loam or heavy fine sandy loam about one foot in depth. It contains some small stones, but is easily cultivated. The subsoil contains so much gravel that it is wellnigh impenetrable with a spade or plow.

One area of this type lies on the north county line just east of White River in the form of a small gravelly terrace, 10 or 15 feet above the valley, and composed of glacial material brought down by Jacks Creek, which at this point flows northwest along the east side of this terrace. Another small area is found east of Worthington, where it occupies a low terrace between a ridge of Miami sand and an arm of the river valley. Here the soil is gray in color and coarser in texture than the soil of the area just described. It is also somewhat deeper and contains fewer stones. The organic content is low, but the presence of considerable fine material gives it a loamy character. The subsoil consists of a coarse reddish-brown sand with more or less gravel.

This type will not endure drought, but in seasons when the rainfall is well distributed it produces good crops of corn and wheat. Its very limited extent in this survey makes it of minor importance.

Marco Fine Sandy Loam.

The surface soil of the Marco fine sandy loam is an incoherent sandy loam becoming heavier with depth. The dry surface is usually of a dull gray color, but the body of the soil is yellow or yellowish brown. At a depth of from 12 to 15 inches the material is much more compact. Here it is a sandy clay loam, usually moist and plastic, but not very sticky. The sand is sometimes somewhat coarser than at the surface and the texture is not uniform. Thin streaks or pockets of medium to fine sand may occur at any depth. The color of the subsoil is a light yellow, streaked or mottled with light gray. The sand shows iron stains ranging from chocolate brown to buff.

The Marco fine sandy loam is represented by several small areas adjacent to areas of the Bloomfield sandy loam. It is usually developed along the border of the latter type farthest from the river. It is probable that the two soils have a similar origin and that the sandy loam represents the drift or wash of fine sand over the loess. The peculiar topography of some of the uplands on the west side of White River is favorable to such a distribution of the sand. The hills rise very abruptly from the valley, forming quite a high bluff. and then decline very gently toward the low ground which lies a mile or so back from the river.

There is an area of Marco fine sandy loam north of Bloomfield which consists for the most part of land which slopes gradually toward the west. There are areas southwest of Lyons which are nearly level. The one farthest east is bordered by dune-like ridges of Bloomfield sandy loam, and some of the interdune areas have been included in this type. They represent a transition between the Clyde sandy loam and the Marco fine sandy loam. Some of the type in this locality may be fluviatile in origin, but the surface resembles that of the higher ground and indicates more or less drift of its material by the wind.

This is a warm, early soil which stands drought much better than the Miami sand. It is deficient in humus, but the texture of both soil and subsoil and the favorable moisture conditions insure good yields of grain and clover. Some of the hillsides have been drained with tiles, and the level areas southeast of Lyons are greatly benefited by the large ditches which were made to drain the Clyde sandy loam. The slight elevations are very desirable sites for small fruit and truck gardens. Fruit trees do well on all except the lowest places. Wheat and corn are successfully grown, and clover does exceptionally well. Only a few fields of oats or timothy were seen on this type. The cultural methods are similar to those employed on the Clyde sandy loam and the Miami silt loam. All of the type is cultivated and has a higher value than the upland types of soil.

The following table gives the mechanical composition of a typical sample of the soil and subsoil of this type:

MECHANICAL ANALYSES OF MARCO FINE SANDY LOAM.

NUMBER.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
14866	Soil	0.6	5.7	8.3	30.2	10.3	3.09	13.2
14867	Subsoil	.3	2.5	6.8	3.01	7.8	26.9	26.2

WAVERLY FINE SANDY LOAM.

The soil of the Waverly fine sandy loam is a fine sandy loam resembling the Waverly silt loam in its general surface features. The first few inches contain a high percentage of light-gray silt. The color of the surface is always lightest where the silt content is highest and becomes a dark gray where the sand predominates. The surface, if uncultivated, is quite compact, but breaks into a loose, loamy condition when plowed.

At a depth of about eight inches the subsoil is a friable silty loam, much lighter in texture and somewhat coarser than the soil. It becomes lighter with depth, and at 24 to 30 inches is usually a medium to coarse sand, only slightly coherent. It is more or less mottled, the color ranging from a light gray to a dark chocolate brown. Iron concretions are abundant, and along some of the small tributaries of the Goose Pond Marsh the lower subsoil is a sort of conglomerate of various sized iron nodules with the grayish silty sand as a matrix.

This is an alluvial type formed by the deposition of the heavier material as the gradient of the streams decreased. The surface seems to have received considerable silt, either very recently or during the latter part of the period when the type as a whole was being formed. The natural drainage is not good, but is being improved by the increase in the depth of the channels of the water courses which cut through the narrow areas of this type.

Most of this soil has a higher agricultural value than the Waverly silt loam. Its areal extent is so limited, and it is so frequently bordered by a hillside too steep to be cultivated, that much of it is used only for pasture. The cultivated valleys usually produce fair crops of corn, wheat or potatoes.

Huntington Fine Sandy Loam.

The Huntington fine sandy loam is an alluvial type consisting essentially of a fine sandy or silty loam, variable, but usually containing a high percentage of very fine sand and silt overlying fine sand. The color is a yellowish brown, somewhat darker where the silt content is highest and approaching a light gray or yellowish gray where there is more than the average amount of sand. The surface is slightly compact, but the soil becomes lighter in texture and more open in structure with depth. At 12 inches the sand characteristics are usually well pronounced. There is very little coarse sand and a comparatively small amount of clay, with a consequent marked absence of the qualities which these materials impart. The soil is a soft, fine-grained alluvium, with very little tendency to become hard or form clods. The organic matter content is low and practically no dark-colored sediment is being added to the surface. The soil is easily plowed and will remain in good tilth the entire season. The upper part of the subsoil contains considerable fine material, but this rapidly decreases with depth, and at from 25 to 30 inches it becomes a fine sand of loose and incoherent structure.

In Greene County this type is confined to the valleys of White River and its eastern tributaries. The largest areas are found on the inner curves of the river. Along the small creeks its distribution is somewhat irregular. On Richland and Plummer creeks it usually lies between the stream channel and the terraces of Waverly silt loam that so frequently skirt the foot of the hills. On the smaller creeks the narrow strip of alluvium, if of sufficient width to be shown on a map of the scale used, has been classed with this type. These small, irregular areas are generally cultivated, and while they contain more coarse material in both soil and subsoil, they resemble the normal phase of this type in color, structure, and crop value. The surface is a silt or silty loam grading into sand. There are frequently additions of shale fragments and other debris washed from the hills.

The White River does not deposit permanently much fine sediment below the level of its present banks. Such old channels or other depressions as exist near the stream are filled with relatively coarse material until built up to about the height reached by the overflows. Then the fine sand and silt are assorted and spread over the surface, thus forming the Huntington fine sandy loam and the closely related Huntington silt loam. No well defined boundary can be drawn between these two soils.

The chief sources of the alluvium along the small streams in the eastern part of the county, as well as a large part of the sediment carried by the river, are the Mansfield sandstone, certain associated shales, and the loess. The Sandstone consists largely of medium to fine siliceous sand carrying a good deal of iron. The shales are arenaceous and do not contain much clay. It is probable that both of these alluvial types owe most of their productiveness to the material derived from the loess.

All this type was originally timbered, but is now cleared. Corn is the chief crop. Some of the heaviest phases produce good winter wheat, but there is considerable danger of damage by spring floods. It is not a typical grass soil, but clover and timothy generally do well, because of the good supply of moisture. No definite statement as to the average yield of grain can be made, but on some of the small irregular fields on the creeks and some larger areas of this type along the river excellent yields of corn of good quality are secured. The methods are similar to those practiced on the Huntington silt loam. Some of the sandy strips along the stream banks require very little cultivation to keep them in good tilth.

No commercial fertilizer and very little barnyard manure is used on this soil. Its general value, as well as adaptability to crops, is dependent upon the elevation above the usual level of the stream. Areas subject to very frequent overflow are generally very sandy. It constitutes the most valuable land for agricultural purposes on many of the small farms in the eastern part of the county.

The following table gives the average results of the mechanical analyses of the soil and subsoil of this type:

MECHANICAL ANALYSES OF HUNTINGTON FINE SANDY LOAM.

NUMBER.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
15392 15394.......	Soil...............	0.0	0.7	1.6	18.5	22.7	48.2	7.9
15393 15395.......	Subsoil............	.0	.4	2.2	39.5	23.6	28.3	5.5

CLYDE SANDY LOAM.

The soil of the Clyde sandy loam is a black sandy loam, medium to fine in texture, characterized by a friability very apparent in all cultivated fields. There is a small amount of coarse sand present, the angular grains being easily seen on the surface. The clay and silt content is sufficiently high to give a considerable degree of firmness and coherency to the soil, but it is seldom so compact as to form clods or necessitate more than a minimum amount of labor to reduce it to good tilth. This loamy nature of the surface is due in some measure to the comparatively high organic content as well as to the presence of so much fine sand. There is some variation in texture in the large areas of this type. Near the low ridges of Miami sand there is more than the average amount of coarse to medium sand both in the soil and subsoil, while in the central parts of the areas the finer grades of sand predominate.

The subsoil is usually a sandy loam a little coarser in texture than the soil and distinguished by its plasticity and rather open structure. At a depth of about four feet it is a very sandy loam or sometimes a yellowish or brown sticky sand which grades rapidly into a coarser, water-bearing sand and gravel. This stratum lies between five and six feet below the surface, and usually there is good capillary movement between it and the soil. The color of the subsoil is variable and is generally some shade of gray, darker where the organic matter in the soil is abundant, and lightest in those sandy phases of the type near the Miami sand.

In both the area adjoining Worthington and in the one east of Lyons, called the Four-mile Marsh, there is no line of demarcation between the soil and subsoil. In color and texture there is a gradation from the very dark surface to the gray or sometimes yellowish subsoil 24 to 36 inches below. Near the drainage lines the subsoil is frequently a heavy sandy loam of a dark-brown or slightly reddish-brown color with numerous yellow iron stains.

This soil is easily cultivated. If plowed deep, an excellent seed bed for corn may be prepared. By plowing shallow, or even by the use of the disk harrow followed by a drag and roller, a firm condition of the soil suitable for small grain is obtained.

In each of the largest areas there are occasional small mounds rising only a few feet above the general level. Otherwise the surface of all this type is flat, with a very slight inclination toward the south. Artificial drainage is necessary. Very few tile drains have been laid; large open ditches being depended upon to remove the surplus water.

The Worthington Marsh is drained by a dredged ditch about six feet deep and twice as wide. The Four-mile Prairie is intersected by a number of somewhat smaller ditches. These artificial drainage lines frequently overflow, but serious damage is done only occasionally. Both Four-mile Prairie and Worthington Marsh are practically a part of White River valley. The surface of each is only a few feet above that of the highest parts of the present flood plain of the river.

A small area of Clyde sandy loam northwest of Marco is entirely surrounded by ridges of Bloomfield sandy loam, and probably represents some local variation in origin. It is finer in texture and also higher in its organic matter content than the average and forms an especially valuable land for general farming. The area south of it is practically a part of the flood plain of White River. The surface is characterized by numerous broad, shallow depressions quite variable in texture, while the minor elevations are usually sandy. Along the lower part of the Goose Pond Ditch these slight elevations on the east side are quite silty and grade into the Huntington silt loam.

The material which constitutes the water-bearing stratum below the subsoil is plainly of glacial origin, and doubtless was deposited in its present position when Eel River and White River were lines of discharge for the last ice sheet, which reached their upper tributaries. The finer material which now forms the soil is largely of foreign origin, for mica, hornblende and feldspar may be detected among its sand grains. These surface materials probably represent the closing part of this stage of the river's history when it selected its present course and Eel River permanently abandoned a line of discharge for its surplus water to the north and west of Worthington. At this time the southern outlets for this part of the valley were obstructed, thus ponding the waters between the uplands on the north and west and the high land near the river. The Clyde sandy loam areas were the more shallow or transient part of this lake, while the heavier materials of the Clyde clay represent the deeper and more permanent part near the bluffs.

Before artificial drainage was introduced the surface of these areas was more or less flooded during the spring months, but usually dry during the summer and fall. Bluestem and other varieties of prairie grass, as well as those peculiar to wet locations, grew luxuriantly and for many years furnished excellent grazing. The surrounding uplands and the low sandy mounds were timbered, but the marshy tracts, though open, long remained uncultivated. On account of their slow natural drainage they were generally considered as little better than the true marshes on the small creeks north and west of them.

Corn is now the principal crop grown upon this soil. Small grains, timothy, and clover do well. A few small fields of alfalfa have proved successful. The yield of corn in favorable years has frequently exceeded 80 bushels per acre. The presence of the so-called "alkali spots," which seem to affect this crop only, reduces the average production to some extent. While this yield is much above the average, the soil with its abundant supply of water beneath, which amounts to subirrigation, gives sure and large returns of all the ordinary crops.

Tomatoes are now being grown quite successfully on this type near Worthington. It is well adapted to any crop which requires a sure and abundant supply of moisture and is not too susceptible to frosts. Its topographic position does not especially commend it for general trucking. Fruit trees grow well, but the yields are somewhat uncertain.

For many years the natural productiveness of this soil seemed to render crop rotation or fertilization unnecessary, but now many farmers assert that the yield of corn averages less than formerly and advocate clover growing. Very few have any regular rotation. Oats usually follow corn, the seed being sown broadcast and a disk used to pulverize the surface, which afterwards is harrowed. Winter wheat conveniently follows oats. The stubble is plowed shallow and well harrowed, and the seed is always drilled. The wheat also serves as a nurse crop for clover, which is sown in the early spring. A good deal of the land planted to corn is necessarily plowed in the spring. Various means are used in getting rid of the stalks, but not much consideration is given their possible value in adding organic matter to the soil. Many farmers burn them. The disk and slant-tooth harrow are found very effective in preparing the seed bed in this soil. Much of the corn is drilled and shallow cultivation is practiced. No commercial fertilizer is used with the ordinary crops, and the limited number of cattle and other stock which most farms support preclude the possibility of applying much manure, although it is found that the soil very readily responds to its application.

Some of the best improved farms in the county are located on this type. The value has steadily risen during the last decade, and now $100 an acre is about the average price which the land commands.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

MECHANICAL ANALYSES OF CLYDE SANDY LOAM.

NUMBER.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
14690 14700 15398.	Soil...............	0.4	4.8	13.9	42.4	7.9	18.9	11.5
14691 14701 15399.	Subsoil...........	.2	4.6	13.2	39.2	6.1	20.5	15.8

MIAMI SILT LOAM.

The Miami silt loam is the most extensive type in Greene County. It is the familiar "yellow clay" seen in the hillside ditches, and gives the characteristic color to the surface of all the upland fields. The soil is a silt loam, high in silt, and usually containing very little sand, even of the fine and very fine grades. When moist, a sample taken in the hand is soft and readily molded, while on drying the material crumbles into fragments that may be easily pulverized. Much of the surface of a well-tilled field is frequently a loose, floury dust, and the small clods are light and porous. On the hillsides the color is yellow or light reddish-yellow, but where the surface has little slope it is usually some shade of light gray. In both instances the addition of organic matter causes the soil to become much darker.

The subsoil usually contains a little more clay than the soil, but otherwise they resemble each other in texture. The subsoil is slightly plastic, but crumbles on drying. At a depth of 12 to 18 inches the light-yellow material is more or less streaked with gray. This mottled appearance increases with depth, although in some places where this underlying formation contains much iron the deep subsoil is a dark reddish-yellow.

Along the streams, and also near areas of Miami sand, the first few inches of the soil may contain a considerable amount of sand. Along the glacial boundary there are areas which have some small stones and gravel mixed with the soil, and in a few localities this coarse material occurs in the subsoil. Such phases have been indicated by the gravel symbol.

The Miami silt loam is derived from the loess, and, with the exceptions mentioned, practically no other materials enter into its composition. It is easily cultivated. If plowed when slightly moist, the surface is crumbly and may be worked to a loose, friable condition. This is especially true if there is a little more than the average amount of organic matter present. Old land is sometimes very cloddy, and if plowed when too wet it gets into poor physical condition.

Excepting some small areas of Bloomfield sandy loam and the rough stony land, this type occupies all the uplands. The minor differences in depth of soil, texture and color observable are due chiefly to topographic influences. The yellow color is most pronounced on the steepest slopes, and the color invariably becomes lighter where the surface is nearly level. Where the gradient is highest, the loess is generally thin, seldom exceeding a depth of four or five feet, and is in contact with the ferruginous rock or sand. On the more level areas the silt is thicker, and frequently overlies glacial material which evidently had undergone considerale leaching and oxidation prior to the deposition of the loess.

There are areas of this type where the surface soil is light in color and contains abundance of small, soft, iron concretions. These are associated with slow, imperfect drainage, but in only a few places on the upland does this obtain to an objectionable degree. Whenever a slight depression, other than a limestone sink, exists, the soil is white, becomes very hard when dry, and at a depth of 18 or 20 inches is so compact that it is frequently termed "hardpan." Beneath this stratum the subsoil presents the usual silty, mottled appearance. In Secs. 6 and 19, Twp. 8 N., R. 7 W., and in Secs. 18 and 22, Twp. 8 N., R. 6 W., small areas of this phase of the Miami silt loam are found. In general, the lighter colored phases are not quite as easily managed, nor as satisfactory in their crop yields as the yellower areas on the hillsides.

There is a marked deficiency of organic matter in the virgin soil. This may be ascribed to the original forest, a heavy timber growth not being conducive to the accumulation of humus in the soil. Most of the vegetable debris oxidized upon the surface and did not become incorporated with the soil. The large and permanent roots of trees do not add so much fertility to the earth in which they grow as the roots of grasses which are annually renewed.

Corn, wheat, oats, clover, and timothy, are the leading crops grown on the Miami silt loam. The rougher parts along the stream are used for pasture, and some limited areas yet remain uncleared. During recent years there has been an increase in the acreage sown to tame grass.

On many farms the rotation followed consists of two or more crops of corn, one of oats, and then wheat, the latter serving as a nurse crop for clover, which is sown in the spring. Some farmers, when seeding land to clover, also sow timothy, while others prefer to keep them separate. On many of the rented farms, however, none of the fields are seeded to clover, except possibly at long intervals. In seeding for winter wheat, the oat stubble is plowed in August, or sometimes earlier, and in making the seed bed the roller is freely used. The seed is always sown with a drill. The time of sowing depends somewhat upon the season, but usually between the 10th and 30th of September. As long as winter wheat continues to be grown, it does not seem practicable to avoid exposing the bare surface of the land to the hot summer sun for several weeks. But the practice certainly tends to hasten the oxidation of the organic matter in a soil which has none of that essential element to spare.

In preparing land for corn, the plowing is deeper than for wheat. Both the disk and the roller are generally used. Some farmers check their corn, but many of them prefer to plant it in a drill. Surface cultivation is practiced by many farmers, but there are some who continue to use large cultivator shovels which stir the soil to a depth of five or six inches. Practically all the corn grown is husked in the field, very little of it being cut and shocked or used as silage. The quality is good and crops are seldom injured by frost.

This soil is well adapted to oats, but the crop is not always a successful one. The quality and yield of this grain is probably more dependent upon the season than either wheat or corn. The yield of corn varies greatly even on adjoining farms. As already indicated, the soil may be kept in fair physical condition even where the humus content is apparently low. Other conditions being equal, the organic content is of greatest importance and largely determines the crop yield. The average yield of corn is less than 40 bushels. The present average yield of wheat on this soil is about 15 bushels in favorable years, and is very often much less.

Nearly all the commercial fertilizer used in this county is applied to the Miami silt loam of the eastern section. An increasing number of farmers are depending upon it to maintain the yield of wheat. The brands generally used have a guaranteed analysis of two to four per cent. of potash, and eight or nine per cent. of phosphoric acid. They are applied at the rate of about 150 pounds to the acre. A good deal of raw bone meal and untreated phosphate rock are also used, either separately or in some combination. Except that very little nitrogen is purchased, no common practice is followed. The use of commercial fertilizer is steadily increasing.

The present condition of much of this type in the three eastern townships deserves special consideration. There is a great deal of once cultivated land now abandoned or used only for the scanty pasturage it affords. From hundreds of acres of the steepest hillsides the virgin soil has been washed away. There now remains only the former subsoil, from which has long since disappeared the last trace of the tree roots which penetrated it in every direction and extended downward into the broken rock beneath. Deprived of all this woody material, which constituted no small part of the total mass, the silt has assumed the properties of clay. It is so close in structure that during a brief drought its moisture is largely lost by evaporation. When saturated it washes badly. On scores of hillsides V-shaped gullies extend from the foot of the slope to the top. Their depth is determined by the thickness of the silt, which may be only a few inches or several feet. When the rock is reached, vertical cutting ceases and the wash begins to widen. The upper extremities soon coalesce and then the damage is irreparable. In many old fields, so completely has the loess been removed that the underlying rock is more or less exposed over many acres. Such places can never be restored to their original productiveness. The sandstone and shales consist largely of quartz sand, with little of the finer grades of material.

The three eastern townships are better adapted to dairying and fruit growing than to general farming. The silt loam is a good grass soil and there is abundance of water, fine springs being of common occurrence. Fruit trees of all kinds, and nursery stock, make a good growth on this land. It is well adapted to orchards, for the high ridges insure excellent air drainage, and the character of the rocks immediately underlying the loess favors the maintenance of the proper moisture conditions and admits of a deep root development. The transportation facilities, however, have not been favorable for the development of the fruit-growing industry.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

MECHANICAL ANALYSES OF MIAMI SILT LOAM.

NUMBER.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
14696 15382 15384.	Soil	0.3	1.6	0.9	2.3	2.8	73.3	18.3
14697 15383 15385.	Subsoil	.2	.8	.6	1.3	1.9	68.1	26.3

HUNTINGTON SILT LOAM.

The Huntington silt loam is the characteristic soil of the White River valley. The soil is a yellowish-brown silt loam, usually containing from 15 to 20 per cent. of sand of the finer grades. The surface is sufficiently friable to yield readily to cultivation and, except in some of the heavier phases, is seldom cloddy. The soft, fine-grained quality which the soil possesses is due to the predominance of very fine sand and silt to the exclusion of coarser material. It contains very little organic matter, and consequently lacks the dark color and the open or mellow structure which this material would contribute. Even the heavier phases have little or no tendency to become granular.

There is no line of demarcation between the soil and subsoil. The latter resembles the surface, with perhaps the exception that it is a little brighter in color. The deep subsoil is a fine sand or fine sandy loam, grading into a coarse water-bearing material, which is said to lie from 10 to 15 feet below the surface.

In common with all alluvial types, the texture of both soil and subsoil varies considerably. Near the present river channel or in the neighborhood of former channels, portions of this type are underlain by a fine sandy loam, which may be much lighter at a depth of a few feet. Practically all of this soil has excellent capillary connection with the saturated stratum below, so that crops seldom suffer from drought.

With the exception of a few small areas on Richland, Plummer and Indian creeks, this type is confined to the flood plain of White River. It is strictly an alluvial soil of recent origin. All of it is subject to overflow, with a consequent deposition of much fine sediment. The most of the material now brought down during floods is the light yellow silt from the cultivated uplands. In the earlier days of the agricultural development of the county, the sediment left after each inundation was much darker in color, and doubtless consisted of the humus-bearing material from the virgin soils then in process of being cleared.

All this type was originally forested. Walnut, sycamore, elm, ash, yellow poplar, and many varieties of trees of less value attained a magnificent size. All the valley has long since been cleared excepting a fringe of timber along the river channel. Nearly all of this soil, as well as the adjoining areas of Huntington fine sandy loam, is annually planted to corn. Some wheat is grown on the high levels where there is little risk of damage by flood. There are very few clover or timothy meadows on this type.

Under favorable circumstances the yield of corn is seldom less than 40 or 50 bushels per acre, and twice this quantity is frequently produced. The quality is exceptionally good. Serious damage has been done several times by high water in June or even later, but the floods usually occur in the early spring and the land becomes dry enough to be prepared for corn.

The improvements on this type are of the poorest character, some areas not even being fenced. The greater part is devoted to corn year after year. Much of this acreage is planted by tenants who give from two-fifths to one-half of the grain for rent. Crop rotation and fertilization are given no consideration whatever. In many instances the land is plowed while wet, and were it not for the property this soil possesses of maintaining an almost constant moisture content it would not, with the poor preparation some of it receives, give such good yields. All of this type is valued highly for the production of corn, and ranges in price from $40 to $80 an acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

MECHANICAL ANALYSES OF HUNTINGTON SILT LOAM.

NUMBER.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
14698 15390.......	Soil...............	0.1	0.4	0.3	4.2	12.9	67.1	15.0
14699 15391.......	Subsoil............	Tr.	.3	.2	4.4	14.4	66.3	14.0

MARSHALL SILT LOAM.

The soil of the Marshall silt loam is a very dark brown or nearly black silt loam. The surface is loose and porous, slightly granular, and is easily pulverized. In a well-tilled field it is a soft, silty loam that absorbs moisture readily and has only a light tendency to crack or become compact. There is a good deal of organic matter present, and the dark color extends to a depth of 12 or 14 inches. The subsoil is lighter in color. From 14 to 24 inches it is usually a dull gray, somewhat mottled by yellowish-gray streaks, but grades below into a yellow, plastic silt loam, usually very moist and containing a few small iron concretions.

In some of the slight depressions and bordering areas of the Clyde clay the soil has a tendency to break into cubical fragments when dry and is rather sticky and tenacious when wet. Both the soil and upper part of the subsoil are apparently heavier and closer in structure than the average of this type elsewhere, but the clay of the surface is slightly lower. The greater part of the areas of this soil, however, have a very silty surface, and the clay content is highest from a depth of three or four inches to about 14 inches.

The few small areas of the Marshall silt loam found in this county lie along the margins of the marshes and at an elevation only slightly higher. All of them have been improved by artificial drainage. Tile drains have been found especially satisfactory, and the level fields are intersected by very few open ditches.

The soil was originally covered with prairie grass, and to the presence of this kind of vegetation may be attributed the high organic content which it has compared with the adjoining Miami silt loam. Low mounds of the latter type are associated with the areas of the Marshall silt loam, and while the textural differences are slight, the color and crop value of the two soils present a marked contrast.

Practically all this type is cultivated and included in exceptionally well managed farms. The average yield of corn is about 50 bushels per acre, and in favorable seasons 75 bushels is not unusual. It is probable that the average yield of oats exceeds that of most other soils in the county, yields of 40 to 60 bushels being made very frequently. The acreage sowed to wheat is not large, and the yield per acre is hardly in proportion to that of corn. It is an excellent clover and timothy soil, and heavy crops are usually secured. The second crop of clover is generally cut for seed.

No commercial fertilizer is used, and, in common with most of the black land, it receives but little barnyard manure. It is largely devoted to corn, and changes to wheat or oats, followed by one or two years of clover, are considered sufficient rotation to maintain the productiveness of this soil.

Well-improved farms on the Marshall silt loam are worth from $100 to $125 an acre. It is considered more desirable for general farming than the soils which have a slightly lower topographic position, and therefore are more dependent upon artificial drainage.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

MECHANICAL ANALYSES OF MARSHALL SILT LOAM.

NUMBER.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
15371	Soil	0.0	0.3	0.5	6.3	9.7	70.7	12.8
15372	Subsoil	.0	.6	.3	2.5	11.5	72.8	12.6

WAVERLY SILT LOAM.

The soil of the Waverly silt loam is a light-gray silt loam containing a moderate quantity of fine sand. When dry and in good tilth the surface is loose and floury, but when wet it is very soft, inclined to be miry, and on drying becomes compact and bleaches almost white.

The subsoil is a plastic gray silt loam, similar in texture to the soil. It is very retentive of moisture and is usually wet and cold. It generally contains numerous small iron concretions, which in some locations are so abundant at a depth of two or five feet that the subsoil is termed gravelly.

There is no distinct line of separation between the soil and subsoil. At a depth of 10 to 12 inches, iron stains give a more or less mottled appearance, gray and light yellow being the prevailing shades of color, with some of the small iron stains a deep brown.

There is generally little organic matter in the soil, but where there is more than the usual amount present it gives a dark-gray color, contrasting strongly with the very light surface of most of the type. The narrow strips along the small streams have better natural drainage than the large areas. They also contain a little higher percentage of sand, evidently through loss of the finer materials by erosion.

There are sandy phases of the type in the American bottoms and in some of the small areas in the southern part of the county. Here the soil, if it has been cultivated a long time, has an ashy gray color and a peculiar, inert appearance in the field, differing in this respect from the other silt and sandy loams of this area.

When in the proper condition with regard to moisture, the soil yields readily to cultivation. It is friable and often will be quite pulverulent to a depth of two or three inches, though deeper the soil is very moist.

This type is developed on the borders of the marshes. It is the alluvium of many of the small creeks in the western townships, and forms most of the second bottom land in the eastern half of the county. Several small areas are found on Eel River, but there is none of it in the valley of White River.

The surface is nearly level, and therefore the larger areas have poor drainage. They remain cold and wet in the spring when the surface of the darker soils is warm and mellow. Tile drains are said to be almost useless unless they are laid quite close together. Practically all the Waverly silt loam is included in the flat areas lying at the foot of the slopes covered with loess. In most instances the areas are underlain at a depth of 6 to 10 feet by an impervious silty clay. The excess of water from the higher levels must necessarily traverse the Waverly soil before it escapes into the natural or artificial drainage ways. The latter have invariably been constructed through the central parts of the low ground instead of at the margin. In some places the location of a ditch at the foot of a hill would intercept the ground water which follows the surface of the underlying rock. It is probable that the difficulty experienced with the tile drains is due to the very fine rounded sand or coarser grades of silt which this soil contains. These constituents are abundant enough in some places to give the soil a yielding quality something like that of quicksand.

The narrow areas of white soil on the creeks are said to be difficult to manage in wet seasons. Some of them are underlain by sand, and the poor drainage may be due to textural peculiarities, There are a few of these bench lands, however, which are underlain by rock.

All of this type was originally forested, the predominant varieties being beech and white and post oak. Much of it is now cleared. It is an excellent soil for timothy, and very heavy yields of a fine quality of hay are secured. Redtop and blue grass do well, and in a few years supplant the timothy in mowing lands. Well-drained fields will produce clover, but not all of the soil is now suited to this legume. The same may be said with regard to the cereals, the adaptability of a field to any one of them and the probable yield depending almost entirely upon the moisture conditions. If well drained, the returns are reasonably sure. If not ditched or tiled, the ground has little capacity to equalize any seasonal extremes, and the growing season must have frequent light showers to produce good yields of corn. Therefore no definite statement can be made with regard to the average yields of corn, wheat, or oats. All of the type is well adapted to grass, and many fine fields are found on the larger areas in the western section of the county.

This soil is greatly in need of humus. Applications of manure are apparent in change of color in the soil and a marked improvement in the growth of corn. The farmers state that no other kind of land responds so promptly to barnyard manure. It effectually changes the physical condition, rendering the soil more easily cultivated and greatly decreasing the tendency to bake at the surface.

This type is not valued so highly as the best Miami silt loam, but if well drained it may command $20 to $30 an acre.

The following table gives the average results of the mechanical analyses of the soil and subsoil of this type:

MECHANICAL ANALYSES OF WAVERLY SILT LOAM.

NUMBER.	Description.	Fine Gravel Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
14692 15361 15363.	Soil	0.3	1.1	0.7	3.7	5.8	68.5	19.2
14693 15362 15364.	Subsoil	.3	1.1	.8	3.8	7.3	64.1	22.1

MARCO CLAY LOAM.

The soil of the Marco clay loam is a light-colored silty clay loam. The surface varies from a very light gray to a dull yellowish gray. The soil is distinguished by its tendency to break into cubical fragments on drying. These particles are not generally as fine as the granules of Clyde clay. When wet the soil is very soft and plastic rather than sticky. It carries but little sand, and in its typical development the organic content is low. In some places a few inches of the surface is quite dark, but this color seldom extends much below the plow line.

The subsoil is usually a stiff, silty clay containing no coarse sand and very little fine sand. It is lighter in color than the soil, grading downward into a plastic yellow silt or silty clay. It has the properties of a silt loam rather than a clay. The underdrainage is poor, due principally to the low topographic position, but in some places the subsoil at a depth of five or six feet is a light bluish, tenacious clay identical with that which underlies so much of the Clyde clay.

This soil is distinguished from the Waverly silt loam by its somewhat darker color, its property of granulation, and the absence of small iron concretions. It is much lighter in color than the Clyde clay and lacks its high organic matter content. While not so strong a soil as the latter, it is very productive when well drained and cultivated. The largest body of this type lies in the south end of the Goose Pond Marsh. It is also typically developed in the Cane Marsh and in a small area west of Marco. The Marco clay loam which is found along some of the ditches west of Worthington has considerable organic matter in the first few inches of soil, but otherwise it resembles the typical soil as developed in the larger depressions.

All of the areas of this type are intersected by open ditches, for most of them are subject to overflow. Tile drains work well and render the land much more satisfactory in respect to drainage than the adjoining areas of Waverly silt loam.

The degree of success with all the cereals is determined by the efficiency of the drainage. Where the water table is constantly maintained at a depth of three or four feet, as it may be by tile drains, a loose granular condition of the soil is secured, very much in contrast with the surface of undrained fields. A yield of 75 bushels of corn per acre is said to be obtained upon one farm where a very efficient drainage system is in operation.

No very accurate statement can be made with regard to the yields of wheat and oats. The frequency with which some of the lower parts of the type are flooded, especially in the early spring, render these crops rather uncertain. The type is well adapted to grass, and heavy crops of clover and timothy are grown. Most of it is cultivated, however, and only a small percentage is used for pasture.

Aside from fences and drains, this type has very few improvements. It is usually included in farms which have other kinds of lands upon which the buildings are located. The cultural methods are similar to those practiced on the adjoining Clyde clay. Much of it has been under cultivation for such a short period that the necessity for rotation has not become apparent. Fall plowing for corn is considered desirable on account of the loose, crumbly condition of the surface which is thus secured.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

MECHANICAL ANALYSES OF MARCO CLAY LOAM.

NUMBER.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
14864 15369.......	Soil...............	0.3	2.0	2.5	15.9	11.9	38.4	29.5
14865 15370.......	Subsoil............	.1	.3	.9	5.1	2.8	57.7	32.9

CLYDE CLAY.

The soil of the Clyde clay is a black, silty clay or clay loam containing a high percentage of organic matter. When dry, the surface is very granular, breaking into small cubical fragments to a depth of two or three inches, thus forming a sort of mulch. When moist, the soil is soft and yielding to the touch, but if saturated it becomes very sticky. There is usually less than 15 per cent. of sand present and the loamy character of the surface is due principally to the large amount of organic matter and the consequent property of granulation.

There is no line of demarcation between the soil and subsoil. From the plow line to a depth of 20 or 30 inches the subsoil resembles the surface in color and texture. Below this depth it is a bluish-gray silty clay, very compact and exceedingly adhesive and tenacious.

In the Four-mile Marsh the subsoil of this type has strata of mucky material in some places near the drainage ditch. It usually becomes quite silty a few feet below the surface. At 8 to 10 feet a bed of very fine silty sand is found which possesses the properties of quicksand. In the Goose Pond Marsh the deep subsoil is a light bluish-gray clay, almost destitute of even the finest grade of sand and so compact and tenacious that it is practically impervious.

Where the organic content of the soil is above the average, there is usually some peaty material present which imparts a somewhat more open structure to the surface than other parts of the same field may possess. Such places are quite easily plowed and reduced to a good state of tilth. This is especially the case if the moisture content is low and granulation has taken place. If, however, the surface has been trampled when wet, or if for some reason the tendency to granulation is lacking, the soil is exceedingly refractory. A heavy plow can with difficulty be held in the furrow, and the irregular clods into which the ground breaks can not be pulverized until subjected to considerable weathering. In most cultivated fields, however, the surface is in loose, granular condition, favorable in every respect for plant growth, and presents no difficulty in its cultivation if work is not attempted too soon after a rain.

The soil of the Goose Pond Marsh has been modified and improved in texture during recent years by the deposition of material from the uplands. The northern and western tributaries of the Goose Pond Ditch drain more than 30 square miles of land. Most of this is cultivated, or at least cleared, and the storm waters are rapidly discharged into the main ditch. The marsh is frequently flooded, and the sediment, derived principally from the Miami silt loam, has affected the surface to a marked degree. The light-colored loess has been mixed with the original black soil as deep as the ground has been plowed. The silt forms a matrix, in which the black granules of clay and bits of peaty materials remain more or less distinct. The resulting soil, however, is easily tilled, and is in this respect superior to certain other areas of the type.

This soil is found in a few other locations besides the ones just mentioned. They are all low, level tracts, with poor natural drainage, and evidently were never timbered. Both of the larger areas —in the Four-mile and Goose Pond marshes—are level and drained by dredged ditches which have but slight fall. Crops on the Four-mile Marsh area are seldom injured by floods, but serious damage is of frequent occurrence on the Goose Pond area. A high ridge of upland, on the north and west, overlooks the Four-mile Marsh and has a decided tendency to check air drainage and to induce early frost.

Corn is the principal crop grown on this type. The average yields are high, and in favorable years 80 to 90 bushels per acre have been produced. Wheat and oats do not do so well. The latter crop is liable to lodge and the grain is of poor quality. Timothy and clover make excellent yields, but at present are not extensively grown.

The cultural methods generally employed on this type do not differ materially from those practiced on the Clyde sandy loam. Whenever practicable most farmers plow the corn ground in the fall in order to get the benefit of the granulation affected by alternate freezing and thawing. More care has to be exercised with regard to working the land when wet than is necessary on any other type in the county.

Notwithstanding its high organic matter content, this soil is said to respond to applications of barnyard manure and be benefited by clover. It is probable that as long as the present profitable returns can be secured without rotation or use of manure, corn will continue to be almost the only crop grown. The productiveness of this soil is of remarkable permanency, but continued grain growing will at length get the land in such a condition that change to other crops will be necessary. Clover and timothy can be introduced into a rotation for this soil, as it is well adapted to both.

In value this type ranks well with the Clyde sandy loam. Its areal extent is limited and of such irregular distribution that only a few farms consist entirely of this kind of land.

The drainage of Goose Pond Marsh has not yet been as successful as could be desired, the main ditch being inadequate to carry all the water its several branches and natural tributaries discharge into it. Improvements now in course of construction will probably prevent such damaging floods as have occurred in the last few years.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

MECHANICAL ANALYSES OF CLYDE CLAY.

NUMBER.	Description.	Fine Gravel, Per Cent.	Coarse Sand, Per Cent.	Medium Sand, Per Cent.	Fine Sand, Per Cent.	Very Fine Sand, Per Cent.	Silt, Per Cent.	Clay, Per Cent.
14694 15388.......	Soil...............	0.1	2.5	1.9	4.7	2.3	38.2	50.0
14695 15389.......	Subsoil...........	.0	1.5	1.3	6.4	3.1	41.9	45.8

Peat.

Several areas of peat are found in this county. The largest one lies in the southern part of the Beehunter Marsh and has an area of two square miles. Beginning about one-half mile north of Bushrod, this type occupies the greater part of the valley for a distance of two and a half miles and then gives place to the Waverly silt loam. The peat to a depth of six inches is a loose, fibrous or chaffy material containing a relatively large amount of silt and clay. Beneath this is a layer of true peat, a coarse, brown mass of vegetable fiber resembling old sawdust in color, but more or less stratified in its arrangement. There is very little earthy matter in it, and when dry it burns readily. This stratum grades downward into a black, sticky, water-logged layer of mucky material, soft and rather spongy and light in structure, but containing a relatively high percentage of mineral matter derived from the clay upon which it rests. The underlying clay is quite black where it is in contact with the muck, but changes with depth to a light bluish silty clay, very close grained and tenacious. In some places it is slightly marly.

The thickness of the peat varies from a few inches at the margin to several feet along the main ditch. The central ditch frequently overflows, and much silty sediment is dropped upon the surface and subsequently mixed with the vegetable matter through cultivation. This process, however, has been effective only during recent years, or since the surrounding uplands have been under cultivation and so many road ditches and other drains have been constructed.

Throughout the entire depth of this soil there are bits of decayed wood and other forest debris. Before it was drained there was considerable growth of bushes, besides grasses and other aquatic plants.

The Peat bed on Lattas Creek is not quite so large as the one just described. It consists essentially of the same kind of material, excepting that the soil does not contain so much mineral matter. Some parts of it are often overflowed, but the upper layer is very loose and chaffy and is almost a true peat. The entire formation rests upon clay or silty clay, and there is an intermediate layer of muck identical with that of the Beehunter Marsh. The eastern and some of the northern margin of the Lattas Creek bed is a shallow layer of chaffy, partially decayed vegetable matter, with a subsoil of black, compact clay. The central portion, however, contains the two quite distinct materials, peat overlying muck.

A few other small areas occur, all similar to the one just described. The small development in the Four-mile Marsh is, for the most part, a black muck.

The two larger areas of peat have been under cultivation about fifteen years. They were planted to corn as soon as cleared and drained, and for the first few years the crops averaged about 80 bushels per acre. In common with all such soils, this land does not produce a first-class quality of grain. The ears are large, but shrink on drying, and the grain does not possess as high feeding value as that grown on the heavier soils. During the last few years, owing to the danger from floods, these areas have been unsatisfactory for corn growing.

On most of this soil it has become difficult to secure a stand of corn on account of the cutworms and wireworms which infest it. Many fields have been planted to corn ever since they were drained, and the pests have thus been furnished with food and hiding places for years in succession. A change to other crops is usually the most effective method of ridding the land of these insects, though in the present case the selection of a suitable crop is difficult. Neither oats nor wheat are available, and timothy is the only common crop to which this peculiar soil is adapted. It makes an exceedingly heavy growth and is profitable for either hay or pasture, but since both of the injurious insects thrive in sod, a change to grass will not prove effectual in exterminating them. Similar soils in other areas are devoted to the production of onions and celery, but under present conditions it does not seem probable that these crops could be grown except in a limited way for the home markets. The larvæ of both insects pass the winter in the ground, and therefore deep plowing in the fall might prove helpful in some instances.

When these areas of peat were drained they gave great promise of being very valuable corn lands, and were rated accordingly. During late years they have declined in price to about one-half of what they were formerly considered worth. It seems probable that their true value lies between these extremes and should be determined by their adaptability to timothy, millet, and other forage or pasture crops, with the additional consideration that occasional heavy crops of corn of somewhat inferior feeding value can be grown.

Rough Stony Land.

The rough stony land embraces all those areas so rough or stony as to be of little agricultural value. It includes the rock outcrop along the streams, the steep, stony hillsides, and the land which is intersected by numerous deep ravines so close together that the narrow intervening ridges are worthless for general farming.

On Beech Creek both branches of clifty, and along the middle part of Richland Creek, there are bold outcrops of limestone. In many places the loess extends quite to the crest of the bluff. There is generally more waste land along the short tributaries which cut back into the upland than on the immediate borders of the creeks.

The limestone and the more resistant strata of the sandstone frequently outcrop well up toward the top of the divides and the slope below, while strewn with numerous fragments, has a depth of yellow silt over most of its surface. In general the crests of all the ridges, however narrow, are covered with loess, seldom less than two or three feet deep. This thins out on the steepest parts of their flanks and on their truncated extremities which overlook the deep valleys.

In the absence of a topographic sheet it is not possible to show the exceedingly irregular and branching outlines of these areas. There are many hillsides of high gradient, which, on account of the sandy nature of the underlying formations, have retained their loess covering better than those which consist of harder material. Wherever the average depth of silt exceeds 12 to 18 inches, these have been mapped as Miami silt loam. Much of the gravelly, sandy material along the glacial border is thus obscured by a mantle of silt which covers all except the very steepest parts, usually too narrow to be shown on a map of the scale used.

The value of this land ranges from $5 to $10 an acre. Most of it is used for pasture. There is very little of it which has not enough interstitial soil to support a fair growth of bluegrass. Much of the timber that remains in the county stands upon the least valuable portion of this type.

Riverwash.

Riverwash consists of coarse sand and gravel deposited on the inner side of some of the curves and in the abandoned channels of the river. The largest areas have been indicated on the map. These areas have no agricultural value.

SUMMARY.

This survey embraces all of Greene County, Ind. The county consists of four main physiographic divisions—the valley of the White River; the level, prairie-like bodies of land west of the valley; the undulatory highlands of the west and northwest townships, and the rough rolling uplands of the eastern half of the county. It is in the latter section that all the rough stony land occurs.

The climate is favorable for all agricultural pursuits common to the central part of the Mississippi Valley. The rainfall is very evenly distributed, and the period between killing frosts is about twenty-four weeks.

Each of the central and western townships has a larger population than the eastern ones. The western section is more generally productive, and there is a smaller percentage of waste or useless land. Very little arable land yet remains uncleared. The river valley is all under cultivation, but no farm residences are located in it. The reclaimed marsh land includes the largest and most productive farms.

Corn, wheat, oats, clover, and timothy are the chief crops. Stock raising receives comparatively little attention. While some live stock is kept on each farm operated by the owner, the greater part of all the grain produced is sold at the local market.

The soils of this county embrace fourteen distinct types. These range in texture from medium sand to heavy clay, but the majority of them are silts and fine sandy loams. The upland soils are very deficient in organic matter, and this is also true of several of the bottom land soils. Some of the alluvial types which carry a high percentage of humus are remarkably fertile.

The light-yellow silt loam of the Miami series—the Miami silt loam—is the dominant type. It occupies nearly all the upland and constitutes more than three-fourths of all the arable land in the county. It is a good grass land, and on account of its deficiency in humus its value as a grain soil depends very much upon the organic matter added through the application of barnyard manure or changes to grass. The roughest areas of this type frequently sell as low as $6 an acre, while the best of it, if well improved, commands $50 to $60.

The Miami sand and the Bloomfield sandy loam give good returns, except in unusually dry seasons. Their crop value is determined by the presence of a silty, clayey substratum that arrests the percolation of the rainwater and holds it within reach of growing crops.

The Marco fine sandy loam has a higher agricultural value than the Miami silt loam. The silty subsoil is a good moisture reservoir, and the type in general is very reliable for most farm crops.

The Marshall silt loam is one of the best soils in the county. It ranges in value from $100 to $125 an acre, a valuation based upon its worth for agricultural purposes.

The Clyde sandy loam is one of the best corn soils of the area and is well adapted to small grains and grasses.

The Clyde clay is a strong soil and has produced some very heavy yields of corn.

The Huntington silt loam and the Huntington fine sandy loam are the heavy and light soils, respectively, of the White River and its eastern tributaries. They are almost exclusively devoted to the culture of corn. They stand less in need of change to other crops than any of the other soils, for they are subject to floods that carry a great deal of sediment.

The Waverly silt loam is a very light-colored soil and is locally termed "crawfish land." Its natural drainage is poor, and it is deficient in humus. Such areas as have been drained produce fine crops of corn and wheat, but most of the type is better adapted to timothy.

The peat has been drained and is devoted to the production of corn and timothy. The average yields of the former have declined during recent years, but good crops are frequently secured.

The main county roads are well constructed, and many of them are graveled. Those in the eastern section are generally located on the crests of the divides, but necessarily have many steep grades. The eastern townships have practically no local markets, and the difficulty of transporting farm products to the larger towns or to other shipping points has retarded the development of this part of the county along those lines of agriculture to which it is best adapted.

The greater part of the area is well served by numerous local telephone lines and has rural free delivery of mails. Five railway lines afford good shipping facilities to outside markets, especially to Chicago, Indianapolis and Evansville.

Soil Survey of Marion County, Indiana.

By W. J. Geib and Frank C. Schroeder.
U. S. Bureau Soils.

DESCRIPTION OF THE AREA.

Marion County is located approximately in the center of the State of Indiana and is bounded on the north by Hamilton and Boone counties, on the west by Hendricks, on the south by Morgan

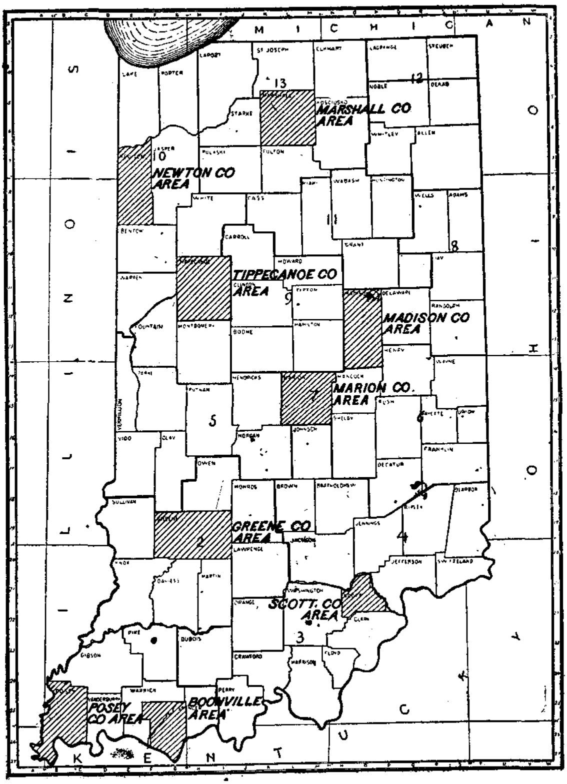


Fig. 1.—Sketch map showing location of the Marion County area, Indiana.

and Johnson, and on the east by Shelby and Hancock counties. It has an area of 248,704 acres, or about 389 square miles.

In topography the surface varies from level to gently rolling or rolling. That portion of the area which lies within the bottoms along White River is level, with only here and there slight undulations, and about one-third of the remainder of the area is also level or undulating. The level stretches in the upland, which vary in size from one to four or five square miles, are surrounded by and gradually grade into gently rolling and rolling lands. The roughest portion is found along Eagle Creek in the northwestern corner of the county. Here a few of the slopes are too steep to be cultivated. Other limited areas of broken land are found at intervals along Eagle and Fall creeks and White River. One very conspicuous hill lies in the southwestern part of the county on the west side of the White River, about one and a half miles from the county line. It can be readily seen for miles, as it reaches an elevation of nearly 100 feet above the surrounding country. Another prominent hill or short ridge lies immediately northeast of Glen Valley.

The average elevation of the county above sea level is 860 feet, and occasionally an elevation of 900 feet is reached. The mean elevation of the land above the valley of White River is 175 feet.

The White River, running in a tortuous course 20° east of north and south of west, divides the county unequally, the western portion being a little more than one-half as large as the eastern, or one-third of the whole area. After crossing Marion County the White River continues in a southwesterly course until it is joined by the east fork of the White River, and thence it flows into the Wabash River and later into the Ohio.

The drainage of practically the entire county is directly into the White River. Eagle Creek enters the area near the northwest corner, flows southerly, and empties into the White River a few miles below Indianapolis. Fall Creek enters the northeast corner of the county, flows southwest, and empties into the White River within the city limits. Several other smaller streams traverse portions of the county and join the river. Buck Creek, which crosses the southeast corner of the county, flows into the east fork of the White River.

Throughout those portions of the county where the surface is gently rolling or rolling, or where there are gravel beds within four or five feet of the surface, the natural drainage is good. Where the surface is level, however, as is frequently the case throughout the uplands and always in the bottoms, the natural drainage is often deficient. There are also numerous small depressions, formerly swamps, in which the natural drainage is poor. Tile drains and open ditches have been employed with marked success where the natural drainage is deficient. Practically all the swamps, none of which were of great extent, have been reclaimed, and the value of these formerly cold and wet lands has been greatly increased.

The first settlement within the limits of the present survey was made on the site of Indianapolis in 1820. Marion County was organized by act of the Legislature in 1821. The central and western portions were settled first, but it was not long until settlers were scattered over the entire area. The early settlers came from Kentucky, Ohio and Pennsylvania, and a few from Virginia and the Carolinas. At the present time the population throughout the rural districts is evenly distributed.

Indianapolis, the capital of Indiana and the county seat of Marion County, is located in the central part of the area, as well as in the center of the State. From the completion of the first railway, in 1847, to the breaking out of the Civil War there was a decided quickening of the city's energy and development. More railroads were constructed and business expanded. Railroad building continued with Indianapolis as a center, and the population increased rapidly. The growth of the city has been and still is steady and permanent. The industries of the city have a wide range, and include the manufacture of farm implements, carriages, and farm machinery. The most important villages are Southport, West Newton, Valley Mills, Bridgeport, Clermont, Broad Ripple, Lawrence, Oaklandon, Cumberland, New Bethel, and Acton.

The transportation facilities for this county and the surrounding country are excellent. Radiating from Indianapolis like the spokes of a wheel, there are fifteen steam railways and twelve electric lines. So completely do these roads traverse Marion County that no point is more than four miles distant from a steam or electric railroad. Within the area there are approximately 175 miles of steam railways and 135 miles of electric lines.

The dirt roads of the county are kept in excellent condition, and owing to the numerous deposits of gravel there is an abundance of excellent road-building material. There are about 350 miles of free gravel roads within the area and more are being improved each year. All toll roads have been abolished.

Indianapolis, with its population of 230,000, affords an excellent market for the products of Marion and the adjoining counties.

Large quantities of hay, grain, dairy and poultry products and vegetables are shipped in from the surrounding country to supply the city markets.

Climate.

There are no marked peculiarities in the climatic conditions of the area. Extreme temperatures seldom occur and the rainfall is well distributed throughout the year. The following table, compiled from the records of the Weather Bureau station at Indianapolis, shows the mean monthly, annual, absolute maximum and minimum temperature, and mean monthly and annual precipitation, as well as the total amount for the driest and wettest years, and also the average depth of snow:

Normal Monthly and Annual Temperature and Precipitation, Etc., Indianapolis.

Month.	Temperature.			Precipitation.			
	Mean. ° F.	Absolute Maximum. ° F.	Absolute Minimum. ° F.	Mean. Inches.	Total Amount for the Driest Year. Inches.	Total Amount for the Wettest Year. Inches.	Snow, Average Depth. Inches.
January	28	69	—25	2.8	1.6	4.9	6.9
February	31	72	—18	3.3	1.6	4.6	4.4
March	40	82	0	3.8	4.1	7.4	3.6
April	52	87	19	3.4	3.2	2.3	1.2
May	63	96	31	4.0	2.4	5.1	0.1
June	72	100	39	4.4	3.5	7.5	0.0
July	76	106	48	4.2	0.8	7.5	0.0
August	74	101	46	3.2	3.6	5.9	0.0
September	67	98	30	3.3	0.7	3.9	0.0
October	55	89	—22	2.8	3.5	4.4	Trace.
November	42	76	— 5	3.7	1.2	2.3	1.6
December	33	68	—15	3.0	4.1	0.9	5.1
Year	53	106	—25	41.9	30.3	56.7	22.9

As will be seen from the foregoing table, the average annual precipitation is 41.9 inches. The greatest amount of rainfall occurs in May, June, and July, and the smallest in October and January. The average annual temperature is 53° F.

The following table gives the dates of the last killing frosts in the spring and the first in the fall, for the period of seven years:

Dates of First and Last Killing Frosts.

Year.	Indianapolis.		Year.	Indianapolis.	
	Last in Spring.	First in Fall.		Last in Spring.	First in Fall.
1899	Apr. 9	Sept. 30	1904	Apr. 21	Oct. 23
1900	Apr. 13	Nov. 6	1906	Apr. 23	Oct. 19
1901	Apr. 9	Oct. 18			
1902	Apr. 8	Nov. 23	Average	Apr. 13	Oct. 24
1903	Apr. 5	Oct. 24			

It will be seen from this table that the average date of the last killing frost in the spring is April 13, and of the first in the fall is October 24, thus giving a growing season of over six months.

AGRICULTURE.

As stated elsewhere in this report, the first settlement in Marion County was made in 1820, prior to which time little was known of this immediate locality, except the information gained by early hunters and traders. The Indians who occupied this portion of the State before the advent of the white settlers had cleared small patches of ground here and there in the forest, and small quantities of corn were raised.

At this time the entire county was covered with forests of oak, beech, maple, walnut, ash, elm, hickory, and sycamore, and the clearing of fields was a difficult task. The timber, which would now be very valuable, was cut down and burned. The first crop was usually corn, and there was more of this staple grown than any other in the early days. Wheat was also grown, and hay was made from the wild grasses. By 1850 there were in Marion County 82,525 acres of improved land in farms, the cash value of which was $3,461,545. During this year there were 1,123,860 bushels of corn; 110,334 bushels of wheat; 89,318 bushels of oats; 21,831 bushels of potatoes, and 7,485 tons of hay produced within the county.

The methods of culture followed were somewhat crude. Cultivation was never as thorough as at the present time. The ground was turned with a breaking plow, harrowed once, sometimes not at all, and the seed planted. Though the cultivation was deficient, the soil was new and strong and good yields were obtained. Corn was often grown upon the same field for twenty consecutive years, and the same was true of wheat. Practically no attention was paid to the rotation of crops. The bottoms were recognized as being better adapted to corn, while the uplands were known to be better suited to small grain crops.

Corn, which was the leading staple in early days, is still the first crop of importance. Probably the largest acreage was devoted to corn in 1880, when there were 60,937 acres, which yielded 2,227,537 bushels, or about 37 bushels to the acre. A larger yield was obtained in 1900, when 56,759 acres produced 2,431,640 bushels, or an average of 43 bushels per acre. In 1906 the acreage was 42,845, with an average of 45 bushels per acre. The average for 1905 was 45¼ bushels per acre. Yellow corn is grown almost entirely, and it is of good quality. While portions of the area produce as high as 70 bushels per acre, a conservative estimate places the average yield at 40 bushels. Much more care is being taken now than formerly in selecting seed and in cultivating the crop.

The extensive growing of wheat has been continued longer in this part of the country than in many other sections, for the reason that the soil is fairly well adapted to the production of this grain and a comparatively small amount of labor is required. Only winter wheat is grown. In 1880 there were 34,527 acres in wheat, which produced 729,330 bushels, or an average of 21 bushels per acre. In 1900 there were 49,791 acres, which yielded 848,980 bushels, or 18 bushels per acre. In 1906 there were 27,944 acres, which yielded 707,583 bushels, or 25 bushels per acre. This last was an exceptional yield and the largest in the history of the county. For the years 1903, 1904, and 1905 the averages were, respectively. 13, 11, and 16 bushels per acre. For the entire county 16 bushels per acre is considered an average crop. The acreage of wheat is decreasing, as is also the yield per acre. Continuous cropping of wheat on the same fields has reduced the productivity of the soil until under present conditions wheat growing is not as profitable as formerly.

The acreage of oats in Marion County has always been comparatively low, but it has been on the increase for the last few years. In 1880 there were 6,275 acres; in 1900, 6,071 acres; and in 1906, 15,786 acres devoted to this crop. A yield of 35 to 40 bushels per acre is considered an average for this section.

The soils of the county are well adapted to the production of grasses, and the yields of hay are from 1¼ to 2½ tons per acre. Timothy and clover both yield well. These are usually seeded with wheat, there being but little of either sown without a nurse crop. Hungarian and German millet are also grown to a small extent, and a few patches of sorghum are seen. Little attention has been given to alfalfa. A few small fields occur, but do not give satisfactory yields. With careful attention alfalfa could be profitably grown.

Considering the excellent market afforded by Indianapolis, it would seem that more Irish potatoes could be profitably grown in the area. In 1900 there were 2,421 acres in the county, which yielded an average of 73 bushels per acre. In 1905 there were 2,052 acres, with an average yield of 104 bushels per acre, and in 1906 the average was 70 bushels per acre. Within the last few years the growing of tomatoes and peas for canning purposes has received some attention. In 1906 there were 1,230 acres of tomatoes and 1,379 acres of peas in the county. The yield of tomatoes varies from 125 to 225 bushels per acre, and the price paid thus far averages about 22 cents per bushel. An average crop of peas is expected to net about $40 an acre.

There is but one canning factory in the area, but another is located a few miles south of the county line. These factories contract with the farmers to grow a certain acreage. The factory grades the peas and pays a stated price for each grade. A large percentage of the vines are fed to stock. Substations or branch factories should be established at various points throughout the county.

Strawberries are grown to some extent, and 250 crates of 24 quarts each is considered an average yield per acre. The vines are allowed to bear for two years, when the beds are plowed up. Currants, raspberries, blackberries, cabbage, lettuce, radishes, and other truck crops are also grown, but the trucking industry has never been extensively developed in the vicinity of Indianapolis. Apples, peaches, and pears are grown only to a limited extent. There are a few pear orchards of commercial size. Almost every farm has a few apple trees and sometimes a few peach trees, but these fruits are not especially adapted to this section. A few grape vines have been planted and do fairly well. It is thought that the grape and pear industry could be profitably extended.

Owing to the large quantity of dairy products consumed in Indianapolis, dairying has developed into an important industry in the surrounding country. A number of farmers make a specialty of dairying, while many others practice general farming and engage in dairying to some extent. Most of the cows are turned out to pasture during the summer. By employing soiling crops, much larger herds could be supported upon the same acreage. Comparatively few silos are found in the area. Judicious planting of such crops as oats, peas, millet, corn, and sorghum will provide a continuous supply of good forage until the time of killing frosts in the fall, and sufficient silage for the remainder of the year. There is at present a predominance of Jersey blood in the dairy stock, but there are also many of the so-called dual-purpose cows. It would be more advisable for the dairyman to make a specialty of the dairy breeds.

Approximately 20,000 gallons of milk and 8,000 gallons of cream are delivered daily to patrons in the city of Indianapolis.

Only one-sixth of this quantity is produced in Marion County, the remainder being shipped in on the electric and steam roads from the surrounding country for a distance of 50 to 60 miles. The county produced in 1906 719,424 pounds of butter. Much creamery butter is shipped in from various parts of Indiana, Illinois and Wisconsin. There are only a few creameries within the county.

The number of beef cattle is much less than the number of dairy cattle. There were in the county in 1905-6 about 3,000 head. The number of hogs on hand over three months old was 17,337. Only a few sheep are kept at the present time. Taking the statistics of the State agricultural report for 1906 and reckoning the number of horses, cattle, sheep and swine in the county, it is found that there are approximately three acres of improved land for each animal. By more intensive farming the number of live stock should be greatly increased.

There are large stockyards in Indianapolis to which local stockmen can easily deliver their fat stock directly. The nearness of this market tends to encourage the raising of fat stock, as freight charges and commissions are saved. There are several farms in the area which make a specialty of raising horses, mostly racing stock.

In the matter of crop adaptation, it has been recognized for many years that the soil along the bottoms of White River and its tributaries is better adapted to corn, and that the upland soils are better suited to the small grain crops. The closer adaptation of crops to soils has not been worked out. The following rotation is practiced: Corn, oats, wheat, and grass. Hay is usually cut from a field for two years, after which the field may be pastured for one or two years longer.

All the stable manure produced on the farms is applied to the fields, but this supply is insufficient to meet the needs of the soil. Large quantities are also brought from Indianapolis. The manure from the stockyards can be obtained for 25 cents a load. This is very rich and contains but little straw or litter of any kind. Loss is frequently incurred by stacking the manure in the field and allowing it to remain for considerable time. It should be spread upon the field as soon as hauled.

Throughout this county, as in many other sections, the farmers experience some difficulty in securing labor for the farm. To obtain good help the farmer must be willing to pay as much as the factories or other industries of the city. When such wages are paid, sufficient labor can be secured. On the farms $1.50 a day with board is usually paid for ordinary work, though it is sometimes necessary to pay $2 a day during harvesting or other busy periods.

Many of the larger farms are being divided into smaller holdings and more intensive methods of cultivation are being followed. The average size of farms in the county in 1900 was 70.6 acres. The census of 1900 states that 48.4 per cent of the farms of the county were operated by the owners. As the average size of farms decreases the proportion of those who operate their own farms increases. The rental price of farm land is high, ranging from $4 to $7 an acre, and even as high as $10 an acre. The highest rent is paid for the trucking land near the city. Only a few farms are rented on shares, but when this system is followed the renter furnishes everything and gives the landowner one-third of the crop, or each may furnish half and divide the crop equally. The cash rental is preferred.

The value of farm lands in the county is constantly increasing. The price ranges from $75 to $300. There are few farms for sale in the county for less than $100 an acre.

Considering the high price of land and the low yields of wheat, the acreage of that crop should be reduced and the land be devoted to more intensive farming. The yields of corn can be increased by careful selection of seed, thorough cultivation, and proper fertilization. A careful study should be made of the needs of the soil, so that fertilizers may be applied intelligently. In Indianapolis it is no uncommon thing for the customer to pay $1 or more a bushel for Irish potatoes, and the price seldom falls below 50 cents. It can not be too strongly urged on the attention of the farmers of this section that there is a good opportunity for the growing of this crop.

There is also splendid opportunity for the higher development of the dairy industry, since so small a percentage of the dairy products consumed in Indianapolis are produced in Marion County. Milk sells for seven cents a quart, and the price of creamery butter seldom falls below 30 cents a pound.

SOILS.

Marion County includes three distinct geological formations. The eastern portion of the area is underlain by Carboniferous limestone 60 to 100 feet below the surface. Two miles west of the city of Indianapolis the limestone is underlain by black Genesee shale, which has a thickness of 40 feet. In the extreme southwest corner of the county the Genesee shale is overlain by the Knob sandstone. These rock formations are covered to a depth of from 50 to 100 feet by a deposit of drift which forms the surface of the county and determines the character of soils. This drift is foreign in character and general in distribution. It is not a promiscuous deposit of clay, sand, and water-worn pebbles and bowlders like much of the eastern glacial drift. Such materials are found in it, but with not nearly as much regularity and order as is usually found in stratified rocks. At the base of the drift formation is usually found a compact lead-colored clay. Occasionally may be found thin deposits of very fine gray or yellow sand. Between the clay and the rock on which it rests is generally interposed a layer of coarse gravel or small siliceous bowlders. Sometimes this is wanting and the clay lies directly on the rock. In Marion County this clay bed ranges from 20 to 100 feet in thickness and is very uniform in character throughout, except where the light strata of fine sand occur. Above this is generally found a few feet of coarse sand or fine gravel and on this gravel from 20 to 30 feet of true glacial drift of more promiscuous character. In and upon the drift are a few glacial bowlders of granite, gneiss, and trap, which rocks are not found in place nearer than the Lake Superior region, whence they have been carried. In the upper drift are the glacial terraces and beds of gravel from which is obtained the best available material for road construction. The most of it is yellow or orange colored clay with considerable quantities of sand and lime. The gravel terraces are generally found in a succession of small mounds or ridgelike elevations from 10 to 15 feet above the surrounding country and usually rest on a compact clay.

The lower blue clay represents an earlier glaciation (probably Illinoisan) than the overlying softer drift of late Wisconsin Age. The material is fine and very much harder and more compact than the drift forming the present surface. The glacial debris which covers this entire region has been influenced since its deposition by weathering and the action of water until at the present time there are seven distinct though closely related soils within Marion County.

Excluding the Muck these soils represent two series—the Miami and the Huntington. The Miami series, which is by far the more extensive, gives rise in the present survey to five soil types, namely, Miami clay loam, Miami loam, Miami sandy loam, Miami gravelly loam, and Miami black clay loam. The Miami clay loam, the most extensive type in the county, embraces nearly all of the upland soil, It has been formed directly from the unmodified drift and is therefore very uniform in texture. The Miami loam, which is closely related to the clay loam, though coarser in texture and containing a higher percentage of sand and fine gravel, has been formed from drift which has been modified to some extent by the action of water, and much of it occurs as a terace soil lying between the bottoms and the upland. The Miami sandy loam contains a high percentage of sand and some fine gravel and occurs as low ridges or patches adjoining the bottom land. The Miami gravelly loam also occurs as low ridges or hills. The Miami black clay loam occupies depressions in the upland where swampy conditions formerly prevailed and where large amounts of organic matter have accumulated.

The Miami soils occur throughout Indiana, Ohio, Michigan, Illinois, Wisconsin, Iowa, and Minnesota. They are all of glacial origin, and owing to the fact that the organic matter content is low, they are, with one exception, light in color.

The Huntington series, which comprises the alluvial soils lying along the water courses throughout this region, is represented in the present survey by only one type, the Huntington loam.

The Muck represents accumulations of organic matter in advanced stages or decomposition. Only a very limited amount of Muck was encountered in the area.

The following table gives the names and areas of the several soil types shown in the accompanying map:

AREAS OF DIFFERENT SOILS.

Soil.	Acres.	Per Cent.	Soil.	Acres.	Per Cent.
Miami clay loam	188,672	75.9	Miami sandy loam	512	0 2
Huntington loam	31,040	12 5	Muck	256	.1
Miami loam	24,768	10 0			
Miami black clay loam	2,880	1.1	Total	248,704	....
Miami gravelly loam	576	.2			

MIAMI CLAY LOAM.

The surface soil of this type consists of a light-brown or ash-gray fine loam or silty loam extending to a depth of 8 to 12 inches. The color varies considerably with the moisture conditions. Immediately after a rain when there is the maximum amount of moisture present the soil is of a brown color, but when the surface becomes dry the soil is ashen-gray, or frequently whitish in color. In the small depressions where organic matter has accumulated the surface is always darker than on the higher places. The texture may vary slightly in different localities, but there is always present a high percentage of silt which imparts to the soil a smooth feel.

The subsoil to a depth of 36 inches consists of a brown, yellow or mottled, stiff, tenacious clay loam. There is frequently present in the subsoil below 24 inches a sufficient amount of angular gravel to impart a slightly gritty feel. This gravel content sometimes increases with depth, and the size and proportion of gravel may increase until a gravel bed in a clay matrix is encountered. The gravel is often lacking when the subsoil grades into bowlder clay. The areas under which gravel beds may be encountered are small when compared with the extent of the entire type.

Some difficulty is occasionally experienced in securing a good seedbed if cultivation is not carried on under proper moisture conditions. Clods sometimes form, and considerable time is required to pulverize them. If plowed when moisture conditions are favorable, however, there is but little difficulty in putting the soil in good tilth.

The Miami clay loam is the most extensive type, occupying nearly 76 per cent. of the area of the entire county. The same soil extends for many miles beyond the limits of the present survey. It occurs with remarkable uniformity in different parts of the county, with the exception of such changes as attend the varying drainage conditions in local areas. Occupying the uplands, its elevation is greater than that of any other soil in the area. The White River, which is bordered on both sides throughout most of its course by the Huntington loam and Miami loam, divides the survey into two parts of unequal size. The continuity of the two extensive areas of Miami clay loam is broken only by the bottom land along the small streams and the small areas of Miami black clay loam which occupy the depressions where large amounts of organic matter have accumulated.

The surface of the Miami clay loam varies from level to gently rolling, becoming more rolling and broken along some of the streams. The roughest portions are found in the northwest corner of the county along Eagle Creek and in the northeast corner along Fall Creek. There is a sharp descent from the upland to the streams, and here some of the slopes are too steep to be cultivated. The broken areas are of small extent, however, and the gently rolling surface is again encountered at a distance of from one-fourth to one-half mile from the streams. Between the areas of Miami clay loam and the White River the steep descent found along portions of Fall and Eagle creeks is absent, but there is usually a gradual descent to the bottom lands. Sometimes there is a well-defined terrace where a drop of 8 to 20 feet occurs. The gradation from the Miami clay loam into the Miami loam is frequently so gradual that it is difficult to establish a boundary.

Where the surface of the type is rolling or where there is gravel underneath, the natural drainage is good, but where the surface is level or nearly so, and in the small depressions, the drainage is poor. In these places tile drains and open ditches have been constructed and their use has proved very profitable. The extension of these drains would further increase the value of the land in many instances.

The material from which the Miami clay loam is derived consists of glacial drift which was laid down by the great ice sheet. The depth of the younger glacial drift is usually from 20 to 30 feet, while the depth to the underlying rock is from 50 to 150 feet. A few glacial bowlders occur upon the surface, but not in sufficient numbers to interfere with cultivation. These are of granite, gneiss, and trap.

The original timber growth on this type consisted of beech, oak, hickory, maple, elm, ash, and walnut. The entire county was originally covered with timber, but the forests have gradually disappeared until only a few scattered wood lots of 5 to 15 acres are to be seen.

The Miami clay loam is considered a good general farming soil, and such crops as wheat, corn, oats, and hay are grown successfully. In the early days wheat was grown extensively and often on the same field year after year. The acreage of corn is greater now than formerly, though this crop was always extensively produced. Instances were found where fields have been cropped continuously to corn for twenty years. This custom has been greatly improved upon, but even at the present time it can not be said that a systematic crop rotation is practiced upon this type. The most common practice is to have wheat follow corn. Clover and timothy are seeded with the wheat and the meadow is left for two years, after which the field may be pastured for one or two years, when it is planted again to corn. When oats are grown this crop usually follows the corn. Corn and wheat are frequently grown for two years in succession in the same field. It will thus be seen that there is little regularity in the system of cropping.

The yields of wheat vary considerably, but an average for ten years is placed at 16 bushels per acre. Forty bushels is considered an average yield of corn and oats. Hay yields from 1½ to 2½ tons per acre. Irish potatoes do fairly well upon this type and yield an average of 100 bushels per acre. Tomatoes and peas are grown for canning purposes, and the acreage is increasing. Tomatoes yield 200 bushels per acre and an average price for the last few years has been 22 cents a bushel. Forty dollars is considered a fair average net return from an acre of peas.

Near Indianapolis some trucking is carried on, and this industry could be profitably extended. Strawberries do very well; also currants and raspberries. Grapes, though not grown to any extent, could be profitably produced on a commercial scale. The acreage of wheat should be reduced and a more intensive system of agriculture practiced. A greater number of live stock should be kept and there is a good opportunity for the extension of the dairy industry.

All the stable manure produced on the farm is used upon the fields and considerable amounts are brought from the city. Commercial fertilizers are also used, and their use is considered profitable.

Farms in the Miami clay loam range in value from $75 to $250 an acre, depending on the location.

The following table shows the average results of the mechanical analyses of the soil and subsoil of this type:

MECHANICAL ANALYSES OF MIAMI CLAY LOAM.

NUMBER.	Description.	Fine Gravel. Per Cent.	Coarse Sand. Per Cent.	Medium Sand. Per Cent.	Fine Sand. Per Cent.	Very Fine Sand. Per Cent.	Silt. Per Cent.	Clay. Per Cent.
17620 17624	Soil	1.1	6.6	3.9	13.9	9.2	50.6	14.1
17621 17625	Subsoil	.5	5.1	4.3	14.4	10.3	44.4	20.4

MIAMI LOAM.

The surface soil of the Miami loam consists of a mellow brown loam of medium to fine texture extending to an average depth of 12 inches. There is frequently present on the surface and mixed with the soil a small amount of gravel, but this is never sufficient to interfere with cultivation or to affect the agricultural value. The subsoil to 36 inches consists of a heavy loam or light clay loam which contains sufficient fine, angular gravel to make it decidedly gritty. The gravel content usually increases with depth, and a bed of gravel is sometimes encountered at three to four feet. Small ridges of gravelly loam occur at intervals and where these are of sufficient size they have been indicated on the map. On the slopes between this type and the Huntington loam there is often found a narrow band of gravel, but it is usually too small to be indicated.

The Miami loam differs from the Miami clay loam in that the surface is darker in color and coarser in texture. There is much less silt present in the surface soil; the subsoil contains a much larger percentage of fine gravel than the Miami clay loam, which makes the natural drainage conditions somewhat better. The Miami loam is easy to cultivate and a mellow seed bed can be secured more readily than on the clay loam.

The Miami loam is frequently spoken of as second bottom land, and throughout a portion of its extent it appears as a terrace soil between the Huntington loam and the Miami clay loam. The largest area lies directly west of Indianapolis, between White River and Eagle Creek, and extends south on the west side of Eagle Creek to two miles below Maywood. Another area of considerable size lies between Lick Creek and the south county line bordering the bottom land along the river. Other areas of smaller extent occur along the White River to the north of Indianapolis and along Fall and Eagle creeks.

The surface varies from level to gently rolling. Where level, as is more often the case, the areas of this soil have the appearance of being a broad terrace. The boundary between this and the Huntington loam, or first bottom, is often very distinct, there being a sharp descent of 5 to 20 feet, with a distance of a few rods. The boundary between the Miami loam and the clay loam, however, is not so marked. There is occasionally a sharp rise, but it is more often a gradual slope, so that the two soils grade into each other, making it difficult to establish a dividing line. Where the surface is gently rolling the appearance is practically the same as the surface of the clay loam, and there is no suggestion of its being a terrace or second bottom.

Owing to the gravel present in the subsoil, the natural drainage is good. Over portions of the type, however, where the surface is level, tile drains greatly improve the physical condition and the productivity of the soil. The Miami loam has been derived from the glacial drift which covers the region. The presence of beds of water-worn gravel at depths of from three to five feet indicates that portions of the type at least have been influenced by the action of water to a greater extent than the Miami clay loam, in which the gravel is more angular.

The Miami loam is a good general farming soil and produces fair yields of wheat, oats, corn, and hay. The system of cropping is the same as on the Miami clay loam, no definite crop rotation being followed from year to year. Potatoes, tomatoes and peas are also grown, and the trucking industry has been developed to a greater extent than on any of the other soils of the county.

Wheat yields an average of 15 bushels per acre, corn 45 bushels, oats 45 bushels, and hay from one and a half to two tons per acre. Corn and oats seem to do a little better on this soil than on the heavier type, but all things being considered they are of about the same value for general farm crops. The loam is better adapted to truck crops than the clay loam and it should be devoted more extensively to this industry, as much greater returns per acre could be secured than are now obtained by general farming. Stable manure is used extensively and commercial fertilizers are also applied to this soil.

Farms on this type of soil range in value from $100 to $300 an acre.

The following table shows the average results of the mechanical analyses of fine-earth samples of the soil and subsoil of this type:

MECHANICAL ANALYSES OF MIAMI LOAM.

NUMBER.	Description.	Fine Gravel. Per Cent.	Coarse Sand. Per Cent.	Medium Sand. Per Cent.	Fine Sand. Per Cent.	Very Fine Sand. Per Cent.	Silt. Per Cent.	Clay. Per Cent.
17614 17616.......	Soil...............	1.3	9.1	11.6	16.5	8.3	39.9	13.3
17615 17617.......	Subsoil............	2.3	12.9	12.7	11.4	5.5	41.5	14.1

HUNTINGTON LOAM.

The surface soil of the Huntington loam to a depth of 10 to 16 inches consists of a mellow, brown to dark-brown loam of medium to fine texture. There is usually sufficient silt present to impart a smooth feel to the soil. In small depressions and for a short distance back from some of the streams the soil is often nearly black in color, owing to the excess of organic matter accumulated in these places.

The gradation from soil to subsoil takes place gradually, and frequently there is little change to a depth of 20 inches. The subsoil becomes slightly heavier with increased depth until at 24 inches it is a heavy loam. The color is a dark brown, usually becoming lighter with depth. The subsoil contains considerable silt to a depth of 36 inches, where a bed of sand is sometimes encountered. Lenses of sand are scattered throughout the type, but these are not of sufficient size to be indicated in the map. This type is comparatively easy to cultivate, and a mellow seed bed is readily secured.

The Huntington loam occurs as first bottom along the White River and all of the smaller streams within the survey. The most extensive area lies along White River from Indianapolis south to the county line. Throughout this distance it varies in width from one to two miles. The type continues north of the city, but is scarcely ever more than one-half mile in width. The bottoms along Eagle and Fall creeks are also of this type, and there is a narrow strip along practically all of the smaller streams within the county. The soil in these smaller bottoms is frequently influenced by the wash from the higher lands, and therefore there are some differences in this soil in the more extensive bottoms. This variation, however, is never of sufficient importance to warrant the establishing of a new type.

The Huntington loam is an alluvial soil, being composed of glacial material which has been reworked and redeposited by the action of the streams, along which it is now found. The surface is level, with only here and there slight undulations and small depressions. Owing to this topography and the low-lying position, the natural drainage is poor. The soil lying close to the river is frequently overflowed, and as a result crops are damaged. Levees have been constructed in some places, and these now keep the river within its banks for a portion of its course. Tile drains and open ditches have been constructed, and at present almost the entire type is under cultivation. When the river overflows a sediment is left upon the surface, which is very beneficial to the soil.

The original timber growth on this soil consisted of ash, elm, and sycamore, with some hickory, oak and beech. The land is used for general farming, although corn is grown more extensively than any other crop and is better adapted to the soil than grass or grain crops. While wheat and oats are grown to some extent, the grain often lodges badly and does not properly mature. Hay makes a rank growth and may also lodge before it matures.

On that portion of the type subject to overflow the yield of corn is about 70 bushels per acre, while on that not overflowed 50 bushels is considered a good average crop. This difference is due to the sediment deposited, which proves to be a very valuable fertilizer. Oats average 40 bushels and hay from $1\frac{1}{2}$ to 2 tons per acre.

Stable manure is used to some extent on a portion of this soil which is not overflowed, but commercial fertilizers only sparingly. Upon some of the areas near the city trucking is followed with good results. Tomatoes, peas, lettuce, cabbage, onions, radishes, strawberries, and potatoes are grown with profit. This industry should be extended.

Farms range in value from $125 to $400 an acre, depending on the location.

The following table gives the results of mechanical analyses of samples of soil and subsoil of this type:

MECHANICAL ANALYSES OF HUNTINGTON LOAM.

NUMBER.	Description.	Fine Gravel. Per Cent.	Coarse Sand. Per Cent.	Medium Sand. Per Cent.	Fine Sand. Per Cent.	Very Fine Sand. Per Cent.	Silt. Per Cent.	Clay. Per Cent.
17626	Soil	0.0	0.8	1.1	13.0	31.1	44.2	9.0
17627	Subsoil	.6	1.8	1.0	16.4	22.2	48.4	9.6

MIAMI BLACK CLAY LOAM.

The soil of the Miami black clay loam consists of a heavy, black loam or light clay loam extending to an average depth of 14 inches. The depth varies somewhat, being greater in the center of an area than near the outer margin. The soil contains a high percentage of organic matter, and to this may be attributed the black color. With increased depth the color becomes lighter. The soil is cohesive, with a tendency to puddle, and if cultivated too wet large clods are formed which are difficult to pulverize. On drying, cracks an inch wide and a foot deep are often formed on the surface. If cultivated at the proper time little difficulty is experienced in securing a good seed bed. The soil gradually becomes heavier with increased depth; below 14 to 16 inches it grades into a clay loam of drab or grayish color, and at 24 to 30 inches it may have a yellowish or mottled appearance.

The Miami black clay loam occupies only a small percentage of the area surveyed. It occurs in small basinlike depressions throughout the upland, and is occasionally found along some of the smaller streams. These bodies vary in size from 5 to 160 acres. They are most numerous in the southern part of the county in the vicinity of Southport, but small patches may be encountered in any part of the survey.

The material composing the Miami black clay loam is of glacial origin, but since its deposition it has been modified to considerable extent. Prior to the construction of drainage systems sufficient to carry off the surplus water these small areas were covered with swamps and marshes. Through the growth and decay of vegetation large amounts of organic matter have been added to the soil, the rapid oxidation of which was prevented by the excessive moisture. Some of the finer particles of soil have been washed into these depressions from the surrounding higher land, and this has had considerable influence on the texture of this soil.

Though of limited occurrence, the Miami black clay loam is very good soil, especially for the production of corn. When well drained and under favorable climatic conditions it produces 50 bushels per acre. Although there is danger of lodging, the average yield of oats is estimated at from 35 to 40 bushels per acre. It is also well adapted to clover and timothy, the latter yielding from one to two tons per acre. Only the best drained areas are suited to clover, because in the wet places the soil heaves badly and the plants are killed.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

MECHANICAL ANALYSES OF MIAMI BLACK CLAY LOAM.

NUMBER.	Description.	Fine Gravel. Per Cent.	Coarse Sand. Per Cent.	Medium Sand. Per Cent.	Fine Sand. Per Cent.	Very Fine Sand. Per Cent.	Silt. Per Cent.	Clay. Per Cent.
17618..............	Soil...............	0.2	3.1	3.7	12.5	12.5	56.3	12.1
17619..............	Subsoil............	.0	2.1	2.7	11.8	10.5	56.0	17.6

MIAMI GRAVELLY LOAM.

The surface soil of this type consists of a heavy brown sandy loam or loam of medium texture extending to an average depth of 12 inches. There is present on the surface and mixed with the soil from 10 to 20 per cent. of gravel usually less than one-half inch in diameter. The subsoil is a brownish, light clay loam usually containing a higher percentage of gravel than the soil, and frequently grading into a bed of gravel at two to four feet.

The soil is of small extent. The largest area is found in the extreme southern portion of the county just northeast of Glen Valley. Here the soil occurs as a ridge 40 to 50 feet higher than the surrounding country, and extends for 1½ miles from northwest to southeast. Another gravel hill of considerable size lies adjacent to the west side of the White River, one-half mile north of the south county line. Other small bodies are scattered about the county, but most of them are found near White River or one of its tributaries. These small divisions occur as low, narrow ridges or nearly level areas. The largest area somewhat resembles a moraine. The entire type is of glacial material, portions of which have been influenced by the action of water.

The greater proportion of the type is under cultivation and, while it frequently suffers from drought, fair yields are obtained. The crops grown are the general farm crops, corn, oats, wheat, and grass, which are common to this section of the country.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

MECHANICAL ANALYSES OF MIAMI GRAVELLY LOAM.

NUMBER.	Description.	Fine Gravel. Per Cent.	Coarse Sand. Per Cent.	Medium Sand. Per Cent.	Fine Sand. Per Cent.	Very Fine Sand. Per Cent.	Silt. Per Cent.	Clay. Per Cent.
17610.............	Soil...............	3.4	16.1	14.0	8.5	7.8	39.6	11.4
17611.............	Subsoil............	6.4	9.3	18.1	9.3	3.9	21.5	31.9

The following samples contained more than one-half of 1 per cent. of calcium carbonate ($CaCo_3$): No. 17610 2.41 per cent., No. 17611 8.80 per cent.

MIAMI SANDY LOAM.

The surafce soil of this type, to an average depth of 10 inches, consists of a light, brownish sandy loam of medium texture. There is present on the surface and mixed with the soil a small amount of fine gravel. The subsoil is a light-brown or yellowish loamy sand of medium to coarse texture, containing varying amounts of fine gravel and frequently grading into a gravel bed at three feet.

This type is of very small extent, occupying only about one square mile. Four small patches, which constitute the greater part of the Miami sandy loam, are found about seven miles southwest of Indianapolis, lying adjacent to the bottom land along White River. There are a few small areas scattered about the county, but all are of little importance. The usual occurrence of this soil is in the form of low ridges, knolls, and small terraces. The material is derived from glacial débris, much of which has been modified to some extent by the action of water.

The natural drainage is excellent and the type is somewhat droughty at times. At present the soil is used for general farming, but as it is earlier and more easily worked than the other soils of the county, it should be devoted to the trucking industry. The yields obtained are slightly below those from the heavier soils.

The following table gives the results of mechanical analyses of samples of the soil and subsoil:

MECHANICAL ANALYSES OF MIAMI SANDY LOAM.

NUMBER.	Description.	Fine Gravel. Per Cent.	Coarse Sand. Per Cent.	Medium Sand. Per Cent.	Fine Sand. Per Cent.	Very Fine Sand. Per Cent.	Silt. Per Cent.	Clay. Per Cent.
17612..............	Soil................	4.3	34.2	19.4	19.0	2.4	13.6	6 5
17613..............	Subsoil............	3.7	34.4	21.6	18.0	2.6	12.9	5.8

MUCK.

Only two areas of Muck were mapped in the survey of Marion County, and those are of a very limited extent. The material consists of vegetable matter in advanced stages of decomposition. Fine earth from the higher surrounding land has been mixed with this type. In color the Muck is black and extends to a depth of 18 inches to four or five feet, usually resting upon a bed of clay.

One of the areas lies five miles due west of Southport, while the other is about the same distance northwest. The former is now in a condition of swamp, but could be easily drained; the latter is cleared, drained, and under cultivation. Corn and grass are grown, but the type is better adapted to celery, and as there is an excellent market for this vegetable in Indianapolis the soil should be entirely devoted to its production.

SUMMARY.

Marion County lies in the central part of Indiana and comprises an area of approximately 389 square miles. The surface varies from level to gently rolling, becoming broken near some of the streams, especially in the northwestern part along Eagle Creek and in the northeastern part along Fall Creek. The average elevation above sea level is 860 feet.

The first settlement in the area was made in 1820. Indianapolis, population 230,000, the capital of the State and the county seat of Marion County, is located in the center of the area. Fifteen steam and 12 electric railways enter the city. There are over 350 miles of free gravel road within the county. All toll roads have been abolished.

The climate does not differ materially from that of other Middle States in the same latitude. Extremes of temperature seldom occur and the rainfall of 41.9 inches is well distributed throughout the year.

Corn is the principal crop. The average yield for the county is 40 bushels per acre. The soils are well adapted to wheat, but continuous cropping has reduced the yield, the average yield being 16 bushels per acre. The acreage is also decreasing at the present time. The acreage of oats has always been comparatively small, but it is increasing slowly. Irish potatoes do fairly well and yield an average of 90 bushels per acre. All trucking crops suited to this climate do well, although the trucking industry has not been extensively developed. Considering the excellent market afforded by Indianapolis, there is a good opportunity for the truck farmer.

Dairying is not followed as extensively as would be expected near a large city. Approximately 20,000 gallons of milk and 8,000 gallons of cream are consumed by the city daily, and of this only about one-sixth is produced within Marion County. There is a fine opportunity for the extension of the dairying industry.

In 1900 the average size of farms was 70.6 acres, and at the same time 48 per cent. of the farms were operated by their owners. The size of farms is decreasing, while the proportion of farms being worked by the owner is increasing.

The soils of the area belong to the Miami and Huntington series. The Miami soils have been derived from the glacial material which covers this entire region to a depth of from 50 to 150 feet. The Huntington soils are alluvial in origin. Seven types, including muck, were mapped.

The Miami clay loam, the most extensive soil in the county, occupies about 76 per cent. of the area surveyed. The surface is level or gently rolling, except near some of the streams, where it is broken. It is considered a good general farming soil, and farms upon this type vary in value from $75 to $250 an acre.

The Miami loam is also a good general farming soil and somewhat better adapted to truck crops than the Miami clay loam. Farms on this type range in value from $100 to $300 an acre.

The Huntington loam occurs as an alluvial soil along the White River and its tributaries. It is especially adapted to corn, and frequently produces 70 bushels per acre. Portions of it are subject to overflow. It has practically the same value as the Miami loam.

The Miami black clay loam occupies the depressions in the upland. It contains a very high percentage of organic matter and is very productive. It produces an average of 50 bushels of corn per acre.

The Miami sandy loam and Miami gravelly loam are types of very small extent and little consequence.

The Muck comprises two areas of decaying vegetable mold in advanced stages of decomposition. Both areas are small and of little importance.

Water Power of Indiana.

By W. M. Tucker.

The work of this report is the continuation of the work contained in the Thirty-fifth Annual Report. In this report, the water power of the northern part of the State is treated in about the same manner as the water power of southern Indiana was treated in the thirty-fifth report. The subject is treated in a very preliminary way, with the idea of giving a general view of the water power conditions and possibilities in the north. All the work was done on the St. Joseph and Wabash systems. The Maumee and Kankakee systems have not been investigated. All the field work of this report was done during June, July and August of 1911. During this time the following streams were traversed between the points named, by boat:

River.	*Upper Point.*	*Lower Point.*
Pigeon	Howe	State Line.
Elkhart	Benton	Mouth.
St. Joseph	State Line, E.	State Line, W.
Eel	North Manchester	Mouth.
Tippecanoe	DeLong	Mouth.
Mississinewa	Marion	Mouth.
Wabash	Benton	Logansport.
Wabash	Mouth of Tippecanoe	State Line.

The Pigeon River was traversed on foot and leveled from Howe to Mongo, and also Sugar Creek from Bluff Mills to near its mouth.

The plan of traversing these streams was to ship the boat to the head of the stream and work down stream. The boat was fully equipped for camping, with tent, folding cots, cooking utensils, etc. A level, current meter and other instruments were also carried in the boat. The entire weight of boat and outfit was about 500 pounds. A camp could be quickly established wherever there was work to be done, or when night came on. The writer was assisted in this work by J. C. Clark, a student of civil engineering in Purdue University. Mr. Clark's work was highly commendable and his companionship entirely pleasant. We received many accommodations from chance acquaintances and wish to express our thanks to them. The work of the gage readers has also been highly commendable during the year.

The water power of northern Indiana is much more valuable than that of the southern part. This is due to the natural storage afforded by the numerous lakes and swamps and by the deep deposits of glacial sand and gravel. This is the one important point of difference between the two sections of the State. The dividing line between these sections is the Wabash River. All the northern tributaries of the Wabash, and all the streams which lie north of the Wabash basin have considerable storage. The long belt of small lakes which extends from the northeast corner of the State to Kosciusko County forms an immense storage, and equalizes the flow of all the streams which rise therein. All the streams north of the Wabash, which were traversed during the field work of this report, rise in this belt of lakes. All of the streams show the effect of the lakes by a much more regular discharge than those which do not rise in this region.

The climatic conditions in the northern part of the State are slightly less favorable to water power than in the southern part. The average temperature is several degrees colder, which results in greater interference from ice. Ice interferes with the development of water power in three ways, namely, as ice jams, as anchor ice, and by stopping the flow of the tributaries. Ice jams are caused by floating ice which may form a temporary dam that will rob a site of its water so effectually that no power can be produced for some time. This does not usually last long, but it comes at an unexpected time and is especially troublesome to plants producing power for public use. Even if auxiliary steam power is installed, it could not be started soon enough to keep the power from running low in case of an ice jam. The jam is also dangerous to the exposed works of the site. An ice jam is often responsible for the destruction of a dam or other development.

Anchor ice is the name given to small particles of ice which form in the water just before the stream freezes over. These small particles will collect suddenly on the wheels and gates of a plant in sufficient quantities to completely shut down the power. In case that the anchor ice begins to form on the wheel, the best thing to do is to shut off the water until the stream freezes over. Anchor ice is much less apt to form after the stream has frozen over.

The freezing of tributary streams usually occurs during extremely cold nights. The ripples of the smaller streams freeze entirely to the bottom and the discharge of the stream is entirely stopped. This often causes extremely low discharge on the main stream and it may last for several days.

The rainfall is somewhat lighter on the average in the northern part of the State than in the southern. The difference is about three inches per year. This makes considerable difference in the runoff.

The absence of bed rock formations for dams in the north makes the building of dams more expensive and also a greater risk. Great care must be exercised to prevent undermining where the foundation is of mantle rock.

The conditions which have been discussed in the introduction pertain especially to the St. Joseph system. This system lies mainly in Michigan. In discussing the water power of this system, the tributaries will be treated first and the main stream last.

PIGEON RIVER.

Pigeon River rises in the lake district of Steuben County, south of Angola. It flows west by northwest across Steuben and Lagrange counties, Indiana, and St. Joseph County, Michigan, and empties into the St. Joseph River near the southeast corner of Cass County, Michigan. Its total length is approximately seventy miles, of which the lower fourteen miles are in Michigan.

Pigeon River valley is shallow. The bluffs average about forty feet in height. The average width of the valley is about three-eighths of a mile and is very irregular. The wider parts of the valley are swampy and usually covered with small timber and swamp grasses. At several points the valley narrows to a width of 300 yards or less. These narrows are excellent points for power development.

The basin of Pigeon River lies entirely within the glacial drift, and at no point is bed rock exposed. Its tributaries have their source in the small lakes of southern Lagrange and Steuben counties. The tributaries lie almost entirely south of the main stream, because Fawn River runs parallel to the main stream, about five miles to the north of it. Thus the tributaries to Pigeon River from the north are necessarily small. The abundance of small lakes within the basin tends to make the discharge of the stream fairly constant. The drainage area of Pigeon River basin within Indiana is approximately 350 square miles.

The United States Weather Bureau has three observation stations in or near this drainage basin. The stations are at Angola, Steuben County, at Auburn, Dekalb County, and at Lima, Lagrange County.

TABLE SHOWING THE MONTHLY, ANNUAL, MEAN MONTHLY AND MEAN ANNUAL PRECIPITATION IN INCHES AT ANGOLA FOR YEARS 1900-1907.

YEAR.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total Annual.
1900.......	1.37	5.23	2.88	2.21	2.23	4.60	8.02	3.86	1.50	4.35	5.58	0.65	42.48
1901.......	3.19	1.93	3.26	2.54	2.75	4.10	5.95	4.58	0.87	6.15	1.81	3.47	40.60
1902.......	1.10	1.32	4.04	1.20	5.28	8.52	3.64	1.55	4.81	1.77	2.66	4.67	40.56
1903.......	1.59	4.15	1.81	4.20	2.44	3.35	5.66	5.80	3.15	1.91	1.93	3.27	39.26
1904.......	3.96	4.77	7.72	2.71	3.84	1.78	3.15	4.39	2.93	2.54	0.14	1.83	39.76
1905.......	2.15	2.29	2.37	3.67	5.61	4.10	4.13	2.88	4.45	4.42	2.07	1.69	39.83
1906.......	2.64	1.12	2.53	2.60	2.49	5.17	3.81	7.28	2.68	3.15	3.49	4.11	41.07
1907.......	4.01	0.28	3.54	2.95	4.13	2.98	*	*	*	*	*	*	....
Mean......	2.50	2.39	3.52	2.77	3.60	4.32	4.91	4.33	2.91	3.47	2.53	2.81	40.06

TABLE SHOWING THE MONTHLY, ANNUAL, MEAN MONTHLY AND MEAN ANNUAL PRECIPITATION IN INCHES AT AUBURN FOR YEARS 1900-1910 INCLUSIVE.

YEAR.	Jan.	Feb.	Mar.	Apr.	May.	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total Annual.
1900.......	0.76	5.05	1.89	1.98	2.44	5.61	5.29	3.87	1.39	2.44	4.45	0.45	35.62
1901.......	1.58	1.44	1.15	1.94	2.45	2.87	1.38	3.71	1.30	3.71	1.15	1.57	24.25
1902.......	0.43	0.63	2.73	1.42	3.81	7.84	2.57	0.80	*	*	2.07	2.85	....
1903.......	1.15	3.89	1.08	4.92	3.04	4.10	2.62	3.50	1.75	2.10	0.93	2.14	31.22
1904.......	4.28	3.75	5.37	2.86	3.10	1.79	1.72	4.92	3.31	1.40	0.13	1.17	33.71
1905.......	2.40	0.96	2.00	3.64	6.35	5.03	3.11	2.91	2.62	2.59	3.62	1.74	36.97
1906.......	1.89	0.78	2.36	2.40	2.94	3.85	3.46	3.99	2.52	2.29	*	3.60	....
1907.......	4.35	0.19	3.15	1.91	4.95	6.23	5.72	2.01	2.92	2.17	2.44	4.95	43.35
1908.......	*	4.04	2.64	2.37	5.11	0.96	2.80	3.24	0.63	0.44	*	1.58	....
1909.......	2.95	5.28	1.79	3.59	3.68	5.09	1.69	3.38	2.64	2.40	3.81	2.87	39.17
1910.......	2.53	1.51	0.13	3.03	2.05	0.42	4.33	4.11	3.30	1.30	1.97	2.15	26.83
Mean......	2.03	2.50	2.21	2.73	3.63	3.97	3.15	3.31	2.24	2.08	2.29	2.29	32.43

*Report missing.

TABLE SHOWING THE MONTHLY, ANNUAL, MEAN MONTHLY AND MEAN ANNUAL PRECIPITATION IN INCHES AT LIMA FOR YEARS 1905-1910 INCLUSIVE.

YEAR.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total Annual.
1905.......	......	......	......	......	.....	......	......	......	......	......	1.85	1.40	....
1906.......	2.32	0.40	1.99	2.89	3.41	4.99	1.96	2.38	1.74	2.02	3.21	3.33	30.64
1907.......	2.94	0.22	5.03	3.26	4.55	4.87	6.68	2.69	4.07	2.80	1.58	5.30	43.99
1908.......	0.89	4.83	2.63	3.25	6.51	1.30	2.18	2.90	0.91	0.53	2.30	1.15	29.38
1909.......	2.28	4.14	1.74	4.99	5.51	6.94	3.58	6.63	3.21	2.28	4.27	2.60	48.17
1910.......	2.30	1.55	0.73	3.61	3.35	1.81	4.49	1.93	2.76	1.68	2.10	2.18	29.94
Mean......	2.15	2.15	2.43	3.60	4.76	3.98	3.78	3.31	2.54	1.86	2.53	2.48	36.42

The mean annual rainfall for the Pigeon River basin as shown by these tables is 35.87 inches. The lowest monthly records are in November, 1904, February, 1907, and March, 1910, in which the rainfall was less than .2 inches. These months, however, were preceded and succeeded in each case by a monthly rainfall of 1.5 inches or more, except at Auburn, in November, 1904. Thus the average for any three consecutive months, except in the one case at Auburn, is more than 1.0 inch. A monthly rainfall of 1 inch over 350 square miles would supply a continuous discharge of 313.7 cubic feet per second, if all the water were carried away. However, since the discharge of the stream in this latitude is usually about one-third of the precipitation within its basin, the discharge of Pigeon River would be slightly more than 100 cubic feet per second for the months of 1 inch rainfall. The average precipitation for the eleven years was 1,129 cubic feet per second, and the average runoff should have been 376.3 cubic feet per second.

The discharge of Pigeon River is very regular because of the storage facilities of the lakes and swamps which it drains. The minimum discharge never reaches as low as 100 cubic feet per second. Two discharge measurements taken at the wagon bridge near Howe, Indiana, on July 11 and 12, show a discharge of 126 and 120 cubic feet per second respectively. At this time the stream was very low, and close observers of it claimed that it was as low as they had ever seen it. Since the stream is considerably larger at the State line than at Howe, the discharge would be correspondingly larger. Since no gage is maintained on this stream, the minimum discharge will be considered as 120 second-feet at Howe and 150 second-feet at the State line.

The profile of Pigeon River is very irregular, which is characteristic of young streams. The fall is greatest near the source and mouth and more gentle in its middle course. The following table shows the profile of the stream as derived from railroad levels.

PROFILE OF PIGEON RIVER.

LOCATION.	Distance, Miles.	Altitude, Feet.	Fall per Mile, Feet.
Source	0	1000	....
Mongo	32	895	3.28
Ontario	7	865.5	4.21
Howe	3	861	1.5
Seybert	7	834	3.86
State Line	5	813	4.2
Mouth	14	752	4.36

POWER SITES ON PIGEON RIVER.

Within the part of Pigeon River in Indiana which has been investigated by the survey, there are three developed power sites and two which could be easily developed. The developed sites are at Mongo, Ontario, and Scott. The undeveloped sites are one-fourth mile west of the section line between Sections 1 and 2, T. 37 N., R. 10 E., and at the crossing of the L. S. & M. S. Railroad between Seybert and Twin Lake.

Mongo.—This site was first developed and a mill erected in 1831. The dam was built of earth and has not been rebuilt. It is still in good condition. The gates and spillway have been replaced from time to time. The natural advantages for a dam at this point are not good. The river is wide and the dam is in two sections, separated by an island. It is built on glacial drift. The height of the dam is ten feet and total length about 300 feet. There is a deed reserve for a 10-foot head at this point. The water is conducted by two short races to the wheels.

On the north side of the river the power is used in a flour mill and electric plant. The present mill was built in 1869 and the electric plant installed in the same building recently. There are six wheels in this building, five of which are old style, wood curb, single bucket wheels. The other is a modern Samson Leffel, 35-inch wheel, which is rated at 77.9 H. P. under a head of ten feet.

On the south side of the river the power is used in a sawmill and an elevator. Two wheels are employed in these buildings. They are old style standard Leffel wheels which are improperly installed and are therefore inefficient. They produce ample power for the two plants.

The total power produced at this site was estimated by the owners at 100 H. P., which is approximately the amount that can be produced by a minimum discharge at this point. This power is owned and employed by Hawk Brothers.

Proposed Site in Section 2, T. 37 N., R. 10 E.—Between Mongo and the proposed site in Section 2, the valley is irregular in width and is bordered by considerable swamp land. At present, this land is worthless except for pasture land. The fall between Hawk Brothers' tail race and the proposed site is 18.26 feet. At the quarter section line, west of the section line between Sections 1 and 2, the valley suddenly narrows to a width of 500 feet from bluff to bluff. The bluffs are thirty feet high and are composed entirely of glacial drift. A dam of twelve feet could be constructed at this point, which would submerge about 300 acres of land. With this storage and a minimum discharge of 110 second-feet about 250 H. P. could be produced for a ten-hour day and twelve feet fall. The cost of developing this power would be comparatively small if reasonable options could be secured on the land which would be submerged.

Ontario.—The power site at this point was first developed about 1840. Since its establishment it has been used constantly and has furnished power at various times for a woolen mill, a chair factory, a glove mill, a planing mill, a flour mill, and will operate an electric plant which is now being installed. The dam is situated in a broad, flat part of the valley. It is seven feet high and approximately 500 feet long. The dam is built of boulders and brush, with concrete abutments. The storage basin covers approximately five acres. The fall from the site in Section 2 to the tail race is 10.5 feet. The mill is situated one-fourth mile below the dam on the south side of the stream. It is a flour mill and was built in 1882. The race is built in glacial drift and is well removed from the stream which bends northward below the dam. During the summer of 1911, the whole site was improved. New concrete abutments, gate and forebay were built and two 45-inch Samson Leffel wheels installed with a joint capacity of 287 H. P. An electric plant was installed in the mill, and the electricity is being used in Lagrange for light and power. The flour mill is also in operation. The head used at the mill is ten feet. The minimum discharge was estimated by a representative of the Leffel Wheel Company from one rough measurement, using the old irregular dam crest as a weir, at 19,000 cubic feet per minute. This discharge would produce a continuous 287 H. P. and a head of ten feet. Careful discharge measurement with a current meter at Howe on July 12, 1911, showed the discharge to be 120 cubic feet per second, which on a head of ten feet will produce 109 H. P. continuously. This discharge was probably near the minimum. However the periods of deficient flow will not occur often and the discharge will usually be sufficient to produce 287 H. P. This power is owned and operated by C. F. Cain, Ontario, Indiana.

Proposed Site in Section 28, T. 38 N., R. 9 E.—Between Ontario and the proposed site in Section 28, the Pigeon River valley is irregular in width. For three miles the stream has little fall and the valley is narrow. After passing Howe, the valley widens and much swamp land appears. In Section 34, T. 38 N., R. 9 E., the stream flows through Pigeon Lake, a body of water one-half mile long and one-eighth mile wide. In Section 28, where the L. S. & M. S. Railroad crosses the stream, the valley narrows to a width of 400 feet. The bluffs are about thirty feet in height. The fall from Ontario is 31.5 feet. A dam twenty feet in height at this point would submerge a large tract of land, not only along Pigeon River but along Buck Creek, which flows into Pigeon Lake from the south and along the tributary from the north which drains Twin Lakes. This storage basin would probably cover five square miles, and would be sufficient to store enough water for dry seasons so that the discharge could be maintained far above the regular minimum. The minimum of 200 second-feet could certainly be maintained at this point, and practically the whole year the discharge could be held to 250 second-feet. Two hundred second-feet on a 20-foot head would produce 364 H. P. continuously and for a ten-hour day, 700 H. P. could be maintained. The convenience of the L. S. & M. S. Railroad makes this an inviting site for a manufacturing plant. One disadvantageous feature of this site is that the dam site is lower than the railroad bridge and a 20-foot dam would submerge the railroad.

Scott.—Pigeon River again enters swamp land after passing the narrows in Section 28. No favorable site for dam construction occurs between Section 28 and the State line. At Scott, formerly known as Van Buren, is an old power site which is located in a very poorly adapted place. Even at low water in this part of the course, the channel is banked full and the least rise causes it to flood the swamps on either side. In the midst of such conditions, a dam has been constructed and a race leads away to the mill a half mile below. A mill was located at this site about fifty years ago. The present mill was built in 1905. A concrete dam was built in 1907 but proper foundation was not secured and it was undermined and broken out in 1908. At present there is a boulder dam flanked by the remains of the concrete. A head of seven feet is maintained at the mill. Two 56-inch Standard Leffel wheels, each rated at 50 H. P. under seven foot head, are employed. The power is used for grinding and sawing. This power is owned and employed by the firm of Boehmer & Ritzer.

Between Scott and the State line there is no feasible power site. One developed site occurs at White Cloud, Michigan, where the power is used in a paper mill.

Tables showing developed and undeveloped power on Pigeon River in Indiana:

Developed.

Location.	Head. Ft.	Min. Flow, Sec.-Ft.	Min. Power, H. P.
Mongo	10	110	100
Ontario	10	120	109
Scott	7	150	96
Total			305

Undeveloped.

Sec. 2, T. 37 N., R. 10 E.	12	110	120
Sec. 28, T. 38 N., R. 9 E.	20	250	364
Total			484

ELKHART RIVER.

The Elkhart River rises by many small tributaries among the lakes of Noble and southern Lagrange counties. It flows in a general northwestern direction, across Noble and Elkhart counties, and empties into the St. Joseph River at Elkhart. Its total length is approximately seventy miles.

The character of the valley of Elkhart River is much like that of Pigeon River. However, the valley is more distinct and has much less swamp land bordering it than has the Pigeon River valley. Some swamp land occurs between Benton and Goshen, but below Goshen the valley is distinct and no swamp land occurs. The valley lies entirely within glacial drift, and no bed rock is exposed. The glacial drift of this section of the State is heavier than in any other section and is approximately 200 feet deep on the average.

The entire basin of Elkhart River lies within the heavy glacial drift and no rock is exposed. Nearly all the tributaries rise in the small lakes which abound in this region. A group of lakes about Rome City and Walcottville, another south of Albion, and a small group east of Ligonier aggregate an enormous storage in the head waters of the Elkhart and tend to cause the flow to be very regular. The sudden and destructive floods of the streams of similar drainage areas of the southern part of the State are unknown and there is no time, even in the driest seasons, when there is not considerable water flowing in this stream, while streams of similar drainage area in the southern part of the State would entirely cease to flow. The drainage area of the Elkhart River is practically 450 square miles.

United States Weather Bureau maintains but two observation stations within the basin of the Elkhart. These are at Auburn, Dekalp County, and Elkhart, Elkhart County. The stations at Lima, Angola and Winona are near this basin. The records from Angola, Auburn and Lima have been given in the discussion of Pigeon River.

TABLE SHOWING MONTHLY, ANNUAL, MEAN MONTHLY AND MEAN ANNUAL PRECIPITATION IN INCHES AT ELKHART FOR YEARS 1902-1910 INCLUSIVE.

YEAR.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total Annual.
1902	......	......	......	......	......	......	......	......	......	0.70	2.10	2.03	....
1903	1.60	1.76	1.18	3.76	1.38	1.36	6.26	4.82	3.72	1.13	1.85	2.18	31.00
1904	2.79	3.31	4.22	2.02	2.72	3.75	2.35	3.26	2.43	*	*	*	....
1905	*	*	*	*	6.23	3.14	4.84	4.49	2.64	2.81	2.57	1.49	....
1906	3.29	1.04	2.61	1.97	2.02	3.82	3.89	4.08	1.30	2.12	3.38	4.03	33.55
1907	3.17	0.25	4.95	2.91	5.57	3.06	5.34	3.01	3.45	2.53	1.92	3.49	39.65
1908	1.79	6.49	3.71	3.60	6.77	2.28	1.62	2.72	1.02	0.17	2.31	1.69	34.17
1909	2.12	2.81	1.96	3.20	2.70	5.32	3.51	4.21	2.92	*	4.49	2.77	....
1910	1.57	1.46	0.42	3.40	4.56	1.32	2.94	3.01	5.69	2.49	3.18	2.25	32.29
Mean	2.33	2.45	2.72	2.98	3.99	3.01	3.84	3.70	2.90	1.71	2.47	2.49	34.59

*No report.

TABLE SHOWING MONTHLY, ANNUAL, MEAN MONTHLY AND MEAN ANNUAL PRECIPITATION IN INCHES AT WINONA LAKE FOR YEARS 1908-1910 INCLUSIVE.

YEAR.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total Annual.
1908	......	5.13	3.44	*a*3.72	8.16	0.67	2.77	*f*2.00	......	0.16	1.59	1.36	....
1909	2.35	4.85	2.58	4.23	3.47	7.80	3.53	1.67	2.80	2.29	4.55	2.62	42.74
1910	2.09	2.11	0.17	3.90	3.86	0.77	1.72	2.48	5.61	1.85	2.22	2.12	28.90
Mean	2.22	4.03	2.06	3.95	5.16	3.08	2.67	2.05	4.20	1.43	2.79	2.03	35.67

Letters indicate the number of days missing from monthly record, as *a*, 1; *b*, 2, etc.

These tables show a precipitation of .17 inches at Winona Lake, in March, 1910, and at Elkhart in October, 1908. These are the months of least precipitation. In each case the precipitation of the preceding and succeeding months was sufficient to make an average of more than one inch. Because of the lake storage in this basin, the flow during dry seasons is very regular. If we consider one inch per month over the entire basin, 450 square miles, and consider the discharge to be one-third of the precipitation, it would be 134.4 second-feet continuously. This discharge would produce 12.2 H. P. per foot fall.

A single discharge measurement on the Elkhart, one and onhalf miles east of Station 19 on the Elkhart-Goshen Traction line and about five miles above the mouth, showed a discharge of 212.17 second-feet. This measurement was taken July 25, 1911, during comparatively low water. Such a discharge would produce 19.3 H. P. per foot fall continuously.

According to the estimates made by the manager of the Hawks Water Power Company, at Goshen, Indiana, the amount of power which they produce during the minimum flow on a head of sixteen feet for 10 hours per day is 300 H. P. This would be equivalent to 8.33 H. P. per foot fall continuously.

No gage has been established on this stream and the minimum discharge as estimated from the foregoing data is approximately 135 second-feet at the mouth and seldom falling below 200 second-feet. Such a discharge would produce 12 and 18 H. P. per foot fall respectively.

The profile of the Elkhart is somewhat irregular and has the greatest fall in its lower part. The following table shows the profile as derived from the L. S. & M. S. Railroad profile.

PROFILE OF ELKHART RIVER.

LOCATION.	Distance, Miles.	Altitude, Feet.	Fall per Mile, Feet.
Source	0	1000	....
Millersburg	35	853	4.20
Benton	6	833	3.33
Goshen	13	774	4.54
Mouth	12	720	4.5

POWER SITES ON THE ELKHART RIVER.

Between Benton and the mouth of the Elkhart River there are four developed power sites and one which it is feasible to develop. The developed sites are at Benton, Baintertown, Goshen and Elkhart. The undeveloped site is between Goshen and Elkhart.

Benton.—One-half mile above the wagon bridge at Benton is the site of an old mill and dam which has been abandoned. The dam was three feet high and a race one-fourth of a mile long increased the head to six feet. The owners of some low-lying land on the backwater brought suit for damage in 1888. The case was decided against the mill owners and the height of the dam was ordered to be reduced by eighteen inches. This reduction made the power useless and it was abandoned. The situation of the power site was very poor. It was located in a wide part of the valley where the banks were very low. It was established about 1850. It is not feasible to redevelop this site.

About one-half mile below the wagon bridge at Benton is a new dam built in 1902 by the Syracuse Power and Light Company. This dam is 130 feet long and 3.86 feet high. It is built of concrete. The backwater reaches a short distance beyond the Benton wagon bridge. After passing the dam the river makes a wide bend toward the south and a race one-half mile long follows the north bluff across this bend. The power house is located at the point where the race re-enters the river. The head on the wheels is eleven feet.

Two Little Giant turbines are employed on this head. Each is rated at 101 H. P. The power is used entirely for the production of electricity which is transmitted to Syracuse and Milford, where it is used for power and light. The power during minimum flow is about 100 H. P. but during the greater part of the year the wheels can be employed to their full capacity. This power is owned and employed by the Syracuse Power and Light Company, of which Mr. J. P. Dolan of Syracuse, Indiana, is the president.

Baintertown.—The old Redden mill site is located in Section 34, R. 6 E., T. 36 N. It has been in continuous operation for about eighty years. The dam is located three-eighths mile above the mill. It is a concrete dam 137 feet long and three and one-half feet high. The backwater from this dam reaches the Wabash Railway bridge in Section 2, R. 6 E., T. 35 N. From the dam, the river makes a wide bend northward and the race leads along the south bluff. The water is divided at the lower end of the race. Part is used in the flour mill of J. D. Redden and part in the saw mill of T. J. Harrington. There are two Little Giant tubines in use in the Redden mill. These wheels are 36 and 42 inches respectively and their capacity is unknown. The head on these wheels is 7 feet. The tail race of this mill has a fall of .63 feet, which could be added to the head by deepening the tail race. The power is employed by J. D. Redden for grinding purposes.

The Harrington mill is situated about 40 rods below the Redden mill. There is one 60-inch old style turbine employed. The head on this wheel is 8.33 feet and a power of 35 H. P. is utilized from it. This mill has been in operation for forty-five years. No supplementary power is used in either of these mills. The estimated minimum discharge at this point is approximately the same as that at Benton and the power should be about 70 H. P. under 7.5 feet head. This power is owned jointly by T. J. Harrington and J. B. Redden of New Paris, Indiana.

Goshen.—The power on the Elkhart River at Goshen was first developed about 1860. The dam is situated about two miles above the point where the power is employed. It is 205 feet long and 14.5 feet high. It is built of concrete and is very substantial. The backwater from this dam reaches three miles and a great storage reservoir is formed by former natural lake basins. The storage is not sufficient for a long continued drought, but could be drawn upon for several days. This storage makes the power at Goshen the most valuable on the Elkhart.

The race skirts the east bluff from the dam to the city where the power is employed by two plants, the Hawks Electric Company produces electricity for lighting Goshen and for motor power. There are two 50-inch Samson Leffel wheels employed in this plant. Each is rated at 300 H. P. under a head of 16 feet. The head at this point was but 14.73 feet when measured by the writer, but both plants were running and the head was lower than usual. This plant was established in 1908. The power is employed by the Hawks Electric Company, Goshen, Indiana.

The Goshen Milling Company employs three wheels under a head of 16 feet. The wheels are one 50-inch Samson Leffel rated at 300 H. P., one 46-inch, rated at 250 H. P. and one 30-inch, rated at 75 H. P. This gives a total rating of 625 H. P. in this plant. The power is employed by the Goshen Milling Company, Goshen, Indiana.

The entire power system is owned by the Hawks Water Power Company and the power is sold to the Hawks Electric Company and the Goshen Milling Company. The minimum power, as estimated by the manager of the Hawks Water Power Company, is 300 H. P. for ten hours per day. He based his estimates upon the amount of electricity produced on the switchboard of the electric plant and upon the amount of coal necessary to do the same amount of work at the mill as is done by water during minimum flow. His estimate is very near the result given by considering the discharge as 33 per cent. of the rainfall during the driest seasons.

Undeveloped Site in Section 14, R. 5 E., T. 37 N.—The elevation of Goshen as given in the profile is at the mouth of the tail race of the Goshen Milling Company plant. Thus the fall from Goshen to the mouth of the Elkhart River is 54 feet. Only 11.09 feet of this fall occurs between the crest of the dam at Elkhart and the mouth of the river. The unemployed fall between Goshen and Elkhart is 42.91 feet. The most feasible point for developing part of this power is in Section 14, R. 5 E., T. 37 N., where a mill has been formerly developed but long ago abandoned. The old dam site cannot be detected now, but the old race depression is still distinct and would greatly lessen the cost of redevelopment. From the point where the old dam was located, the river makes a great bend northward. The race ran along the south bluff for a distance of a mile and re-entered the stream near the mouth of Yellow Creek. The fall between the old dam site and the mouth of Yellow Creek is 7.18 feet. At a point 150 feet above the wagon bridge which crosses the Elkhart River directly east of Station 19 on the Elkhart-Goshen Traction line and 300 feet above the former dam site, the bluffs approach the river on both sides very closely. A dam 10 feet high and 250 feet long could be constructed at this point. Such a dam would submerge very little land, for the valley is narrow for a long distance above this point. Not more than twenty acres of land would be submerged by this dam. A race one mile long would increase the head to 17 feet. The development of this site would be without great expense and would yield about 300 H. P. continuously.

Elkhart.—The Burrell & Morgan Milling Company dam occurs three-eighths of a mile above the mouth of the Elkhart River. This dam is built of stone, with a concrete apron 20 feet wide. The dam is 167 feet long and 10 feet high. The backwater from the dam reaches about three miles, but there is no storage except the little furnished by the river channel. From near the north end of the dam, the race leads to the mills, which are one-fourth of a mile distant. The head is not increased by the race. The power is employed in Burrel & Morgan's Flour Mill and in the Elkhart Bristol Board and Paper Company's plant. In the flour mill, four 32.5-inch Leffel special wheels are employed. In the paper mill there are four wheels employed, one 56-inch Trump, two 56-inch American, old style, one 37-inch American, modern. The total power at this point during minimum discharge is estimated by the power owners at 150 H. P. under a head of 10 feet. This estimate is approximately the same as those made at the Goshen site and from the weather reports. During low discharge the paper mill uses auxiliary steam and electric power. This power is owned by Burrell & Morgan, Elkhart, and employed by the owners in the flour mill and by the Elkhart Bristol Board and Paper Company in their paper mill.

ST. JOSEPH RIVER.

The St. Joseph River rises in the lake district of south central Michigan and flows southwest into Indiana, where it makes a great bend to the west and then to the north, and finally re-enters Michigan, where it flows into Lake Michigan at St. Joseph. The total length in Indiana is about forty-two miles.

The valley is narrow and from forty to sixty feet deep. There is no swamp land within the valley and no storage is developed in the stream.

The drainage basin lies entirely within glacial drift and no bed rock is exposed. About four hundred lakes varying in size from five square miles to one-eighth of a square mile or less form a great amount of natural storage. The entire drainage area is approximately 4,600 square miles, of which 1,700 are in Indiana.

The discharge of the St. Joseph River is determined from the gaging station which was established on the Leaper bridge at the North Michigan street crossing in South Bend, on July 11 and 12, 1910. The gage is a chain gage and is located on the up-stream hand-rail of the south span of the bridge. The initial point for soundings and current readings is 16 inches along the hand-rail from the inner edge of the iron post on the up-stream side of the south end of the Leaper Bridge. The bridge is on a broad bend in the river, which throws the main current near the north bank. There are no islands or vegetation to interfere with the readings. The current is swift and very steady. During high water, the discharge is between the two bridge abutments except at extremely high stages, when it flows over the levee upon which Michigan street is built south of the bridge. This has not occurred since the gaging station has been established.

The gage is read daily by Mr. J. W. Fisher, chief engineer of the South Bend Water Works Company.

Discharge Measurements on St. Joseph River at South Bend, Ind., During 1910–1911.

Date.	*Hydrographer.*	Gage Height, Feet.	Discharge, Second-Feet.
July 13 1910	W. M. Tucker	2.20	2,470
February 20 1911	W. M. Tucker	4.05	8,820
April 4 1911	W. M. Tucker	3.05	4,230
July 7 1911	Tucker and Clark	2.25	2,546
July 29 1911	Tucker and Clark	1.85	1,857
July 30 1911	Tucker and Clark	1.15	912

GAGE READINGS ON ST. JOSEPH RIVER AT SOUTH BEND FOR 1910-11.

	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	......	1.4	1.3	1.6	......	......	......	......	2.8	1.9	2.8	1.2	2.4
2	......	2.1	1.5	1.1	......	......	......	......	2.9	1.4	2.6	1.2	2.1
3	......	1.8	1.8	1.4	......	......	......	......	2.4	1.8	2.1	1.6	2.2
4	......	1.7	1.4	1.5	......	......	......	2.6	2.4	2.1	2.5	1.3	2.1
5	......	1.8	1.7	1.4	......	......	......	2.0	2.2	2.7	2.4	1.3	1.9
6	......	1.8	1.4	1.8	......	......	......	2.5	2.2	3.6	2.3	1.6	1.7
7	......	1.7	2.0	2.0	......	......	......	2.4	2.2	3.2	1.3	1.4	1.8
8	......	1.5	2.0	1.9	......	......	......	2.4	2.1	2.9	2.0	2.2	1.5
9	......	2.1	1.9	1.3	......	......	......	2.3	2.0	2.8	1.4	2.6	1.5
10	......	2.0	1.9	1.6	......	......	......	1.7	2.0	2.6	2.0	2.1	1.7
11	......	1.9	1.5	1.9	......	......	......	2.1	2.0	2.4	1.6	1.3	1.6
12	......	2.0	1.8	1.7	......	......	......	2.3	1.9	2.6	1.3	b	1.7
13	3.0	1.5	1.9	1.7	......	......	......	2.7	2.1	2.5	1.1	2.2	1.8
14	1.9	1.4	1.9	1.6	......	......	......	2.0	2.8	2.6	1.2	1.6	1.2
15	2.0	1.0	1.8	1.6	......	......	......	4.0	2.7	2.6	1.6	1.7	1.4
16	1.9	1.7	2.0	1.1	......	......	......	3.8	2.5	2.5	1.7	1.6	1.4
17	1.4	1.7	1.9	1.5	......	......	......	3.7	2.5	2.8	1.5	1.7	1.5
18	1.9	1.8	1.6	1.7	......	......	......	4.0	2.3	2.7	1.7	1.4	1.5
19	2.0	2.0	1.6	1.4	......	......	......	4.6	2.2	2.7	1.5	1.2	1.4
20	2.1	1.4	2.0	1.5	......	......	......	4.5	2.2	3.5	1.5	1.3	1.4
21	1.7	1.4	1.7	1.8	......	......	......	3.9	2.1	4.7	1.2	1.4	1.3
22	2.2	1.4	1.7	1.8	......	......	......	3.7	2.0	4.2	1.4	1.4	1.4
23	1.9	1.5	1.8	1.2	......	......	......	3.4	1.9	4.0	1.2	1.6	1.7
24	1.4	1.2	1.9	a	......	......	......	3.2	1.8	3.9	1.6	1.7	1.5
25	1.3	1.5	1.1	......	......	......	......	3.1	1.8	3.6	1.3	1.4	1.6
26	1.7	2.0	1.9	......	......	......	......	3.1	1.7	3.3	1.1	2.7	1.6
27	2.0	1.5	1.9	......	......	......	......	3.1	1.9	3.1	1.2	3.2	1.6
28	1.8	1.3	1.7	......	......	......	......	2.9	2.0	2.9	1.0	2.9	1.5
29	1.9	1.1	1.4	......	......	......	......	......	2.0	2.8	1.0	2.9	1.3
30	1.6	1.9	1.7	......	......	......	......	......	1.9	2.5	1.4	2.7	1.7
31	1.5	1.7	......	......	......	......	......	......	1.9	......	1.6	......	1.6

a Chain stolen and replaced February 4.
b No report.

RATING TABLE FOR ST. JOSEPH RIVER AT SOUTH BEND, IND., FOR 1910-11.

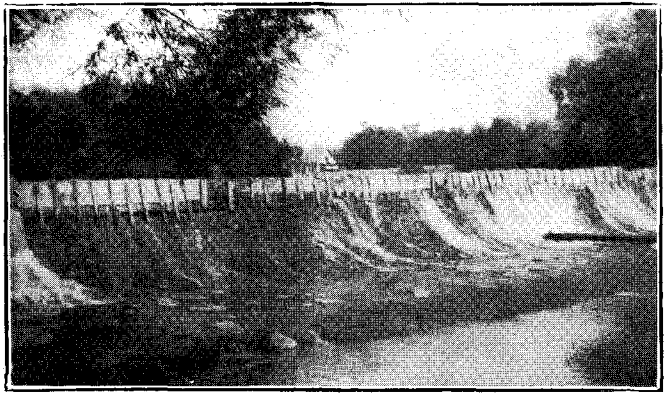
Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
1.0	760	2.0	2,110	3.0	4,140	4.0	8,490
1.1	873	2.1	2,280	3.1	4,430	4.1	9,200
1.2	988	2.2	2,460	3.2	4,760	4.2	9,965
1.3	1,105	2,3	2,640	3.3	5,110	4.3	10,780
1.4	1,227	2.4	2,825	3.4	5,475	4.4	11,650
1.5	1,365	2.5	3,020	3.5	5,870	4.5	12,570
1.6	1,495	2.6	3,225	3.6	6,300	4.6	13,540
1.7	1,640	2.7	3,440	3.7	6,770	4.7	14,560
1.8	1,790	2.8	3,670	3.8	7,280		
1.9	1,950	2.9	3,900	3.9	7,850		

From the above data, which shows the lowest gage height to have been one foot, the smallest discharge was 767 second-feet. The gage was read each day at 6:00 o'clock a. m. with the idea that at that time the river would have filled all the storage above the several dams which are located between South Bend and Elkhart, and would have resumed the natural flow by overflow over the dams. Mr. Fisher expressed the idea, after a year's observation, that this was not the case, but that the discharge at that time of the day was less than normal. To ascertain the real condition, gage readings were taken every hour for 24 hours, from 6 a. m. July 28 to 6 a. m. July 29. The results are shown in the following tables:

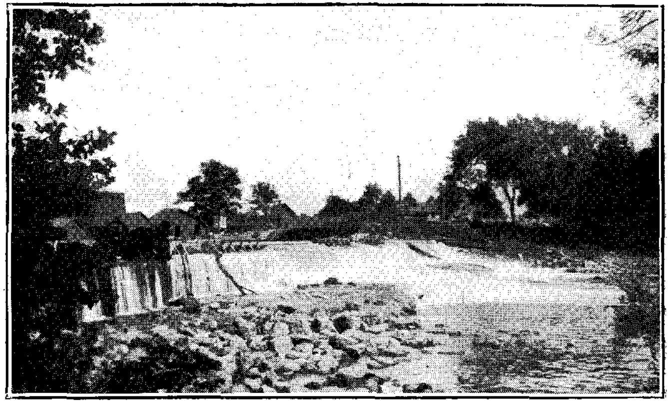
A. M.	July 28.
6:00	1.5
7:00	1.75
8:00	2.25
9:00	2.3
10:00	2.3
11:00	2.3
12:00	2.3
P. M.	
1:00	1.6
2:00	1.9
3:00	2.0
4:00	2.0
5:00	2.6
6:00	2.9
7:00	2.8
8:00	2.0
9:00	1.6
10:00	1.6
11:00	1.55
12:00	1.5

A. M.	July 29.
1:00	1.4
2:00	1.3
3:00	1.2
4:00	1.25
5:00	1.35
6:00	1.3

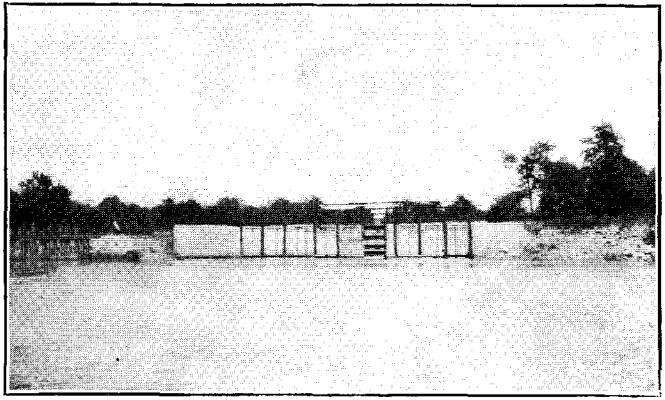
When the discharges for these twenty-five gage heights are taken from the rated table and averaged, the average is found to be 19.91 second-feet. Such a discharge is represented in the rating table by a gage height of 1.925 feet, which is more than .5 feet higher than the average (1.4 feet) of the two 6:00 o'clock a. m. readings. This demonstration corresponds to Mr. Fisher's idea, but is insufficient to prove the exact error. An average result of several such demonstrations could be taken as a correcting factor. It is safe to conclude, however, that the discharge is shown by the gage height is somewhat low. During the time which this station has been in operation, there has probably been no day in which the average discharge has not been below 1,000 second-feet. The estimated discharge at Elkhart, above the mouth of the Elkhart River, is .6 as great as that at South Bend. The profile of the St. Joseph in Indiana shows a fairly regular fall, which varies from 1.99 below South Bend to 2.93 between Elkhart and Mishawaka. The following table shows the profile of the St. Joseph River in Indiana:



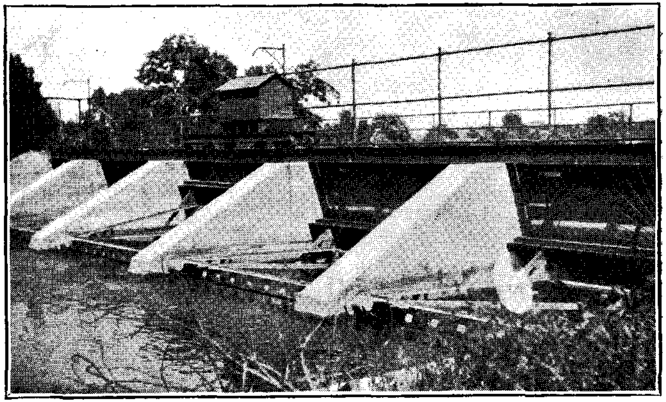
Elkhart River dam at Elkhart. Flashboards used to raise head during low water.



St. Joseph River dam at Elkhart. Flashboards broken and destroyed by flood and drift.



Gates at Goshen dam. Notice height of banks. Dam is to the left of this picture.



Gates at Mishawaka dam.

VIEWS ON ELKHART AND ST. JOSEPH RIVERS.

Location.	Estimated Distance, Miles.	Altitude, Feet.	Fall per Mile, Feet.
Upper State Line	0	750.51	2.03
Elkhart River Mouth	15	720.01	2.03
Mishawaka (below dam)	12	684.82	2.93
South Bend (below dam)	6	671.98	2.14
Lower State Line	9	654.00	1.99

Power Sites on the St. Joseph River.

Within Indiana, there are four developed power sites and one undeveloped site. The developed sites are at Elkhart, Twin Branch, Mishawaka and South Bend. The undeveloped site is at the lower State line.

Elkhart.—The Elkhart power site is situated in Elkhart, 2,500 feet above the mouth of the Elkhart River, 800 feet above the mouth of the Constantine River, and immediately above the Johnson street crossing. The dam is built of wood, with stone abutment and concrete apron. The dam and apron are in poor condition. The dam is 295 feet long and 12.17 feet high. The water is separated and some is used on the north and some on the south side. It is used to produce electricity, which is fed into the system of the Indiana Michigan Electric Company.

This site is owned by the Indiana Michigan Electric Company, whose headquarters are at South Bend. The dam will be replaced during 1912 by a modern concrete dam, and the power concentrated into one plant. The head will be about 15 feet and probably 18 feet. The minimum continuous discharge at this point is approximately 600 second-feet, which will produce 818 H. P. continuously under a head of 15 feet. At normal stages of the river, a power of 1,500 H. P. can be produced at this point.

Twin Branch.—The Twin Branch dam and power station is located about four miles above Mishawaka. The dam is built of solid concrete. It is 408 feet long and 23.2 feet high. The backwater from this dam reaches almost to the mouth of Elkhart River. The power plant is built entirely of concrete and is located at the south end of the dam. Twenty-seven wheels are installed, with a capacity of 250 H. P. each. The minimum discharge at this point is 750 second-feet, which produces about 1,600 H. P. under a head of 23 feet. This is the largest and best installed power station in Indiana. It is owned and operated by the Indiana Michigan Electric Company. The power is used entirely for the production of electricity, which is fed into the system of the company.

The Indiana Michigan Electric Company has water power sites in Michigan, of which the largest is at Barrien Springs, near Buchanan. The power from all the stations operated by the company is used entirely for the development of electricity, and this is fed into one system. The electric power is then sold to manufacturing concerns. The following table gives the principal purchasers and the amount of power furnished each, so far as known:

Traction Lines:
- Goshen to twenty miles north of Benton Harbor, Michigan.
- South Bend to Michigan City.

All local street car service in Elkhart, Goshen, South Bend, Benton Harbor and St. Joseph.

All electric power in South Bend except Singer's, Oliver's and Birdsell's.

Mishawaka Woolen Co	1,500 H. P.
Rubber Regenerating Co., Elkhart	500 H. P.
L. S. & M. S. Ry. Shops, Elkhart	500 H. P.
Elkhart Paper Co	1,000 H. P.

Besides the water power which is used by this company, they are producing 8,000 H. P., auxiliary steam power, and are now developing 7,000 H. P. more.

Mishawaka.—The Mishawaka dam is located within the city of Mishawaka. It is the oldest dam on the St. Joseph River. It is built of wood in three sections, and has a total length of 305 feet. It is 9.95 feet high. The backwater from this dam reaches the tail race of the Twin Branch plant. This power is owned by the Mishawaka Hydraulic Company, which sells the power to local manufacturing companies. There are two races leading away from this dam. The race on the north side leads into the plant of the Mishawaka Rubber Regenerating Company where 600 H. P. is produced on a head of 10 feet. There are six horizontal Trump wheels with a rating of 100 H. P. each. The power is used continuously. The race on the south side of the river furnishes water to five plants. The Mishawaka Water Works Company employs 100 H. P. continuously. They have one wheel and a head of 10 feet. The Ripple Milling Company employs 60 H. P. The head is 10 feet and the power is produced on a single wheel. The Mishawaka Plow Company employs 60 H. P. from one wheel under a head of 10 feet. The Perkins Windmill Company employs 75 H. P. from one wheel under a head of 11 feet. The Mishawaka Woolen Manufacturing Company has four wheels installed. The sizes of these wheels are 66 inches, 61 inches and two 56 inches. The total capacity of these wheels is 700 H. P. under a head of 11 feet.

The total rating of wheels gives an aggregate of 1,595 H. P. This is more power than can be produced during the minimum discharge of the stream. The minimum discharge at this point sometimes reaches 750 second-feet. This discharge would produce 682 H. P. on a fall of 10 feet. During the greater part of the year, however, the discharge is sufficient to produce the rated power at this site.

South Bend.—The power station at South Bend is usually known as the Oliver dam. However, the power is not controlled by the Oliver Company, but is governed by grants and is controlled by the city of South Bend. The dam is located in the city of South Bend. It is 200 feet long and 11 feet high. It is constructed of wood, with concrete abutment. The backwater of this dam reaches the tail race of the Mishawaka Woolen Manufacturing Company. The water is divided by grants, equally on the east and west sides.

The eastern half is divided under fourteen grants, and the amount of power allowed in each grant is specifically stated. The following table shows the firms, the number of each grant, and the amount of water as specified in each grant.

Firm.	Grant Number.	Amount, Sec.-Ft.
Manufacturer's Plant and Power Co	1	42.91 cubic feet.
Knoblock & Gintz Milling Co	2	77.23 cubic feet.
Stephenson Mfg. Co	3	51.49 cubic feet.
Stephenson Mfg. Co	4	68.65 cubic feet.
LaSalle Paper Co	5	60.05 cubic feet.
Miller	6	85.81 cubic feet.
Manufacturer's Plant and Power Co	7	40.00 cubic feet.
South Bend Toy Mfg. Co	8	51.49 cubic feet.
Manufacturer's Plant and Power Co	9	51.49 cubic feet.
F. P. Nicely	10	102.98 cubic feet.
South Bend Woolen Co	11	68.65 cubic feet.
South Bend Woolen Co	12	51.49 cubic feet.
Stephenson Mfg. Co	13	......
Stephenson Mfg. Co	14	343.24 cubic feet.

The conditions of the grants are that in case of deficient discharge the supply is first discontinued to No. 14, then to No. 13, etc. The lowest discharges have made it necessary to discontinue the supply to No. 8. All this water is employed on heads varying from 11 to 13 feet. Since in any case a second-foot of water on a head of 11 feet produces a horse-power, the amount of water supplied by each grant can be considered as the same number of horse-power. The first seven grants aggregate a discharge of 426.14 second-feet, and this would indicate that the minimum discharge at this point is 852.28 second-feet. This corresponds very closely to the minimum discharge as given in the data collected from the gage at Leaper bridge.

The western half of the water is owned by the Oliver Company, known as the South Bend Manufacturing Company, and by the city of South Bend. The Oliver Company owns 85 per cent. and the city 15 per cent. The city employes the 15 per cent. in the city water works plant. Three 54-inch Samson Leffel wheels are employed under a head of 11 feet. The minimum power produced is about 75 H. P.

The Oliver Company employs twelve 68-inch Samson Leffel wheels, each rated at 295 H. P. under 11 feet head. The minimum power produced is about 400 H. P. and the maximum about 1,800 H. P. The power is used to generate electricity which is used for power and light in the Oliver Chilled Plow Works, the Oliver Hotel, J. D. Oliver's residence and Geo. Ford's residence.

The city of South Bend employs an inspector, whose duty is to enforce the conditions of the several grants of this system.

Lower State Line.—The power site on the lower State line is undeveloped. It is in control of the Indiana-Michigan Electric Company. This company has options upon the land which would be affected by the development of the site. A dam 12 feet high would pond the water to the South Bend city limits and to the mouths of the large sewers from the city. The 12-foot dam would not interfere with the city sewage discharge during low stages of the river, but in high stages the height and distance of backwater from a dam are greatly increased. Such a condition would seriously interfere with the city sewage discharge and would result in litigations which make the proposition practically worthless. The electric company has considered a collapsible dam which could be lowered during high stage until the backwater would be under control. However, no steps toward development of this site have been taken at the present time. The development of this site would be of great benefit to the electric company, for the power is needed during seasons of low discharge, and is not needed during seasons of high discharge for it can be supplied by the other plants during such times.

THE WABASH RIVER SYSTEM.

This report has to do with that part of the Wabash River system which lies above the intersection of the Wabash River and the State line, 14.6 miles below Terre Haute. The system drains an area of 12,200 square miles, which lies in a broad curve across north central Indiana between the basins of Kankakee, St. Joseph and Maumee rivers on the north, and of White and Whitewater rivers on the south.

The basin is entirely within the Wisconsin glacial drift area except that portion which lies below the north line of Vigo County. The drift is much heavier in the northern part of the basin than in the southern part. The northern tributaries, Tippecanoe and Eel rivers, rise in the lake regions of Kosciusko and Noble counties, while the main stream and the southern tributaries have no lakes within their basins.

As a whole the Wabash system lies near bed rock. Many exposures occur in the stream beds. The main stream lies in the Silurian formation from its source to the west line of Cass County, in the Devonian to Lafayette, in the Mississipian to Covington, and in the Pennsylvanian to the State line. The Mississinewa and Eel rivers lie entirely in the Silurian. The Tippecanoe is in the Silurian formation to Norway, three miles north of Monticello, where it enters the Devonian. The rest of its course is in the Devonian. Sugar Creek rises in the Devonian, enters the Mississippian near Thorntown, Boone County, and the Pennsylvanian directly north of Annapolis, Parke County.

The mean annual rainfall in the Wabash River basin for the past eleven years was 38.12 inches. The lowest annual rainfall during that period was in 1901 when the average for the Wabash basin was 30.63 inches. The highest yearly record was in 1909, with an average of 47.16 inches. The monthly precipitation in this basin has been very irregular. The highest monthly average for all the stations within the Wabash basin and those closely adjoining was in June, 1902, when 8.35 inches occurred. The low record was in March, 1910, with .195 inches. These figures are based on the records from twenty-five stations as given by the United States Weather Bureau.

The forests of the Wabash River basin are practically negligible. A hundred years ago the forests covered 90 per cent. of this vast area and now the areas covered by forest in the form of wood lots will not aggregate 10 per cent. of the whole area. Even the forests which do remain are thin and made up entirely of second growth timber. Of the magnificent walnut, maple, poplar, beech, hickory and gum trees which grew here a hundred years ago, all are gone. Some were used, but most of them were destroyed. The destruction of the forests also greatly reduced the water power possibilities along the Wabash. In fact, the irregularity of the stream flow is largely due to the depletion of the forests, and this irregularity is so great that the water power of the Wabash River is practically worthless. Mr. F. A. Bryan, general manager of the Indiana-Michign Electric Company, probably the best authority in Indiana on the subject of water power, says that he would not give $10,000 for all the water power on the Wabash.

In discussing the power conditions of the Wabash River system, the northern tributaries will be considered first, followed by the southern tributaries, and finally the main stream.

EEL RIVER.

Eel River rises by several branches in the lake district of southern Noble, northern Whitley, and northwestern Allen counties. It flows in a general southwest direction, across Whitley, Wabash, Miami and Cass counties, and debouches into the Wabash River at Logansport, Indiana. Its total length is approximately 110 miles.

The valley is young and has little bottom land. The bluffs are from 30 to 75 feet in height. The valley lies entirely within glacial drift and does not touch bed rock until within nine miles of the mouth. At Adamsboro, the stream first touches bed rock and a rapid is formed. This rapid is wide and shallow. It is about one-fourth mile in length, with a total fall of six feet. From this point to the mouth, the stream flows on bed rock much of the way.

The drainage basin of Eel River is long and narrow. The tributaries are short and those that do not rise in lakes are intermitten streams. Three small tributaries which debouch in Wabash County rise in small lakes of southern Kosciusko. The tributaries near the source of the stream rise in the lakes of southern Noble County. The storage offered by these lakes makes the discharge regular. The drainage area of Eel River is 777 square miles.

On July 14 and 15, 1910, a gaging station was established on the bridge which crosses Eel River on Third street, Logansport. It is a chain gage, and is located on the down stream hand-rail of the south span of the bridge. The length of the chain from the end of the weight to the first marker is 18 feet 6.7 inches. The gage is read once each day by H. J. Kruck of the Logansport Water Works Company. The stream is straight for 500 feet above this station, and a similar distance below. The channel is about 360 feet wide between the bridge abutments. Two piers divide the channel into three parts. The depth is fairly regular. The bed of the stream is of sand, which is deposited at the head of the backwater from Uhl's mill dam. The backwater reaches a short distance above the station, but the current is regular and steadily down stream. The bed has not changed perceptibly during the years since the gage was established. All the water must pass between the bridge abutments except during extremely high water, when the north bank overflows. The initial point for soundings is three and one-half feet from the north end of the down stream hand-rail. The discharge and gage readings from this station appear in the following table:

DISCHARGE MEASUREMENTS ON EEL RIVER AT LOGANSPORT, IND., FOR 1910-11.

Date.	Hydrographer.	Gage Height, Feet.	Discharge, Sec.-Ft.
July 15 1910	W. M. Tucker	2.8	207.16
Aug. 12 1910	W. M. Tucker	2.4	125.33
Feb. 21 1911	W. M. Tucker	3.6	1,390.2
April 15 1911	W. M. Tucker	3.9	2,147.89
July 5 1911	Tucker and Clark	2.9	263.28

GAGE READINGS ON EEL RIVER AT LOGANSPORT, IND., FROM JULY 16, 1910, TO JULY 15, 1911.

	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	......	2.5	2.7	2.8	2.8	2.8*a*	3.2	3.4	3.0	3.0	3.4	3.2	2.9
2	......	2.3	2.7	2.9	2.8	2.8	3.3	3.3	3.0	3.0	3.4	3.1	2.9
3	......	2.6	2.7	2.8	2.6	2.8	4.0	3.2	3.0	3.0	3.2	2.9	2.9
4	......	2.7	2.8	2.8	2.6	2.8	*b*	3.2	3.0	3.1	3.1	3.0	2.9
5	......	2.5	3.0	3.1	2.8	2.8	*b*	3.1	3.0	3.7	3.1	3.2	2.9
6	......	2.6	3.5	3.1	2.8	2.8	*b*	3.1	2.9	3.9	3.1	3.0	2.9
7	......	2.8	3.3	3.1	2.7	2.8	*b*	3.1	2.9	3.6	3.0	3.0	2.9
8	......	2.7	3.1	3.1	2.7	2.8	*b*	3.0	2.9	3.3	2.9	2.9	2.9
9	......	2.6	2.9	3.0	2.6	2.8	*b*	2.9	2.9	3.2	2.9	2.9	2.9
10	......	2.6	3.0	2.9	2.6	2.8	*b*	2.9	2.9	3.1	2.9	2.8	2.8
11	......	2.5	2.9	2.8	2.7	2.8	*b*	2.8	2.9	3.0	2.9	2.8	2.7
12	......	2.4	2.8	2.8	2.6	2.8	*b*	3.0	3.0	3.0	2.9	2.8	2.7
13	......	2.7	3.2	2.8	2.9	2.8	*b*	3.0	3.0	3.1	2.9	2.8	2.7
14	......	2.8	3.6	2.8	2.9	2.8	*b*	3.3	3.0	3.9	2.9	2.8	2.6
15	......	2.5	3.2	2.8	2.7	2.8	*b*	4.7	2.9	3.9	2.8	2.8	2.7
16	2.8	2.6	3.0	2.9	2.7	2.8	*b*	4.3	2.9	3.5	2.8	2.8	......
17	2.9	2.7	2.9	2.8	2.6	2.8	*b*	4.1	3.0	3.4	2.8	2.9	......
18	2.8	2.7	3.0	2.8	2.7	2.8	*b*	4.0	3.0	3.2	2.8	2.9	......
19	2.8	2.6	2.9	2.8	2.7	2.8	*b*	4.0	3.0	3.9	2.8	2.9	......
20	2.7	2.7	3.0	2.8	2.9	2.8	*b*	3.9	3.0	4.4	2.8	2.8	......
21	2.7	2.8	2.9	2.8	2.8	2.8	*b*	3.6	3.0	4.2	2.8	2.8	......
22	2.7	2.8	2.8	2.8	2.8	2.8	*b*	3.3	2.9	3.9	2.8	2.7	......
23	2.7	2.8	2.8	2.9	2.8	2.8	*b*	3.3	2.9	3.9	3.0	2.7	......
24	2.8	2.9	2.9	2.9	2.8	2.8	*b*	3.1	2.9	3.7	3.0	2.7	......
25	2.5	2.8	3.3	2.9	2.8	2.8	2.9	3.1	2.9	3.3	2.9	2.9	......
26	2.5	2.8	3.2	2.5	2.8	2.8	2.9	3.1	3.0	3.2	2.8	4.3	......
27	2.7	2.8	3.1	2.6	2.9	2.8	3.1	3.1	3.0	3.1	2.8	3.8	......
28	2.6	2.8	2.9	2.7	2.8	2.9	3.8	3.1	3.0	3.1	2.8	3.5	......
29	2.7	2.7	2.7	2.7	2.8	3.2	4.0	......	3.0	3.2	2.8	3.2	......
30	2.8	2.6	2.8	2.9	2.9	3.1	4.0	......	3.0	3.2	2.8	2.9	......
31	2.7	2.7	......	2.6	......	3.1	3.6	......	2.9	......	3.0	......	......

a Ice conditions during all of December. Ice ½ to 6 inches thick. Water over ice on Dec. 29 30 and 31.

b No record.

RATING TABLE FOR EEL RIVER AT LOGANSPORT, IND., FOR 1910–11.

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge. Sec.-Ft.
2.3	115	3.0	332	3.7	1,645	4.4	3,395
2.4	125	3.1	425	3.8	1,895	4.5	3,645
2.5	137	3.2	550	3.9	2,145	4.6	3,895
2.6	155	3.3	720	4.0	2,395	4.7	4,145
2.7	178	3.4	925	4.1	2,645		
2.8	210	3.5	1,155	4.2	2,895		
2.9	260	3.6	1,395	4.3	3,145		

Since the gaging station from which this data is taken is in the backwater from the Uhl dam, the manipulation of the water at the mill has considerable effect upon the data. When the gage stands at 2.7 feet the water is just at the crest of the dam. Whenever the gage registers lower than that, the head is being pulled down at the mill. The gage is read about 7:00 a. m. each day and it is probable that the head has been reduced on some days at the time of reading. From the data it seems that minimum continuous discharge is about 150 second-feet and the maximum is over 4,000 second-feet. A discharge of from 200 to 300 second-feet occurred most of the year.

The profile of Eel River is very irregular and shows the greatest fall near its mouth. After the stream bed crosses the edge of the hard Niagara limestone at Adamsboro, it has heavy fall to its mouth. The following table shows the profile of the river.

PROFILE OF EEL RIVER.

LOCATION.	Estimated Distance.	Altitude Above Sea Level.	Fall Per Mile, Inches.
Source	0	900	
North Manchester	50	732	44.64
Laketon	9	715	22.66
Stockdale	9	701	18.66
Chili	9	682	25.33
Denver	4	671	33.00
Mexico	5	653	43.20
Hoover	7	629	41.14
Adamsboro	6	617	28.00
Mouth	9	574	57.33

POWER SITES ON EEL RIVER.

There are eight developed power sites on Eel River and six intervening points where power could be conveniently developed. The developed sites are at North Manchester, Laketon, Roann, Chili, Mexico and two in Logansport. The undeveloped sites are between North Manchester and Laketon, between Roann and Chili, and Chili and Mexico, between Mexico and Adamsboro, and two between Adamsboro and Logansport.

North Manchester.—The power site at North Manchester was first developed about sixty years ago. The present mill was built in 1874. The dam is 130 feet long, between abutments, and 5.7 feet high. It is built of wood. There is a charter for a 6-foot head at this point. The mill is 300 feet below the dam, and the head race carries the water to the mill where it is used on three wheels —one 48-inch American, one 54-inch American, one 61-inch Standard Leffel. The minimum amount of power which is produced at this point for twelve-hour day is about 60 H. P. The minimum discharge is about 75 cubic feet per second. The power is used entirely for milling purposes and no auxiliary power is employed. This power is owned and operated by the North Manchester Milling Company, of which Allen Dohner is manager.

Power Site Between North Manchester and Laketon.—The fall from the tail race at North Manchester to the tail race at Laketon is 17 feet. The Laketon dam is 5.5 high. This leaves 11.5 fall which is not employed. The water of Eel River valley is such that power on a low head can be installed at almost any point. The point at which this power could be developed must be above the backwater of the Laketon dam. This backwater reaches about 1.5 miles above the dam. In Section 11, T. 29 N., R. 6 E., near the north line of the section is a point at which the dam would have to be located to employ this power. A 6-foot dam would produce 60 H. P. for a twelve-hour day at this point.

Laketon.—In Section 10, T. 29 N., R. 6 E., the river makes a bend towards the south. The bend is a mile in length, but the distance between the ends of the bend is but one-fourth of a mile. The land enclosed in this bend is low. In 1854 a dam was built at the upper end of this bend and a race constructed across the bend. A mill was built where the race intersected the river below. Since that time the power has been used continually at this site. The present mill was built in 1900, and the present dam was built three years later. The mill is a frame building of two stories, and is in excellent condition. The dam is built of concrete. It is 125 feet long and 5.5 feet high. The charter grant is for a 6-foot dam. The head is increased 2.5 feet by the race. Two 40-inch American, and one 40-inch Standard Leffel wheels are employed. The minimum discharge at this point is about 100 second-feet and a minimum of 75 H. P. is produced. This power is owned by Thos. E. Mitchell and employed by Arthur D. Hughes in the manufacture of flour mill machinery. The power is not employed to its full capacity. This little plant is well situated and the water can be placed under absolute control. It is within one mile of the junction of the Erie and Vandalia railroads and is in every way suitable for a small manufacturing enterprise.

The fall from the tail race of the Laketon mill to the tail race of the Roann mill is 11.5 feet. The head at the Roann mill is five feet. This leaves 6.5 feet unaccounted for, but it cannot be developed profitably because of the backwater. A head of four feet could be developed but would not be profitable.

Roann.—This power site is situated one mile west of Roann at Stockdale, which is one of those pioneer towns that has lost everything except its name and water-power. The first mill was built on this site in 1840, and the present one in 1859. In spite of its age, it is in good repair. The dam is built of wood, and the south end was broken by ice during the winter of 1910-11. The breach has been patched with boulders and a new concrete dam will be built soon. The dam is 206 feet long and 4.6 feet high. The dam is connected at the north end with an excellent concrete forebay. The flumes are also of concrete. Two 35-inch and one 30-inch Samson Leffel wheels are employed. The head on the wheels is five feet. The combined power produced by these wheels is estimated at 75 H. P. No auxiliary power is used and there is never a lack of water. Because of the extremely low head used, the power is often diminished by backwater. The power is used for grinding only. It is owned and employed by James M. Deck.

Power Site Between Stockdale and Chili.—The fall from the tail race at Stockdale to the tail race at Chili is 19 feet. The head employed at Chili is five feet. This leaves 14 feet fall which is unemployed. The backwater from the dam at Chili reaches approximately two miles. One and five-tenths miles above the head of this backwater is the site of a former dam which is now entirely destroyed. An abrupt fall of three feet still occurs at this point, which is on the line between Section 16 and Section 21, T. 28 N., R. 5. E. This site could be redeveloped with a head of seven feet. The dam would be 200 feet long. This site is one mile due south of Pettysville on the Vandalia Railroad.

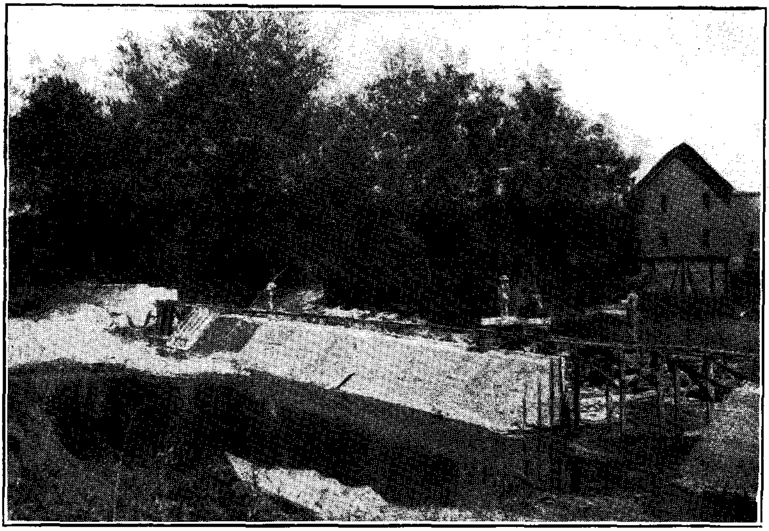
Chili.—This site was first improved during the early history of this part of the State. The present mill was built before 1873. The present dam was built in 1891. It is a wood dam 198 feet long and 4.5 feet high. This dam is built upon piles driven into the gravel. The dam will be replaced soon by another wood dam. During the summer of 1911, a concrete abutment and gates were built upon the north end of the dam. A race 300 feet long leads to the mill. Two 48-inch wheels are employed under a head of five feet. The minimum power produced at this point is about 70 H. P. The power is used for operating a flour mill and elevator combined. It is owned and employed by the heirs of Jacob Myers.

Power Site Between Chili and Mexico.—The fall from the tail race at Chili to the tail race at Mexico is 29 feet. The head employed at Mexico is seven feet. This leaves 22 feet of unemployed fall between these two points. The best point for developing this power is near the line between Sections 20 and 29, T. 28 N., R. 4 E. The bluffs approach the river at this point, and a head of two feet could be developed. This would injure a few acres of land above the dam which would increase the cost of development. This site is 1.5 miles from Denver and one-fourth of a mile from the Vandalia Railway.

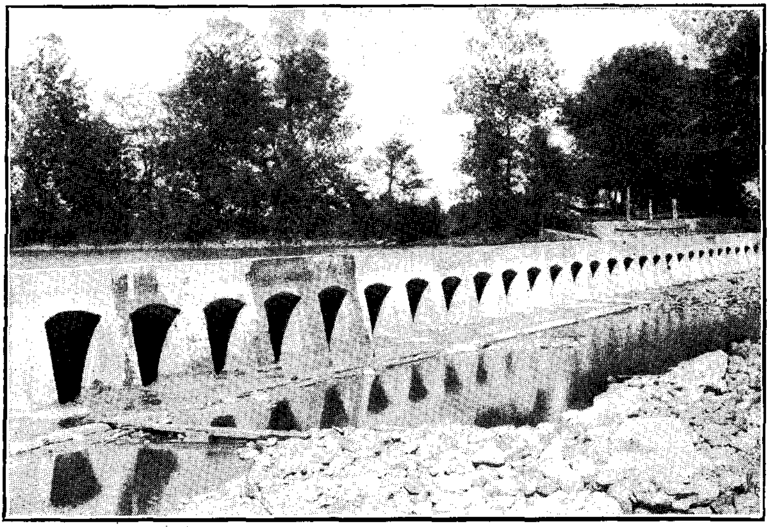
Mexico.—This is an old power site, but its history is unknown. The present mill was built in 1900 and the present dam in 1910. This dam is one of the best constructed dams in the State. It is built entirely of reinforced concrete and its foundation on hard pan. The base of the dam is on an average of four feet thick and 14 feet wide. The dam proper has a 9-foot base which leaves an apron of five feet. The height is six feet from the base. The lower face of the dam is perpendicular for 1.5 feet and has a 1-foot brace slant in the remaining 4.5 feet. This slant also serves to break the fall of the water. The crest is two feet wide and the upstream face has a regular slant at an angle of 45 degrees. The concrete is reinforced every two feet by three-fourths inch steel bars corrugated every inch. The dam is built in sections of 12 feet with expansion joints between. The length of the dam between abutments is 242 feet.

A short race at the east end of the dam leads to the mill where three 48-inch Standard Leffel wheels are employed. The head on the wheels is seven feet. The power is estimated at 300 H. P. at normal flow. The minimum discharge at this point is estimated at 100 second-feet which would produce 63 H. P. on seven feet fall. The power is used for milling only. The mill and power are owned by C. H. Black and operated by R. E. Zinn, who has it leased.

Power Site Between Mexico and Adamsboro.—The fall between Mexico and Adamsboro is 36 feet, of which seven are occupied by the Adamsboro site. Most of the remaining 29 feet occur between Hoover and Mexico. Two heavy ripples occur in Section 6,



View of the dam at Mexico during construction (from above).



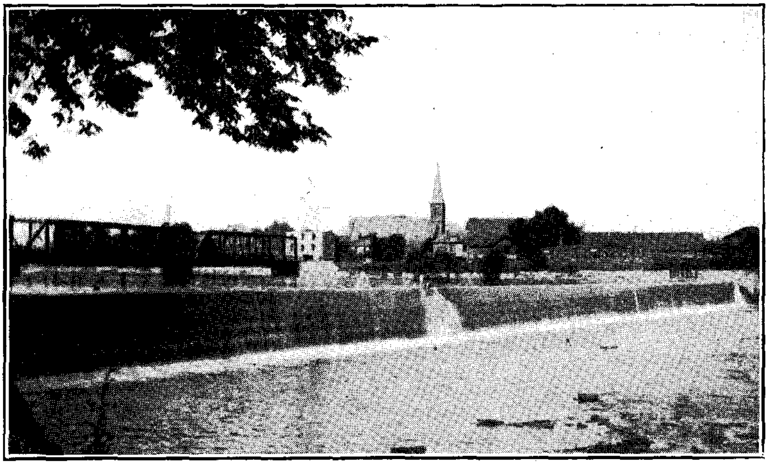
View of the dam at Mexico (from below).

R. 4 E., T. 27 N., and in Section 2, R. 3. E., T. 27 N. Seven feet head could be developed at the ripple in Section 2. The dam would be 200 feet long. The minimum discharge at this point would never fall below 100 second-feet. This would produce 63 H. P. on a head of seven feet. The normal discharge would produce approximately 300 H. P. at this point. It is probable that more of the surplus fall could be utilized between this point and Adamsboro, but no feasible dam site has been selected.

Adamsboro.—The Adamsboro dam is built upon solid limestone. It is an old dam and in poor condition. The leakage is greater than the amount of water which is used. The dam is 311 feet long and 4.09 feet high. A race one-half mile in length leads to an old mill, where the power is used for grinding. The power is not used continually and is often idle for long periods. This site is ideal for a well developed plant. The solid rock foundation makes the construction of a dam very simple. A heavy fall below the dam and above the mill adds 3.5 feet to the head. A dam seven feet high could be constructed at this point which would give a head of 10.5 feet at the mill. The race is in fair condition. It is on the west side of the river. With a minimum of 100 second-feet at this point, a power of 95 H. P. would be produced, while a normal discharge would furnish 350 H. P.

Two Power Sites Between Adamsboro and Logansport.—The fall between Adamsboro and the mouth of Eel River is 43 feet. Of this fall 11 feet are employed by the Uhl site and 11.25 feet by the Logansport Water Works and Electric Company's site. There is a loss of three feet between these sites and below the Uhl site. This leaves 17.75 feet between the tail race at Adamsboro and the backwater from the Water Works and Electric Company's site. This could all be developed at two sites with a fall of seven feet each. One of these would be located in Section 21, R. 2 E., T. 27 N., and the other at the head of the backwater from the Water Works and Electric Company's dam. Both these dams would have bed rock foundations. The power produced at these two sites would be about 100 H. P. each at minimum discharge and 300 H. P. at normal discharge.

Logansport Waterworks and Electric Company.—The dam of this plant is situated near the intersection of Tenth street and Eel River in Logansport. This site was first developed about eighty years ago. The present dam was constructed in 1854. The plant of the Logansport Waterworks Company was built in 1876, and that of the Logansport Electric Company in 1895. They stand immediately adjoining each other on the river bank, 300 feet below the dam. The dam is 340 feet long and seven feet high. It is a wood dam and is in good repair when its age is taken into consideration. It is located on solid limestone immediately above a fall of four feet. The backwater from this dam reaches about two miles, but there is no storage except that in the direct stream channel. A short race built of limestone leads to the plants. The Waterworks Company uses three wheels under a head of 11 feet 4 inches. There are two 48-inch Dowling wheels each rated at 106 H. P. and one 54-inch Dayton wheel rated at 136 H. P. The Electric Company employs two 48-inch Dowling wheels each rated at 106 H. P. The Waterworks Company uses all the power during low discharges



The Dennis Uhl & Co's. dam at mouth cf Eel River.

and has supplementary steam power. The power is used entirely for pumping in the Waterworks Company. The power at minimum discharge is 106 H. P. at this point but should be much higher. A minimum discharge of 150 second-feet under a head of 11 feet 4 inches will produce 154.5 H. P. This power is owned by the Logansport Waterworks Company.

Dennis Uhl & Company.—About one and a half miles below the Logansport Waterworks Company's tail race, and within 250 feet of the mouth of Eel River, occurs the dam of Dennis Uhl & Co. The first dam was built in 1858, about one-half mile further up stream, and races carried the water to the plants. The present dam was built in 1897-98. It is built of wood on a concrete base which is anchored to bed rock. It is 385 feet long and 11 feet high. The backwater from this dam reaches the tail race of the Logansport Waterworks Company's site. The water is employed from both ends of the dam. On the west, a short race leads to the flouring mill and elevator of Dennis Uhl & Co. This mill was built in 1858. Two modern American and two old Dolan wheels are employed in this plant under a head of 11 feet. The combined power rating of these wheels is about 500 H. P. The power is used entirely for milling purposes. No auxiliary power is employed. The tail race of this plant is at the mouth of Eel River.

On the east end of the dam, the Majestic Knitting Company employs one modern American wheel rated at 150 H. P. This wheel is not employed during reduced discharge.

The minimum discharge at this point is about 150 second-feet, which under a head of 11 feet will produce 150 H. P. Backwater from the Wabash River in flood stage is a serious handicap to this power. This handicap is seldom and of short duration, but is uncontrollable while it lasts. This power is owned by Dennis Uhl & Co.

TIPPECANOE RIVER.

The Tippecanoe River rises among the lakes of Noble, Whitley and Kosciusko counties. It is a very crooked stream and flows in a general westward direction to the northeastern corner of Pulaski County and then in a general southward direction to its mouth in Tippecanoe County. It is about 166 miles in length.

The valley contains much swamp land in its upper parts, but below DeLong, little swamp land occurs. The valley is narrow and the bluffs low in the middle course. The level upland at DeLong is about 30 feet above the river, at Monterey 16 feet, at Ora 23 feet, and at Winamac 32 feet. At Monticello the bluffs are 67 feet high, and at Oakdale 100 feet. This is approximately the maximum depth of the valley. The upper and middle courses of the valley lie entirely in glacial drift. It first touches bed rock at Norway, three miles above Monticello. In this part of its course the stream crosses the Cincinnati anticline, whose surface formation in this locality is the hard Niagara limestone. After touching bed rock at Norway, it is near the rock throughout the rest of its course and rock exposures are frequent. The banks below Norway are usually high and there is little overflow.

The basin of Tippecanoe River embraces almost all of White, Pulaski and Fulton counties, half of Kosciusko, and small portions of several other counties. The entire drainage area is about

1,900 square miles. It is overlaid entirely with glacial drift and many small glacial lakes occur in the northern and eastern parts of the basin. There are no large tributaries, but most of the tributaries drain either lakes or swamps and for this reason have a more or less continuous discharge.

No gage has been established by the State department on the Tippecanoe River, but a gage was maintained by the United States Geological Survey at Spring boro, five miles west of Delphi, during parts of the years 1903-06 inclusive. The data from this gaging station gives a good idea of the discharge of the stream. The following data is taken direct from the U. S. G. S. Water Supply and Irrigation papers:

Tippecanoe River at Springboro.—"This station was established March 14, 1903, by George E. Waesche. The station is located at the highway bridge at Springboro, Ind. The nearest railroad station is Delphi, five miles east of Springboro. The standard chain gage is located on the second span from the east bank, one panel length beyond the center of the span. The length of the chain from the end of the weight to the marker is 25.66 feet. The gage is read once each day by Lois Imler. Discharge measurements are made from the downstream side of the bridge to which the gage is attached. The initial point for soundings is the face of the east abutment. The channel is straight for about 1,600 feet above and about 2,000 feet below the station. Its width at ordinary stages is 350 feet, broken by two piers, and at high water is 510 feet, broken by three piers. Both banks are high and can not overflow to any considerable extent. The bed of the stream is rocky and rough; the current is swift. The bench mark is the head of an anchor bolt in the east abutment; it is the outside anchor of the downstream truss. Its elevation above the zero of the gage is 22.25 feet.

The observations at this station during 1903 have been made under the direction of E. Johnson, Jr., district hydrographer.

DISCHARGE MEASUREMENTS OF TIPPECANOE RIVER AT SPRINGBORO, IND., IN 1903.

Date.	Hydrographer.	Gage Height, Feet.	Discharge, Sec.-Ft.
March 16	G. E. Waesche	4.73	3,448
May 18	G. E. Waesche	3.00	747
June 22	G. E. Waesche	2.87	662
July 17	E. C. Murphy	3.03	892
August 14	E. Johnson	2.75	584
September 30	L. R. Stockman	3.05	704
November 11	L. R. Stockman	3.03	653
December 29	E. Johnson Jr	4.00	a1,083

a Partly frozen.

MEAN DAILY GAGE HEIGHT IN FEET OF TIPPECANOE RIVER AT SPRINGBORO, IND., FOR 1903.

DAY.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	3.50	3.82	3.42	2.78	2.99	2.94	3.10	3.08	3.10
2	....	3.50	3.80	3.42	4.20	3.00	3.53	3.20	3.06	3.09
3	....	3.72	3.73	3.28	7.03	3.03	3.40	3.40	3.09	3.08
4	....	4.94	3.65	3.16	7.07	3.11	3.32	3.50	3.10	3.10
5	....	5.54	3.57	3.50	7.18	2.99	3.28	3.47	3.09	3.12
6	....	5.37	3.52	4.15	6.40	3.16	3.02	3.54	3.08	3.18
7	....	5.00	3.49	4.59	5.54	3.07	2.90	3.70	3.06	3.22
8	....	4.64	3.43	4.63	5.05	....	2.88	3.90	3.05	3.28
9	....	4.18	3.36	4.12	4.50	2.96	2.70	4.17	3.04	3.26
10	....	4.21	3.32	3.77	4.10	2.98	2.81	4.07	3.02	3.24
11	....	5.25	3.24	3.67	3.88	2.99	2.87	4.00	3.03	3.21
12	....	6.69	3.20	3.26	3.76	3.00	2.94	3.93	3.10	3.20
13	....	8.55	3.18	3.28	3.56	2.80	2.80	3.87	3.09	3.29
14	5.18	9.65	3.16	3.16	3.40	2.77	2.90	3.81	3.05	3.95
15	4.90	9.30	3.13	3.09	3.27	2.73	3.20	3.74	*a*	4.15
16	4.75	8.53	3.10	3.04	3.15	2.84	3.60	3.67	*a*	*b*
17	4.58	7.86	3.09	3.02	3.07	2.85	3.70	3.63	*a*	*b*
18	4.58	7.10	3.04	3.00	3.10	2.82	3.79	3.58	*a*	*b*
19	4.52	6.02	2.99	2.93	3.66	2.81	3.83	3.40	*a*	*b*
20	4.35	4.89	2.95	2.96	4.00	2.84	3.60	3.39	*a*	4.20
21	4.54	5.30	2.93	2.98	3.87	2.86	3.50	3.38	*a*	4.18
22	4.40	4.85	2.99	2.87	3.45	2.85	*c*	3.36	3.02	4.16
23	4.22	4.62	3.10	2.93	3.30	2.83	*c*	3.35	3.05	4.14
24	3.97	4.47	3.28	2.96	3.14	2.81	*c*	3.34	3.08	4.15
25	3.87	4.33	3.72	2.92	3.10	3.01	*c*	3.31	3.07	4.13
26	3.88	4.47	4.05	2.87	3.05	2.94	*c*	3.25	3.05	4.17
27	3.82	4.38	4.08	2.93	2.97	2.96	*c*	3.24	3.04	4.16
28	3.78	4.14	3.80	2.86	2.93	2.97	*c*	3.20	3.07	4.15
29	3.70	4.05	3.70	2.83	2.91	2.98	*c*	3.19	3.09	4.14
30	3.60	3.90	3.54	2.82	2.94	3.01	3.05	3.14	3.11	4.13
31	3.50	....	3.38	....	2.96	2.97	....	3.09	....	4.13

a Gage reader absent. *b* Frozen. *c* Gage stolen.

RATING TABLE FOR TIPPECANOE RIVER AT SPRINGBORO, IND., FROM MARCH 14 TO DECEMBER 31, 1903.

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
2.7	551	4.0	1,987	5.3	4,230	7.2	7,650
2.8	611	4.1	2,151	5.4	4,410	7.4	8,010
2.9	680	4.2	2,320	5.5	4,590	7.6	8,370
3.0	758	4.3	2,490	5.6	4,770	7.8	8,730
3.1	845	4.4	2,660	5.7	4,950	8.0	9,090
3.2	940	4.5	2,830	5.8	5,130	8.5	9,990
3.3	1,043	4.6	3,000	5.9	5,310	9.0	10,890
3.4	1,154	4.7	3,170	6.0	5,490	9.5	11,790
3.5	1,273	4.8	3,345	6.2	5,850	10.0	12,690
3.6	1,400	4.9	3,520	6.4	6,210	10.5	13,590
3.7	1,535	5.0	3,695	6.6	6,570	11.0	14,490
3.8	1,678	5.1	3,870	6.8	6,930		
3.9	1,829	5.2	4,050	7.0	7,290		

DISCHARGE MEASUREMENTS OF TIPPECANOE RIVER NEAR DELPHI, IND., IN 1904.

DATE.	Hydrographer.	Width, Feet.	Area of Section, Sq. Ft.	Mean Velocity, Ft. per Sec.	Gage Height, Feet.	Discharge, Sec.-Ft.
January 23	F. W. Hanna	448	2,404	4.10	8.48	9,863
March 2*a*	F. W. Hanna	466	3,920	2.55	13.00	10,010
March 28	F. W. Hanna	449	2,560	4.78	8.80	12,240
May 2	Hanna and Johnson	343	917	4.04	4.95	3,708
June 18	F. W. Hanna	253	328	2.12	2.98	694
July 23	Hanna and Johnson	238	292	1.83	2.92	534
August 22	F. W. Hanna	255	370	2.38	3.20	882
September 13	F. W. Hanna	241	278	1.62	2.85	451
October 22	F. W. Hanna	249	273	1.77	2.90	484
November 5	F. W. Hanna	240	266	1.49	2.86	396

a Ice jam.

MEAN DAILY GAGE HEIGHT IN FEET OF TIPPECANOE RIVER NEAR DELPHI, IND., FOR 1904.

DAY.	Jan.*a*	Feb.*a*	Mar.*a*	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.*a*
1	......	......	14.60	9.55	6.59	4.25	3.49	2.85	2.93	3.10	2.83	2.83
2	......	......	13.44	9.43	5.07	4.21	3.37	2.82	2.90	3.07	2.82	2.82
3	......	......	13.21	8.49	4.80	3.87	3.21	2.80	2.87	3.05	2.84	2.80
4	......	......	12.90	8.34	5.60	3.74	3.09	2.81	2.86	3.00	2.84	2.80
5	......	......	12.37	8.21	5.12	3.65	3.17	2.81	2.84	2.95	2.85	2.91
6	4.10	8.25	12.25	8.03	4.96	3.61	3.22	2.77	2.85	2.91	2.85	2.96
7	......	......	12.80	7.95	4.72	3.40	3.75	2.75	2.83	2.90	2.84	2.97
8	3.80	......	13.20	8.20	4.57	3.45	4.03	2.73	2.83	2.93	2.80	2.98
9	......	......	12.47	8.75	4.35	3.49	4.40	2.73	2.84	3.00	2.85	3.00
10	......	......	7.05	8.15	4.05	3.52	4.37	2.72	2.85	3.07	2.87	3.02
11	......	......	7.00	7.75	4.00	3.43	4.26	2.71	2.85	3.05	2.86	3.00
12	......	......	6.95	7.08	3.93	3.18	4.20	2.69	2.84	3.00	2.85	2.99
13	......	7.85	6.90	5.53	3.84	3.17	4.17	2.74	2.81	3.00	2.86	2.98
14	......	......	7.00	4.98	3.89	3.13	3.98	2.73	3.00	2.98	2.84	......
15	......	......	6.87	5.02	3.91	3.13	3.96	2.72	2.98	2.97	2.87	......
16	3.85	......	6.77	5.17	3.89	3.12	3.71	2.71	3.01	3.03	2.89	......
17	......	......	7.00	5.17	3.85	3.54	3.55	2.78	3.05	3.00	2.88	3.04
18	......	......	7.20	5.14	4.01	3.27	3.47	2.80	3.21	2.97	2.86	......
19	......	......	7.23	5.12	3.99	3.20	3.38	2.81	3.10	2.95	2.86	......
20	4.75	8.20	7.10	5.09	3.95	3.16	3.30	2.90	3.05	2.92	2.85	......
21	11.05	......	7.15	4.98	3.90	3.10	3.21	3.05	3.00	2.90	2.83	......
22	11.25	......	7.77	4.91	3.81	3.09	3.00	3.35	2.98	2.98	2.80	......
23	10.95	......	8.10	4.67	3.70	3.07	2.95	3.42	2.97	2.95	2.85	3.05
24	......	......	8.54	4.47	3.64	3.06	2.91	3.40	2.95	2.94	......	3.09
25	......	......	8.92	4.01	3.73	3.00	2.90	3.35	2.93	2.97	......	3.12
26	......	......	11.20	5.80	3.72	2.96	2.90	3.28	3.10	2.95	......	......
27	15.00	8.20	9.41	7.03	3.71	3.00	2.99	3.18	3.15	2.92	......	......
28	......	......	7.94	6.70	3.70	3.83	2.98	2.98	3.23	2.81	......	......
29	......	15.20	7.02	6.35	3.60	3.71	2.93	3.00	3.20	2.85	2.84	......
30	7.25	......	6.76	6.10	3.74	3.79	2.91	2.93	3.16	2.85	2.83	3.05
31	......	......	8.90	......	4.20	......	2.89	2.90	......	2.84	......	......

a Frozen January 1 to March 9 and December 14 to 31.

RATING TABLE FOR TIPPECANOE RIVER NEAR DELPHI, IND., FROM JANUARY 1 TO DECEMBER 31, 1904.

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
2.7	280	3.8	1,770	4.9	3,640	7.0	8,110
2.8	390	3.9	1,930	5.0	3,830	7.5	9,220
2.9	510	4.0	2,090	5.2	4,230	8.0	10,370
3.0	630	4.1	2,250	6.4	4,650	8.5	11,520
3.1	760	4.2	2,410	5.6	5,070	9.0	12,670
3.2	890	4.3	2,580	5.8	5,490	9.5	13,820
3.3	1,030	4.4	2,750	6.0	5,910	10.0	14,970
3.4	1,170	4.5	2,920	6.2	6,350	10.5	16,120
3.5	1,320	4.6	3,090	6.4	6,790	11.0	17,270
3.6	1,470	4.7	3,270	6.6	7,230	12.0	19,570
3.7	1,620	4.8	3,450	6.8	7,670	13.0	21,870

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1903 and 1904. It is well defined between gage heights 2.8 feet and 8.8 feet. The table has been extended beyond these limits. Above gage height 7.4 feet the rating curve is a tangent, the difference being 230 per tenth.

DISCHARGE MEASUREMENTS OF TIPPECANOE RIVER NEAR DELPHI, IND., IN 1905.

DATE.	Hydrographer.	Width, Feet.	Area of Section, Sq. Ft.	Mean Velocity, Ft. per Sec.	Gage Height, Feet.	Discharge, Sec.-Ft.
March 21	S. K. Clapp	319	713	3.9	4.25	2,782
May 27	M. S. Brennan	325	682	3.23	4.29	2,203
June 13	S. K. Clapp	285	672	3.66	4.30	2,459
July 14	S. K. Clapp	272	617	3.44	4.10	2,120
August 24	M. S. Brennan	256	294	1.89	2.98	556
October 5	M. S. Bernnan	251	276	1.76	2.98	486

DAILY GAGE HEIGHT IN FEET OF TIPPECANOE RIVER NEAR DELPHI, IND., FOR 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.04	......	7.8	4.1	7.9	4.4	3.4	3.35	3.9	3.02	3.25	4.4
2	3.08	......	6.9	4.0	7.8	4.2	3.35	3.3	3.5	3.09	3.25	4.4
3	3.09	......	6.1	3.95	7.8	4.0	3.3	3.3	3.6	3.08	3.2	4.25
4	3.08	3.06	5.9	3.7	7.6	3.95	3.25	3.25	3.75	3.04	3.2	4.2
5	3.06	......	5.7	3.65	7.4	3.9	3.15	3.15	3.7	3.02	3.15	4.0
6	3.03	......	5.6	3.6	7.3	3.85	3.15	3.06	3.55	3.0	3.8	3.85
7	3.0	......	5.5	3.5	7.2	3.75	3.25	3.0	3.45	2.98	4.1	3.8
8	3.0	......	5.4	3.55	6.8	3.75	3.25	3.0	3.35	2.98	4.0	3.7
9	......	......	5.1	3.55	6.8	3.9	3.2	2.98	3.15	2.97	3.95	3.65
10	......	......	4.7	3.55	6.5	4.0	3.3	2.98	3.1	2.96	3.95	3.55
11	......	3.1	4.1	3.5	5.6	4.5	3.7	2.97	3.09	2.96	3.9	3.5
12	......	......	4.1	3.5	10.1	4.3	4.3	2.99	3.06	2.95	3.9	3.45
13	......	......	4.05	3.7	9.4	4.4	4.1	3.0	3.1	2.94	3.8	3.45
14	3.0	......	4.05	3.9	10.2	4.4	4.0	3.09	3.3	2.93	3.7	3.65
15	......	......	4.2	3.85	10.0	4.4	3.9	3.2	3.25	2.91	3.6	3.6
16	......	......	4.2	3.85	9.8	4.3	3.7	3.45	3.15	2.9	3.5	3.5
17	......	......	4.2	3.8	8.9	5.0	3.6	3.3	3.15	2.9	3.35	3.45
18	......	3.12	4.2	3.75	7.6	5.6	3.45	3.15	3.15	3.15	3.35	3.4
19	......	......	4.1	5.2	6.5	5.0	3.45	3.15	3.1	4.4	3.3	3.4
20	......	3.1	4.1	7.0	4.8	4.3	3.35	3.45	3.1	4.4	3.3	3.25
21	3.03	......	4.05	6.1	4.8	4.2	3.25	3.4	3.09	4.3	3.3	3.3
22	......	......	4.1	6.0	4.7	4.3	3.2	3.35	3.08	4.1	3.3	3.4
23	......	......	4.3	6.0	4.7	4.05	3.2	3.3	3.1	4.0	3.25	4.8
24	......	......	4.3	6.59	4.6	3.85	3.15	3.25	3.1	3.95	3.25	4.65
25	......	3.15	4.2	5.8	4.6	3.7	3.1	3.25	3.09	3.85	3.2	4.2
26	......	......	4.2	5.5	4.4	3.6	3.07	3.2	3.08	3.8	3.15	3.9
27	......	......	4.2	5.4	4.4	3.65	3.05	3.15	3.06	3.6	3.1	3.9
28	3.1	......	4.1	7.8	4.4	3.7	3.02	3.08	3.05	3.35	3.1	3.85
29	......	......	4.1	8.0	4.5	3.5	3.35	3.01	3.04	3.3	4.3	3.35
30	......	......	4.2	7.9	4.5	3.45	3.65	2.95	3.03	3.3	4.4	3.8
31	......	4.90	4.1	......	4.7	......	3.4	2.98	......	3.25	......	3.75

NOTE.—There were ice conditions during January and February. From January 9 to February 11 the river was frozen over except for a narrow channel near the west bank. February 12-28 river frozen entirely across. Gage heights are to surface of water in hole in ice. The following comparative readings were also made:

Date.	Water Surface, Feet.	Top of Ice, Feet.	Thickness of Ice, Feet.
January 14	3.0	2.9	0.3
January 21	3.03	3.03	.35
January 28	3.1	3.12	.5
February 4	3.06	......	.5
February 11	3.1	3.12	1.0
February 18	3.12	3.12	1.0
February 25	3.15	3.19	1.0

STATION RATING TABLE FOR TIPPECANOE RIVER NEAR DELPHI, IND., FROM JANUARY 1, 1904, TO DECEMBER 31, 1905.

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
2.70	280	4.20	2,410	5.70	5,280	8.40	11,290
2.80	390	4.30	2,580	5.80	5,490	8.60	11,750
2.90	510	4.40	2,750	5.90	5,700	8.80	12,210
3.00	630	4.50	2,920	6.00	5,910	9.00	12,670
3.10	760	4.60	3,090	6.20	6,350	9.20	13,130
3.20	890	4.70	3,270	6.40	6,790	9.40	13,590
3.30	1,030	4.80	3,450	6.60	7,230	9.60	14,050
3.40	1,170	4.90	3,640	6.80	7,670	9.80	14,510
3.50	1,320	5.00	3,830	7.00	8,110	10.00	14,970
3.60	1,470	5.10	4,030	7.20	8,550	10.50	16,120
3.70	1,620	5.20	4,230	7.40	8,990	11.00	17,270
3.80	1,770	5.30	4,440	7.60	9,450	11.50	18,420
3.90	1,930	5.40	4,650	7.80	9,910	12.00	19,570
4.00	2,090	5.50	4,860	8.00	10,370	12.50	20,720
4.10	2,250	5.60	5,070	8.20	10,830	13.00	21,870

NOTE.—The above table is applicable only for open-channel conditions. It is based on 23 discharge measurements made during 1903-1905. It is not very well defined.

Discharge Measurements of Tippecanoe River at Delphi, Ind., in 1906.

Date.	Hydrographer.	Width, Feet.	Area of Section, Sq. Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
February 10a	Brennan and Kriegsman	272	522	3.86	1,450
March 10	E. F. Kriegsman	335	790	4.74	3,320
April 3	E. F. Kriegsman	325	779	4.62	3,090
May 9	E. F. Kriegsman	257	361	3.27	962

a Slush and cake ice running.

Daily Gage Height in Feet of Tippecanoe River Near Delphi, Ind., for 1906.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	3.75	5.17	4.18	5.47	3.49	3.1	3.0
2	3.73	4.8	4.76	5.25	3.45	3.04	3.02
3	3.7	4.2	5.34	4.97	3.57	3.0	3.0
4	3.72	4.16	5.27	4.63	3.51	2.99	2.99
5	3.78	4.09	5.21	4.37	3.44	2.97	2.97
6	3.74	4.02	4.99	4.6	3.43	3.04	2.96
7	3.69	3.96	4.96	4.5	3.4	3.0	2.94
8	3.66	3.93	4.89	4.42	3.33	2.95	2.9
9	3.61	3.9	4.83	5.7	3.27	3.1	2.88
10	3.58	3.87	4.82	5.27	3.25	3.08	2.85
11	3.55	3.84	4.79	5.06	3.21	3.11	2.84
12	3.52	3.81	4.76	4.89	3.19	3.32	2.87
13	3.47	3.78	4.72	4.56	3.22	3.26	2.9
14	3.43	3.76	4.68	4.63	3.18	3.17	2.81
15	3.57	3.68	4.66	5.17	3.16	3.13	2.85
16	3.51	3.64	4.59	4.95	3.15	3.1	2.98
17	3.48	3.61	4.37	4.8	3.14	3.04	2.97
18	3.46	3.66	4.19	4.67	3.11	3.0	2.9
19	3.42	3.64	3.94	4.43	3.09	2.99	2.84
20	4.73	3.6	3.88	4.37	3.08	3.0	2.82
21	5.8	3.57	3.75	4.19	3.05	2.95	....
22	6.12	3.52	3.73	4.0	3.03	2.96	....
23	6.36	3.48	3.7	3.96	3.1	2.94	....
24	6.39	3.45	3.75	3.91	3.15	2.93	....
25	6.3	4.4	3.78	3.84	3.13	2.93	....
26	6.15	4.33	4.12	3.76	3.11	2.9	....
27	6.1	4.28	6.18	3.65	3.07	2.87	....
28	6.0	4.21	6.0	3.6	3.05	2.85	....
29	5.85	....	5.94	3.57	3.03	2.95	....
30	5.57	....	5.86	3.53	3.1	3.02	....
31	5.25	....	5.71	....	3.15	....	....

Note.—Flow slightly affected by ice conditions February 5 to 10.

Rating Table for Tippecanoe River Near Delphi, Ind., for 1904 to 1906.

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
2.80	390	3.70	1,620	4.60	3,090	5.50	4,860
2.90	510	3.80	1,770	4.70	3,270	5.60	5,070
3.00	630	3.90	1,930	4.80	3,450	5.70	5,280
3.10	760	4.00	2,090	4.90	3,640	5.80	5,490
3.20	890	4.10	2,250	5.00	3,830	5.90	5,700
3.30	1,030	4.20	2,410	5.10	4,030	6.00	5,910
3.40	1,170	4.30	2,580	5.20	4,230	6.20	6,350
3.50	1,320	4.40	2,750	5.30	4,440	6.40	6,790
3.60	1,470	4.50	2,920	5.40	4,650		

Note.—The above table is applicable only for open-channel conditions. It is based on 28 discharge measurements made during 1903 to 1906. It is well defined.

From the preceding data the minimum discharge is found to be 269 second-feet, and to have occured on August 12, 1904. The lowest in 1903 was 600 second-feet on July 1; in 1905, 510 second-feet on October 16 and 17; and in 1906, 400 second-feet on July 14. This data leads to the conclusion that a discharge of about 300 second-feet could be taken as a safe minimum.

The United States Weather Bureau shows the slightest rainfall for the time during which this gage record was kept to have been in November, 1904, when the mean monthly precipitation for northern Indiana was but .23 inch. During this month, however, the discharge at Springboro did not fall below 390 second-feet. The mean monthly rainfall for July, 1904, was 3.46 inches in northern Indiana, and in August was 3.17 inches, which is a normal rainfall in each case. A problem presents itself as to the reason for the discharge being so low on August 12 and remaining so high throughout November. The answer is unknown and cannot be derived from the data. The natural storage produced by the lakes would keep the discharge up during drought, but why the discharge should fall so low in August, when 30 per cent. of the precipitation in the Tippecanoe basin would have given a continuous discharge of over 1,200 second-feet, while the maximum discharge, which was on the 23d, was only 1,200 second-feet, according to the gage readings, is a point which cannot be accounted for except by the conclusion that the data in one or the other case is incorrect. It seems very probable that the gage readings are low because the rainfall data is collected from twenty-one stations and the error at any one station would be divided by twenty-one in striking the mean, and it is unlikely that twenty-one people reading rain gages should make an error which would be very large in the average. For these reasons the minimum discharge is estimated to be somewhat higher than the data shows on August 21, 1904.

The profile of the Tippecanoe River is peculiar in that the fall in the upper course is much less than in the lower course. The greatest fall occurs in the vicinity of Monticello. This is due to the fact that the stream flows over the Cincinnati anticline in northern White County and has been unable to cut through the hard rock at Norway. The Wabash River has been deepening its valley at the mouth of the Tippecanoe faster than the Tippecanoe could deepen its valley in the vicinity of Norway. The result of this condition is a gradually increasing fall in the lower course of the stream. The following table shows the profile of the river.

PROFILE OF TIPPECANOE RIVER.

LOCATION.	Estimated Distance, Miles.	Altitude, Feet.	Fall per Mile, Inches.
Source	0	950	....
De Long	80	711	20.85
Monterey	7	703	13.71
Ora	5	698	12.00
Winamac	15	678	16.00
Monticello	31	599	30.58
Oakdale	11	563	37.09
Springboro	8	544	28.50
Mouth	9	524	26.66

POWER SITES ON THE TIPPECANOE RIVER.

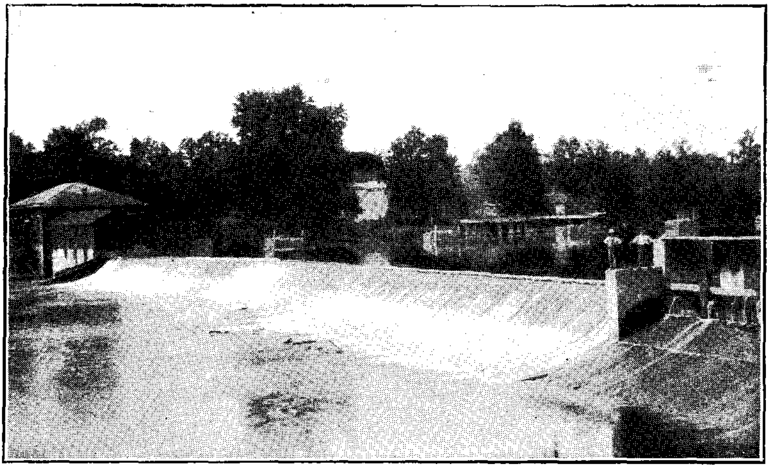
The Tippecanoe River is without doubt the best power stream in Indiana, except the St. Joseph. Its minimum discharge is greater than that of either fork of White River or of the Wabash at Cicott Street bridge in Logansport, which is below the mouth of Eel River. The broad valley flats along the Wabash and White rivers are also distinct disadvantages when compared to the Tippecanoe, which has high banks and little bottom land except in the last ten miles of its course. That part of the Tippecanoe which lies between Winamac and the mouth is the part which is well adapted for power development. In spite of the advantages for power development, there are but two developed sites on the entire stream below DeLong. These sites are at Pulaski and Monticello. The development of power above Pulaski is not feasible. The current in this part of the stream is sluggish but steady. There are no ponds and the bed of the stream is composed of pure white sand, which is extremely beautiful under the water. There are no bowlders and no bed rock. There is little timber drift in this part of the stream, and on the whole it is a stream ideally adapted to pleasure trips.

Pulaski.—The dam at Pulaski was built about 1860 and has not been rebuilt. The present mill was built at the same time. The dam is built of wood and brush. It is in very bad repair and at least half the water goes through it when the discharge is small enough that none goes over. It is 418 feet long and four feet high. The backwater from this dam reaches nearly three miles. The race leads from the west end of the dam to the mill, one-fourth of a mile below. The head at the mill is five feet. Three wheels are employed under this head, one 48-inch and one 35-inch Little Giant, and one 30-inch Standard Leffel. These wheels produce about 75 H. P. The owners say that there would never be lack of water to produce 75 H. P. if the dam were in good condition. This would indicate a minimum discharge of 165 second-feet at this point. The power is used entirely for grinding and all the power is not needed to run the mill. Much of it is wasted, besides the waste through the dam. It is safe to say that the minimum discharge here is not less than 200 second-feet. If the old dam were replaced by a new dam, with a head of eight feet at the mill, and modern wheels installed, a power of 145 H. P. could be produced continually and the installation should be on a 300 H. P. basis. That much power could be produced for eight months of the driest year. This power is owned and employed by C. N. Niedham and S. March.

There is little choice of location for power sites between Pulaski and Monticello. The character of the stream is similar throughout. Long reaches are separated by abrupt gravel ripples. The banks occasionally approach a little nearer to each other and are at some points slightly higher than at others. However, at no place are these peculiarities pronounced enough to be of great importance. The fall from Winamac to Monticello below the dam is 79 feet. About eight feet of this is occupied by the Monticello site and six feet by the Pulaski site. This leaves 65 feet of undeveloped fall between Winamac and Monticello. Ten feet of this should be developed at Norway. The rest of this fall could be developed on low heads, but no particular sites have been selected as superior to others.

Norway.—The first exposure of bed rock on the Tippecanoe occurs at Norway. It is Niagara, and is very hard. There is an abrupt ripple over this exposure with a fall of 2.7 feet. A dam could be located above this ripple with a head of eight feet. Such a dam has been in existence at this point and the race is still in good repair. The race adds 2.7 feet to the head at the dam. A dam eight feet high would injure about 20 acres of low lying land on the east side of the river in Section 16, T. 27 N., R. 3 west. If the minimum discharge at this point be considered 250 second-feet, a continuous power of 230 H. P. could be produced on a head of 10 feet.

Tippecanoe Electric and Power Company.—The dam of this plant is located about 100 yards below the point where the Tippecanoe crosses the line between Sections 27 and 34, T. 27 N., R. 3 W. It is at the northeast corner of Monticello. There has been a dam at this point for over fifty years. The power was formerly used in a woolen mill, and later in a flour mill. At present the power is used to produce electricity. The dam is 320 feet long and 8.55 feet high. It is built of wood with concrete apron and abutments. The foundation is upon gravel, which makes it very unstable. Considerable trouble has been caused already by undermining below the dam. The dam is well constructed. The electric plant is situated on the west end of the dam. Four 50-inch wheels, each with a rating of 100 H. P. under eight feet head are installed. These wheels are not properly installed and do not produce their rated power. The discharge below the draft tube is restricted so that the water is forced out, which accounts for the loss of power. The four wheels produce about 300 H. P. when in full operation. The river discharge is insufficient to run the four wheels during low water, but has never failed to run two to their



Dam and power plant of the Tippecanoe Electric and Power Co., Monticello, Ind.

capacity. Thus, the minimum power produced at this point has not been below 150 H. P. This would indicate that the minimum discharge does not go below 210 second-feet. There has never been a time when there was not waste when only two wheels were running, so that the discharge is probably at the least 250 second-feet. The electric plant is a model concern of its kind. It is run continuously and furnishes the motor power and light for Monticello. Steam auxiliary power is used during low discharge. This power is owned and operated by the Tippecanoe Electric and Power Company, of which D. J. Oglesby is superintendent.

Tioga.—Tioga is the name of a point on the river at the southeast corner of Monticello, about two and one-half miles by the river below the Tippecanoe Electric and Power Company plant, and in Section 3, T. 26 N., R. 3 W. The river makes a great bend eastward between these two sites. The fall from the tail water of the electric plant to the wagon bridge at Tioga is 13.04 feet. One hundred and fifty feet above the wagon bridge is the remnant of an old dam and evidences of an old mill are still visible on the east side of the stream. The river flows against the west bluff, which is about 80 feet high at this point. The east bank is about 25 feet high. The stream is about 350 feet wide. The bed is composed of gravel, but bed rock is said to be within a few feet of the surface. This is probably true, because the river flows on bed rock about one-fourth of a mile above Tioga. This site could be developed with a head of 10 feet without interference to the electric plant. The control of this site and much of the power below this point is in the hands of a corporation, known as the Tippecanoe Hydraulic Company. This company is holding the rights as an investment.

Power Site in Section 22, T. 26 N., R. 3 W.

In Section 22, the river is flowing south by east and bends suddenly to a southwestward direction. On this bend the river flows against the east bluff, which rises abruptly about 30 feet and then slopes gradually to a height of 70 or 80 feet. The west bank is about 25 feet high and slopes immediately into the west bluff, which approaches within an eighth of a mile of the river. After the river has turned southwestward, a remnant of the east bluff forms a long, gradually lowering ridge along the southeast side of it. Back of this ridge is a low bottom field. A dam constructed on this bend and a race cut through the ridge would make an excellent power site, for the water would be under absolute control. The race would skirt the east bluff towards the southeast and re-enter the river at a point in the exact center of the south line of Section 22. The race would be one-half mile long, but would be easily constructed after the cut through the previously mentioned ridge had been made. The cut would be about 250 feet long and the depth would be governed by the height of the dam. If the Tioga site were developed, the height of this dam would be limited to 10 feet. This height is an estimate, because no levels were run over this part of the river. However, if the Tioga site were not developed, a dam of 15 or even 20 feet could be constructed here. There is practically no low land above this site. The race would re-enter the river one and one-half miles below the dam and would add five feet to the head. The power at this point at minimum discharge, 250 second-feet, would be 23 H. P. per foot head. The farm upon which this site is located belongs to Martin Baum.

Oakdale.—Oakdale is the name of a small summer resort in Section 33, T. 26 N., R. 3 W. A water power mill was previously located at this point and part of the old dam still remains. Below the old dam is a considerable ripple. The entire fall over the dam and ripple is 6.38 feet. The old dam was located at a point where the banks are low and the stream bed very wide. Immediately below the ripple the river flows against the west bluff and the east bank is about 12 feet high. A dam at this point would be about 400 feet long. There is no bed rock in the stream at this point. A head of eight feet could be maintained here and a minimum power of 200 H. P. produced.

Springboro.—Springboro is located five miles west of Delphi, near the southwest corner of Section 26, T. 25 N, R. 3 W. The fall from Oakdale to this point is 19 feet. A heavy ripple occurs at Springboro with a fall of approximately four feet. This is a bowlder ripple and no bed rock is exposed. At the foot of this ripple the banks are high. A dam 10 feet high and 500 feet long could be constructed here without damage to low land. Such a dam would produce 273 H. P. when the discharge is 300 second-feet.

The fall from this point to the mouth is 20 feet, and no plan for developing this power seems feasible. The banks of the river become lower and more bottom land occurs in this part of the valley. Back-water from the Wabash River would be a serious handicap to development in this part of the stream. The Wabash River fluctuates a great deal because its headwaters and southern tributaries have no storage. Any rise in this river would diminish the fall between Springboro and the mouth by the amount of the rise.

If the group of sites which have been mentioned were developed by one management, supplemented by steam power and fed into one system, the enterprise should be profitable. The development of the several sites would improve each individual site by the increased storage and water control.

SUGAR CREEK.

A discussion of Sugar Creek will be found on page 75 of the Thirty-fifth Annual Report. This stream was investigated again during the summer of 1911. The estimated discharge was found to be too high. The former estimate was made from one current reading and the statements of men who were acquainted with the stream as to the comparative stages which it presented. Upon the second visit the stream was found to be very low, indeed. A discharge measurement, made on August 21, 1911, at the Shades of Death, where the former measurement was taken, showed a discharge of but 17.62 second-feet. The profile of the stream was determined and is given in the following table:

PROFILE OF SUGAR CREEK.

LOCATION.	Distance, Miles.	Altitude, Feet.	Fall per Mile, Feet.
Source	0	1000	....
Bluff Mill	60	565	7.25
Pleasantview	5	543	4.4
Narrows	8	502	5.12
Mouth	13	459	3.31

A site which could be easily developed is in Section 18, T. 17 N., R. 6 W. The stream flows through a gorge of Mansfield sandstone. The gorge is 100 feet wide and 60 feet deep. The bed of the stream is on bed rock. The stream falls 16.76 feet from the Pleasant View site to this site, and the fall from this site to the Narrows is 23.78 feet. Thus this site could be developed with a head of 15 feet without interference with either of the sites mentioned in the Thirty-fifth Annual Report. The valley above this site is narrow and not more than five acres of cultivated land would be submerged by this development.

The valley widens below this site and there is considerable low land between it and the Narrows. A development of 20 feet at the Narrows would submerge about 20 acres of cultivated land.

When the extreme irregularity of discharge of this stream is considered, it is plain that the power is not feasible for continuous use. Not only is the low discharge a menace, but also the stages are dangerous. Sugar Creek is very wild during high water because of the narrow valley through which it flows. The fact that each of the sites which have been discussed offer locations for power houses above the danger line of floods and the ease with which dam construction can be carried on in each case are favorable to development. No sites for development were located below the Narrows.

MISSISSINEWA RIVER.

The Mississinewa River rises in Darke County, Ohio, flows westward through Randolph County, Indiana, bends to the northwest in Delaware County, and flows in that general direction through Delaware, Grant, Wabash and Miami counties, to its mouth, one and one-half miles east of Peru. It is a very crooked stream and has no large tributaries. It has a total length of 105 miles, practically all of which is in Indiana.

The valley of this stream lies between two glacial moraines left by the Erie glacier. It is entirely within glacial drift, but below Marion continually touches and is excavated into bed rock in many places. At Marion, the valley is about 40 feet deep and becomes gradually deeper toward the mouth. The greatest depth is about 100 feet. The width is variable. Broad bottoms are succeeded by gorges and narrows. The limestone gorges which occur in northern Grant County are the most picturesque in Indiana and the bottom land in Miami County is not surpassed by bottom land anywhere.

The basin of the Mississinewa River is long and narrow. It is bounded by the Salamonie Basin on the north and by White River Basin on the south. The devides between these basins are formed by the glacial moraines which have been previously mentioned. The tributaries are short and about evenly divided on north and south. No natural storage occurs in this basin, since the land has been systematically drained and the forests removed. The absence of wooded land in this basin is particularly noticeable. This is due to the gas boom, at which time the forests were practically all destroyed because it was thought that there would be no wood needed for fuel in the future. Before the land was artificially drained there was considerable natural storage caused by the irregular relief of the glacial drift. This did not take the form of lakes nor even swamps, but was poorly drained land. This land is now perfectly drained by tile. The entire drainage area of this stream is approximately 900 square miles.

The discharge of the Mississinewa River is very irregular. A gaging station has been maintained at Peoria since 1910 and the data which has accumulated will be given. This gage was established on July 6, 7, and 8, 1910. It is located five miles southeast of Peru, Indiana. A discussion of this gage is given on page 76 of the Thirty-fifth Annual Report. This gage is based on one bench mark, which is a wire nail in the north side of a small hackberry tree. The nail is about five inches from the ground. The tree stands 37 feet southwest of the upper end of the gage. It is beside a large bowlder and has a woven wire fence attached to it. The bench mark is 18.69 feet above the 0 of the gage.

DISCHARGE MEASUREMENTS ON MISSISSINEWA RIVER AT PEORIA DURING 1910-11.

Date.	Hydrographer.	Gage Height, Feet.	Dis-charge, Sec.-Ft.
July 8, 1910	W. M. Tucker	1.0	65.49
April 5, 1911	W. M. Tucker	4.6	3191.48
June 23, 1911	Tucker and Clark	1.8	183.34
June 26, 1911	Tucker and Clark	1.9	202.76

GAGE READINGS ON MISSISSINEWA RIVER AT PEORIA FROM JULY 8, 1910, TO JULY 7, 1911.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	.....	1.1	1.0	1.7	1.3	3.0	4.7	4.2	2.3	2.0	3.7	1.2	1.5
2	.....	1.1	1.0	1.5	1.3	2.8	4.5	3.6	2.2	2.0	2.9	1.2	1.5
3	.....	1.0	1.0	1.4	1.2	2.4	4.5	3.4	2.1	2.0	2.8	1.2	1.9
4	.....	1.0	1.0	1.4	1.2	2.2	4.3	3.1	2.0	2.1	2.1	1.2	1.3
5	.....	1.0	1.3	1.3	1.2	2.0	4.0	3.0	2.0	2.1	2.2	1.2	1.3
6	.....	1.0	1.7	1.3	1.2	2.9	3.4	2.8	1.9	5.3	2.2	1.6	1.3
7	.....	1.0	1.7	6.6	1.2	2.8	3.0	2.8	1.8	5.2	2.3	2.5	1.3
8	1.0	1.0	1.5	8.4	1.2	1.7	2.9	2.8	1.9	4.8	2.0	2.5	.....
9	1.0	1.0	1.6	7.8	1.1	1.7	2.8	2.7	1.9	4.0	2.4	2.1	.....
10	1.0	1.0	1.6	7.8	1.1	1.7	2.8	2.7	2.2	3.6	2.4	2.0	.....
11	1.1	1.0	1.6	7.4	1.1	1.7	2.7	2.7	2.8	3.1	2.2	1.7	.....
12	1.0	1.0	1.5	6.4	1.1	1.8	2.7	2.5	3.2	2.6	2.2	1.7	.....
13	1.0	1.1	2.1	4.0	1.1	1.8	2.6	2.4	2.8	2.4	2.0	1.7	.....
14	1.0	1.1	2.0	3.2	1.1	1.7	2.7	2.8	2.5	3.2	2.0	1.4	.....
15	1.0	1.1	2.0	2.1	1.1	1.7	2.9	3.8	2.3	4.6	2.0	1.4	.....
16	1.0	1.1	2.1	1.8	1.1	1.6	5.0	3.7	2.1	4.4	2.0	1.3	.....
17	1.0	1.1	2.2	1.8	1.1	1.6	6.4	3.3	2.1	2.7	1.7	1.3	.....
18	1.1	1.0	2.3	1.7	1.1	1.6	5.6	3.2	2.1	2.3	1.7	1.1	.....
19	1.0	1.0	2.3	1.7	1.1	1.5	4.9	3.0	2.1	2.0	1.8	1.1	.....
20	1.0	1.0	2.3	1.6	1.1	1.5	4.4	2.9	2.2	3.8	1.8	1.4	.....
21	1.0	1.0	2.3	1.6	1.1	1.5	4.1	2.8	2.2	3.8	1.6	1.4	.....
22	1.1	1.0	2.3	1.6	1.1	1.5	3.8	2.6	2.1	3.5	1.6	1.5	.....
23	1.0	1.0	2.2	1.5	1.1	1.6	3.4	2.5	2.0	3.7	1.6	1.8	.....
24	1.0	1.0	2.2	1.5	1.1	1.6	3.6	2.4	2.0	3.2	1.5	1.6	.....
25	1.1	1.0	2.2	1.5	1.1	1.6	3.0	2.4	1.9	2.3	1.4	2.2	.....
26	1.0	1.1	2.1	1.5	1.1	1.6	2.8	2.4	1.9	2.1	1.4	1.9	.....
27	1.0	1.2	2.1	1.5	1.1	1.6	3.4	2.3	2.1	1.8	1.4	1.7	.....
28	1.0	1.1	2.0	1.5	1.5	1.9	7.1	2.3	2.0	1.5	1.4	1.6	.....
29	1.0	1.1	2.0	1.4	2.9	2.8	7.0	.....	1.9	1.5	1.4	1.6	.....
30	1.0	1.0	1.8	1.4	3.3	5.0	6.6	.....	2.0	2.2	1.2	1.5	.....
31	1.1	1.0	.....	1.4	.....	4.8	5.0	.....	2.1	.....	1.2	.....	.....

RATING TABLE FOR MISSISSINEWA RIVER AT PEORIA FOR 1910-11.

Gage Height, Feet.	Dis-charge, Sec.-Ft.	Gage Height, Feet.	Dis-charge, Sec.-Ft.	Gage Height, Feet.	Dis-charge, Sec.-Ft.	Gage Height, Feet.	Dis-charge, Sec.-Ft.
1.0	66	1.9	204	2.8	557	3.7	1,583
1.1	77	2.0	227	2.9	629	3.8	1,743
1.2	89	2.1	252	3.0	711	3.9	1,910
1.3	102	2.2	280	3.1	804	4.0	2,083
1.4	116	2.3	312	3.2	908	4.1	2,261
1.5	131	2.4	349	3.3	1,023	4.2	2,443
1.6	147	2.5	391	3.4	1,149	4.3	2,628
1.7	164	2.6	439	3.5	1,285	4.4	2,815
1.8	183	2.7	494	3.6	1,430	4.5	3,003
						4.6	3,191

From this data it is evident that there are long periods during the year in which the discharge is less than 100 second-feet. The minimum discharge is 66 second-feet. This discharge will produce six H. P. per foot fall. The entire fall from Marion to the mouth of the river is 148 feet. If this entire fall covering 30 miles could be developed, the minimum discharge would yield less than 888 H. P. because the discharge is less at any point above Peoria and much less at Marion.

The profile of the Mississinewa has not been determined. The elevations at Marion and at the mouth were determined and the fall estimated in the various parts between these two points. The elevation at Marion is 781 feet above sea level and at the mouth 633 feet. The fall averages 4.93 feet per mile.

Power Sites on the Mississinewa River.

There are three developed power sites on this stream between Marion and the mouth. One is one mile below Marion, another in Section 9, T. 25 N., R 7 E., and the other in Section 26, T. 26 N., R. 6 E. These sites are known as Charles' Mill, Conner's Mill, and Pearson's Mill, respectively. Another site was developed until the winter of 1910-11, when the dam was destroyed by ice. This site was at Peoria and was known as the Peoria Mill. There are points where power could be developed but with the deficient discharge it is not considered to be profitable. Some of these points will be discussed, however.

Charles' Mill.—This mill is located in the extreme north end of Marion, about one mile from the business section. This site was first developed about 1840. It has been owned by the Charles family for fifty years. The dam is 320 feet long and six feet high. It is built of stone and wood. About 200 feet of the eastern end is built of limestone and is in excellent condition. The remainder is built of wood and is fast falling into decay. The forebay is at the east end of the dam and is built of limestone. The dam and forebay are built upon solid limestone. Three wheels are employed, one 84-inch wheel rated at 45 H. P., one 54-inch wheel rated at 35 H. P., and one 54-inch wheel rated at 25 H. P. These are all old-style wheels. Fifty H. P. is developed at this site for eight months of the year. It is supplemented by electric power during low discharge. The river is practically intermittent in this part of its course. The power is used entirely for milling purposes.

Conner's Mill.—This site is naturally ideally located. The bluffs of the stream converge until they are 300 feet apart. They rise abruptly from the river. They are composed of limestone, as is also the bed of the stream. A dam 30 feet in height could be constructed here but would submerge a great deal of low land. This dam is about forty years old. It is built of wood and is in fair condition. It is 250 feet long and five feet high. The power is employed in a flour mill and in a sawmill. There is one 48-inch wheel in the sawmill. The power developed by this wheel is not known. It is employed by S. B. Kennedy. In the flour mill there are three wheels employed, one 48-inch, one 40-inch and one 38-inch. The rating of these wheels is unknown. This power is employed by Alec Lindsay. The power produced at this site is not more than 25 H. P. during minimum discharge.

Power Site at Joel Garst Farm.—When the river enters Wabash County it becomes more crooked and has several large incised meanders. One of these meanders begins where the river first touches the range line between Ranges 6 and 7 E. The river crosses into R. 6 E., but immediately returns to R. 7 E. It then makes a great bend northeastward and after flowing for two miles has returned to a point about three-fourths of a mile northwest of the point where it first touched Range 6. Between these points lies a depression which is so low that the southeast end must be leveed to keep the flood water from flowing across and injuring the field. At a point immediately below the southeast end of this depression, the river is flowing on bed rock, a shaly, thin-bedded limestone. The fall by river from the upper to lower end of the depression is 5.37 feet. A mill was formerly located in this depression and used the power. The water was conducted across in a race. A six-foot dam, 150 feet in length, could be constructed on the limestone foundation and the race be reconstructed. This would produce a fall of 11 feet. This site is on the farm of Joel Garst.

Pearson's Mill.—At the point where the depression re-enters the river the backwater from the Pearson dam begins. The pond is two miles long. The dam is situated on a solid rock foundation and has a rock bluff 40 feet high for its south abutment. The dam is 183 feet long and four feet, 10 inches high. The bank on the north end of the dam is about 10 feet high above the pond. The mill is located on this bank, in a very pretty park. The land rises gradually to 40 or 50 feet above the river in a quarter of a mile. In the mill are two wheels. One is used for mill purposes and is rated at 20 H. P. The other is used to produce electricity, which is used in lighting the park grounds. The park is used for a summer resort. The power is owned and employed by Richard Pearson.

Power Site in Section 29, T. 26 N., R. 6 E.—This site is about three miles below Somerset. The fall below Pearson's Mill to this point is about 15 feet. The river flows through a narrow, the sides and bed of which are solid limestone. The east bluff rises abruptly for 60 feet, and on the west the solid rock slopes upward to a height of 20 feet within a distance of 75 feet. The river is about 125 feet wide and an average of 12 feet deep. A 12-foot dam at this point would back the water beyond Somerset. The location for a plant on the west side is ideal. With a head of 12 feet, about 100 H. P. could be produced except in very low water, when about 60 H. P. would be available.

Site in Section 14, T. 26 N., R. 5 E.—Below the previous site the river flows through narrows and short canyons. At Redbridge is an old dam which is almost obliterated. It produces a fall of three feet, but is not used. The location is poor for development, for the stream is wide and the dam is on a bend of the stream. In Section 14, the bluffs approach the river until a dam 200 feet long and 15 feet high would retain the water. The stream bed is of solid rock. A power plant could be well located on the west side of the stream at this point. This site is near the ford, which is a short distance above the head of the Peoria mill pond. Fifteen feet head would produce about 100 H. P. during minimum flow, and more during most of the year.

Peoria Mill.—The Peoria Mill was operated by water until the winter of 1910-11, when the dam was destroyed by high water and ice. The dam had been built during the previous summer. A dam was built of bowlders which was covered and filled by cement. The apron was light and extended but two feet below the dam. The dam was three feet high. When the ice went out in December, 1910, it broke the apron and the water undermined the dam and it broke in three places. A race 500 feet long added two feet to the head. On the head of five feet, about 40 H. P. was produced for 12 hours per day. This site is owned by H. F. Whisler.

No sites occur below this point which are feasible for development. The fall from Peoria to the mouth is approximately 15 feet.

THE WABASH RIVER.

The Wabash River rises in the Grand Reservoir, an artificial lake, at Celina, Mercer County, Ohio. It crosses the State line into Indiana near the northeast corner of Jay County and flows in a northwest direction to Huntington, through Adams, Wells and Huntington counties. At Huntington it turns westward and flows in that direction, bearing slightly southward to Logansport, through Huntington, Wabash, Miami and Cass counties. At Logansport it turns toward the southwest and flows in that direction to Covington, through Cass, Carroll, Tippecanoe, and between Warren and Fountain counties. At Covington it bends southward and flows in that direction, bearing toward the west to the State line in Vigo County, between Fountain and Parke counties on the east and Vermillion County on the west and through Vigo County. From this point it forms the west line of Indiana to its mouth. The entire length of the part which lies entirely in Indiana is 320 miles. In this course are the mouths of several large tributaries. The Little Wabash, at Huntington; the Salamonie, near Lagro; the Mississinewa, near Peru; the Eel, at Logansport; the Tippecanoe, near Delphi; the Wildcat, near Lafayette, and Sugar Creek, near Newport, are the largest of these. The main branch from Celina, Ohio, to Huntington, Indiana, is very much like the Mississinewa in its characteristics. It flows between two glacial moraines and the tributaries are small. It runs through glacial drift in this part of its course, although it touches bed rock frequently.

The valley below Markle is everywhere characterized by broad valley flats. The width varies from one-half mile in the upper course to six miles at Terre Haute. The banks are composed of river sediment and usually very low. The bluffs vary in height from 50 feet at Markle to 100 feet or more throughout its course below **Wabash.**

The drainage basin is a broadly curved, unsymmetrical section of land stretching across the north central part of the State. The main branch and the southern tributaries have no natural storage facilities. The northern tributaries rise in the lake regions of the Saginaw glacier. The effect of these streams is to make the discharge more regular below Logansport and Delphi. Above Logansport, the discharge is very irregular. The drainage area above Terre Haute is 12,200 square miles, and above Logansport, including Eel River basin, is 3,163 square miles.

The United States Geological Survey maintained a gage at Logansport from April 27, 1903, to July 8, 1906. The following data is taken from the United States Water Supply Papers:

WABASH RIVER AT LOGANSPORT, INDIANA.*

This station was established April 27, 1903, by Geo. E. Waesche. It is located at the Cicott Street bridge, about 1 mile from the center of the city of Logansport, 1¾ miles from the Wabash Railroad station, 1½ miles from the Pennsylvania station, four blocks from the street car line, and 1,000 feet below the mouth of Eel River. The standard chain gage is placed on the second span of the bridge, at the third panel from the second pier, and is supported by the bridge pins, and is between the lower chord bars. It is reached through a trap door in the floor planks of the bridge. The distance from the end of the weight to the marker is 20.78 feet. The gage is read once each day by C. B. Woodruff. Discharge measurements are made from the downstream side of the bridge to which the gage is attached. The initial point for soundings is the back wall of the bridge seat for the north abutment. The channel is nearly straight for 1,000 feet above and for 1,500 feet below the station. The distance between abutments is 550 feet, and the channel is broken by three bridge piers. The right bank is high and is not subject to overflow at the bridge. The left bank is submerged only at extreme high water. The bed of the stream is covered with small bowlders and is rough. The stream is shallow and the current is never sluggish. Benchmark No. 1 is the top of the north abutment, under the fourth board of the downstream sidewalk. Its elevation is 18.814 feet above gage datum. From Pennsylvania Railroad levels its elevation above sea level has been found to be 591 feet. Bench mark No. 2 is the top of the third course of masonry from the top of the north abutment. Its elevation above the zero of the gage is 15.31 feet.

The observations at this station during 1903 have been made under the direction of E. Johnson, Jr., district hydrographer.

DISCHARGE MEASUREMENTS OF WABASH RIVER AT LOGANSPORT, IND., IN 1903.*

DATE.	Hydrographer.	Gage Height. Feet.	Discharge, Sec.-Ft.
April 27	Geo. E. Waesche	2.50	2,367
June 8	Geo. E. Waesche	4.55	7,180
June 16	Geo. E. Waesche	?	1,444
July 8	Geo. E. Waesche	2.30	1,358
July 16	E. C. Murphy	1.54	719
August 15	E. Johnson Jr	1.35	418
September 30	L. R. Stockman	1.30	349
November 10	L. R. Stockman	1.38	452
December 28	E. Johnson Jr	2.75	1,285

*Water-supply paper U. S. Geol. Survey, No. 98, page 225.

MEAN DAILY GAGE HEIGHT IN FEET OF WABASH RIVER AT LOGANSPORT, IND., FOR 1903.*

DAY.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		2.15	2.30	1.55	1.70	1.70			1.30
2		2.10	2.25	10.15	1.60	1.70			1.30
3			2.70	7.25	1.50	1.70	*a*		1.40
4		2.00	2.50	4.80	1.60	1.70			1.50
5		2.00	3.25	3.65	1.60	1.70			1.60
6		1.95	4.15	3.00	1.55	1.92			1.70
7		1.90	5.50	2.55	1.55	1.72			1.50
8		1.90		2.30	1.50	1.72			1.45
9		1.90	4.30	2.15	1.45	1.70			1.40
10			3.65	2.00	1.40	1.40	*a*	1.40	1.40
11		1.80	3.10	1.90	1.40	1.40		1.40	1.85
12		1.80	2.65	1.95	1.35	1.35		1.40	1.85
13		1.80	2.40	1.90	1.35	1.35		1.40	2.40
14		1.75	2.25	1.25	1.35	1.40		1.40	2.90
15		1.75	2.10	1.70	1.35	1.40		1.40	2.90
16		1.75	1.95	1.60	1.45	1.40		1.50	2.90
17			1.85	1.60	1.40	1.40	*a*	1.50	2.70
18		1.70	1.80	1.75	1.40	1.40		1.80	2.40
19		1.65	1.80	1.85	1.30	1.40		1.60	2.40
20		1.65	1.75	1.85	1.35	*a*		1.40	2.40
21		1.60	1.70	1.80	1.35			1.50	2.70
22		1.65	1.80	1.70	1.30			1.50	2.90
23		1.70	2.05	1.80	1.30			1.40	2.80
24		2.15	2.20	1.75	1.30		*a*	1.40	2.70
25		2.80	2.00	1.70	1.30			1.40	2.70
26		2.70	1.85	1.70	1.30			1.40	2.70
27	2.50	3.00	1.75	1.70	1.35			1.40	2.80
28	2.40	3.60	1.70	1.60	1.90			1.40	2.75
29	2.30	3.30	1.60	1.60	2.10			1.40	2.68
30	2.20	2.85	1.60	1.65	1.90			1.30	2.60
31		2.60		1.70	1.70				2.53

*Water-supply paper U. S. Geol. Survey, No. 98, page 226. *a*Observer absent.

RATING TABLE FOR WABASH RIVER AT LOGANSPORT, IND., FROM APRIL 27 TO DECEMBER 31, 1903.*

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
1.3	380	2.6	1,990	4.8	8,100	8.0	22,780
1.4	460	2.7	2,170	5.0	8,890	8.5	25,130
1.5	550	2.8	2,360	5.2	8,720	9.0	27,480
1.6	650	2.9	2,560	5.4	10,590	9.5	29,830
1.7	750	3.0	2,770	5.6	11,500	10.0	32,180
1.8	860	3.2	3,200	5.8	12,440	10.5	34,530
1.9	980	3.4	3,670	6.0	13,380	11.0	36,880
2.0	1,100	3.6	4,180	6.2	14,320	11.5	39,230
2.1	1,230	3.8	4,740	6.4	15,260	12.0	41,580
2.2	1,370	4.0	5,340	6.6	16,200	12.5	43,930
2.3	1,510	4.2	5,970	6.8	17,140	13.0	46,280
2.4	1,660	4.4	6,640	7.0	18,080		
2.5	1,820	4.6	7,350	7.5	20,430		

*Water-supply paper U. S. Geol. Survey, No. 98, page 226.

DISCHARGE MEASUREMENTS OF WABASH RIVER AT LOGANSPORT, IND., IN 1904.*

DATE.	Hydrographer.	Gage Height, Feet.	Discharge, Sec.-Ft.
1904.			
January 22*b*	F. W. Hanna	13.11	46,660
March 2*c*	F. W. Hanna	8.20	23,660
March 29*c*	F. W. Hanna	10.50	32,480
May 3	F. W. Hanna and Johnson	2.98	3,744
June 17	F. W. Hanna	1.66	878
July 21	F. W. Hanna	1.76	920
August 23	F. W. Hanna	1.50	723
September 14	F. W. Hanna	1.48	542
October 21	F. W. Hanna	1.30	401
November 4	F. W. Hanna	1.27	379

*Water Supply Paper U. S. Geol. Survey, No. 128, page 84.

MEAN DAILY GAGE HEIGHT IN FEET OF WABASH RIVER AT LOGANSPORT, IND., FOR 1904.*

DAY.	Jan.*a*	Feb.*a*	Mar.*a*	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.*a*
1	2.53	3.10	9.90	12.22	3.75	2.90	1.80	1.30	1.30	1.35	......	1.30
2	2.50	3.00	7.88	13.00	3.25	3.00	1.73	1.30	1.33	1.35	1.22	1.35
3	2.33	2.30	7.65	13.02	2.95	3.00	1.75	1.35	1.27	1.30	1.25	1.45
4	2.23	2.50	7.88	11.06	2.75	2.90	1.68	1.33	1.21	1.29	1.27	1.22
5	2.23	2.50	7.30	7.65	2.58	2.70	1.79	1.30	1.25	1.26	1.23	1.28
6	2.20	3.00	6.50	5.73	2.50	2.40	1.90	1.35	1.30	1.25	1.25	1.22
7	2.20	10.20	8.19	4.88	2.40	2.30	3.10	1.29	1.24	1.28	1.27	1.22
8	2.15	9.65	7.35	4.45	2.30	2.20	5.12	1.29	1.20	1.35	1.27	1.28
9	2.15	7.90	5.83	4.70	2.30	2.00	4.95	1.32	1.25	1.45	1.22	1.25
10	2.15	6.35	5.00	4.95	2.35	1.90	4.71	1.25	1.25	1.46	1.30	1.18
11	2.15	5.60	5.00	4.70	2.25	1.90	4.43	1.25	1.25	1.46	1.30	1.31
12	2.10	5.10	5.15	4.68	2.13	1.82	4.14	1.24	1.25	1.45	1.30	1.20
13	2.10	4.20	......	4.30	2.10	1.78	3.53	1.20	1.26	1.45	1.30	1.40
14	2.20	3.60	4.20	3.90	......	1.73	2.99	1.25	1.48	1.40	1.31	......
15	2.20	2.70	3.70	3.60	......	1.70	2.69	1.21	1.41	1.37	1.31	......
16	2.15	2.50	3.42	3.33	2.00	1.70	2.50	1.25	1.25	1.35	1.25	......
17	2.15	2.30	3.45	3.15	1.95	1.65	2.00	1.25	1.30	1.35	1.31	......
18	2.20	2.34	5.40	2.90	2.00	1.73	1.99	1.25	1.41	1.29	1.30	......
19	2.25	2.38	6.75	2.90	2.15	1.75	1.85	1.25	1.49	1.28	1.30	......
20	2.60	2.10	7.00	2.63	2.40	1.90	1.81	1.50	1.49	1.25	1.33	......
21	10.85	2.25	6.20	2.52	2.40	2.56	1.78	1.61	1.51	1.30	1.35	......
22	13.19	2.21	8.30	2.48	2.35	3.30	1.65	1.76	1.39	1.30	1.35	......
23	12.55	2.35	8.10	2.85	2.43	3.15	1.65	1.50	1.37	1.30	1.30	1.31
24	10.00	3.50	6.68	2.15	2.40	2.97	1.61	1.45	1.37	1.30	1.28	1.35
25	7.45	4.80	6.85	2.60	2.40	2.49	1.55	1.40	1.40	1.30	1.31	1.41
26	6.00	4.50	13.45	7.05	2.75	2.20	1.53	1.29	1.56	1.30	1.30	1.50
27	4.75	3.70	14.84	7.12	2.70	2.00	1.53	1.30	1.50	1.30	1.30	1.73
28	4.38	3.88	13.05	5.90	2.53	1.93	1.50	1.27	1.56	1.24	1.34	......
29	4.00	9.22	10.32	5.25	2.40	1.87	1.50	1.30	1.46	1.22	1.30	4.12
30	3.70	......	7.50	4.50	2.43	1.80	1.41	1.33	1.40	1.22	1.28	3.95
31	3.50	......	9.10	......	2.55	......	1.39	1.34	......	......	......	3.41

*Water Supply Paper U. S. Geol. Survey, No. 128, page 85.
*a*Ice conditions from January 1 to March 3 and December 14 to 31, 1904.

RATING TABLE FOR WABASH RIVER AT LOGANSPORT, IND., FROM JANUARY 1 TO DECEMBER 31, 1904.*

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
1.2	260	2.5	2,540	4.2	7,380	8.0	22,770
1.3	360	2.6	2,770	4.4	8,050	8.5	25,060
1.4	480	2.7	3,010	4.6	8,730	9.0	27,410
1.5	620	2.8	3,260	4.8	9,430	9.5	29,790
1.6	770	2.9	3,510	5.0	10,140	10.0	32,200
1.7	930	3.0	3,770	5.2	10,880	10.5	34,650
1.8	1,100	3.1	4,030	5.4	11,640	11.0	37,130
1.9	1,280	3.2	4,300	5.6	12,420	12.0	42,130
2.0	1,470	3.3	4,580	5.8	13,220	13.0	47,130
2.1	1,670	3.4	4,870	6.0	14,040	14.0	52,130
2.2	1,880	3.6	5,460	6.5	16,170	15.0	57,130
2.3	2,090	3.8	6,080	7.0	18,320	....	....
2.4	2,310	4.0	6,720	7.5	20,520	....	....

*Water Supply Paper U. S. Geol. Survey, No. 128, page 85.

The preceding table is applicable only for open-channel conditions. It is based upon 19 discharge measurements made during 1903 and 1904. It is well defined between gage heights 1.3 feet and 8.2 feet. The table has been extended beyond these limits. Above gage height 10.7 feet the rating curve is a tangent the difference being 500 per tenth.*

*Water Supply Paper U. S. Geol. Survey, No. 128, page 86.

DISCHARGE MEASUREMENTS OF WABASH RIVER AT LOGANSPORT, IND., IN 1905.*

DATE.	Hydrographer.	Gage Height, Feet.	Discharge, Sec.-Ft.
March 21	S. K. Clapp	3.75	5,450
May 27	M. S. Brennan	2.22	1,700
June 14	S. K. Clapp	3.79	5,480
July 14	S. K. Clapp	2.75	2,436
August 23	M. S. Brennan	1.95	1,100
September 4	M. S. Brennan	1.74	748

*Water Supply Paper U. S. Geol. Survey, No. 169, page 75.

DAILY GAGE HEIGHT IN FEET OF WABASH RIVER AT LOGANSPORT, IND., FOR 1905.*

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.95	......	6.12	4.82	4.25	3.14	1.67	1.40	1.63	1.48	1.60	4.50
2	2.42	......	5.88	4.25	3.70	2.88	1.70	1.40	1.72	1.55	1.63	4.05
3	2.20	2.15	5.55	3.45	3.20	2.70	1.70	1.36	1.75	1.60	1.58	3.68
4	2.00	......	5.20	2.93	2.68	2.52	1.62	1.25	1.75	1.65	1.55	3.60
5	1.90	......	4.60	2.60	2.55	2.40	1.62	1.35	1.60	1.89	1.60	3.50
6	1.85	......	4.35	2.40	2.80	5.10	1.63	1.58	1.55	1.87	2.00	3.10
7	1.90	......	3.95	2.28	3.40	4.00	1.63	2.45	1.50	1.80	2.35	2.84
8	......	......	3.70	2.20	3.39	3.55	1.63	2.17	1.45	1.75	2.50	2.58
9	......	2.10	3.85	2.15	2.95	3.22	1.63	1.80	1.42	1.65	2.39	2.48
10	......	......	4.00	2.10	2.73	3.23	1.70	1.70	1.42	1.60	2.33	2.40
11	......	......	3.86	2.05	3.80	3.78	2.25	1.53	1.50	1.60	2.20	2.30
12	2.70	......	3.60	2.05	10.50	3.78	3.17	1.45	1.49	1.54	2.05	2.25
13	......	......	3.10	2.05	10.05	3.80	2.95	1.40	3.33	1.50	1.85	2.22
14	......	......	2.85	2.00	8.45	3.72	2.63	1.49	3.48	1.50	1.81	2.15
15	......	......	2.70	2.00	7.10	3.33	2.40	1.77	2.90	1.45	1.80	2.10
16	......	2.20	2.50	1.95	6.12	3.00	2.30	1.90	2.83	1.42	1.78	1.99
17	......	......	2.85	1.90	5.10	2.85	2.10	1.70	3.58	1.40	1.75	2.10
18	3.00	......	3.40	1.86	4.50	2.68	1.92	2.30	4.42	2.13	1.70	2.05
19	......	......	3.60	1.86	3.88	2.65	1.91	2.56	3.78	2.45	1.70	2.00
20	......	......	3.60	1.88	3.50	2.60	1.75	2.70	3.28	2.30	1.65	1.90
21	......	......	3.71	5.65	3.23	2.40	1.99	2.43	3.00	2.20	1.58	2.80
22	......	......	3.47	6.45	2.85	2.72	1.73	2.21	2.80	2.05	1.55	4.65
23	......	2.23	3.10	5.98	2.60	2 60	1.68	1.99	2.00	2.00	1.63	4.58
24	......	......	3.00	5.15	2.45	2.30	1.50	2.00	2.20	1.85	1.62	4.10
25	2.25	......	3.58	4.48	2.30	2.19	1.50	2.57	2.00	1.80	1.59	3.60
26	......	......	3.45	3.75	2.25	2.19	1.43	2.60	1.80	1.78	1.60	3.20
27	......	7.90	2.95	4.65	2.20	2.15	1.40	2.30	1.80	1.70	1.58	2.90
28	......	6.45	2.65	4.12	2.15	2.00	1.37	1.98	1.70	1.65	1 93	2.63
29	......	......	2.45	5.55	2.10	1.88	1.40	1.82	1.55	1.60	5.80	2.60
30	......	......	2.50	4.95	2.25	1.78	1.40	1.72	1.50	1.53	6.10	2.75
31	......	......	5.32	......	2.61	......	1.43	1.55	......	1.60	......	3.00

*Water Supply Paper U. S. Geol. Survey, No. 169, page 75.

NOTE.—Gage heights interpolated March 2, 9, November 16, and December 7. Ice conditions January 1 to February 27. From January 12 to February 27 river was entirely frozen across. Gage was read to the surface of the water in a hole in the ice.

STATION RATING TABLE FOR WABASH RIVER AT LOGANSPORT, IND., FROM JANUARY 1 TO DECEMBER 31, 1905.*

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
1.20	330	2.30	1,805	3.40	4,440	4.50	7,700
1.30	360	2.40	2,010	3.50	4,715	4.60	8,020
1.40	420	2.50	2,225	3.60	4,995	4.70	8,340
1.50	510	2.60	2,445	3.70	5,280	4.80	8,670
1.60	630	2.70	2,675	3.80	5,570	4.90	9,000
1.70	770	2.80	2,910	3.90	5,865	5.00	9,340
1.80	920	2.90	3,150	4.00	6,160	5.20	10,020
1.90	1,080	3.00	3,395	4.10	6,460	5.40	10,720
2.00	1,250	3.10	3,645	4.20	6,760	5.60	11,430
2.10	1,425	3.20	3,905	4.30	7,070	5.80	12,160
2.20	1,610	3.30	4,170	4.40	7,380	6.00	12,910

*Water Supply Paper U. S. Geol. Survey, No. 169, page 76.

NOTE.—The above table is applicable only for open channel conditions. It is based on discharge measurements made during 1903-1905. It is well defined between gage heights 1.2 and 4.00 feet. The table has been extended beyond these limits. Above 6 feet the discharge is estimated, being based on three high-water measurements of 1904.

DISCHARGE MEASUREMENTS OF WABASH RIVER AT LOGANSPORT, IND., IN 1906.*

DATE.	Hydrographer.	Gage Height, Feet.	Discharge, Sec.-Ft.
February 9a	Bernnan and Kriegsman	2.02	1,270
March 10	E. F. Kriegsman	2.78	3,010
April 3	E. F. Kriegsman	5.42	11,800
May 10	E. F. Kriegsman	1.72	1,070

*Water Supply Paper U. S. Geol. Survey, No. 205, page 60.

DAILY GAGE HEIGHT, IN FEET, OF WABASH RIVER AT LOGANSPORT, IND., FOR 1906.*

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	2.73	2.58	2.08	7.90	1.90	1.72	1.52
2	2.57	1.40	1.88	6.85	2.40	1.66	1.55
3	2.48	1.18	2.48	5.60	1.90	1.66	1.60
4	2.38	1.58	3.83	4.85	1.90	1.70	1.60
5	4.88	1.88	3.30	3.90	1.80	1.70	1.75
6	4.43	2.03	2.93	3.80	1.80	1.72	1.87
7	3.88	2.03	2.78	3.60	1.76	1.70	1.75
8	3.20	2.06	2.70	4.40	1.72	1.50	1.75
9	2.63	1.97	....	6.70	1.76	2.70	1.69
10	2.00	1.88	2.78	7.15	1.73	2.40	1.60
11	2.18	1.83	2.68	5.90	1.66	2.06	1.86
12	2.38	1.78	2.58	4.85	1.65	1.80	1.80
13	2.18	1.83	2.53	4.80	1.60	1.86	1.83
14	2.15	1.88	2.41	4.70	1.72	1.80	1.82
15	2.08	2.08	2.28	5.90	1.72	1.76	1.80
16	2.68	2.18	2.23	5.25	1.80	1.72	1.80
17	2.88	2.23	2.18	3.80	1.68	1.70	1.80
18	3.18	1.88	2.08	3.40	1.60	1.72	1.80
19	3.08	1.73	1.93	3.30	1.60	1.66	1.80
20	2.88	1.78	1.98	2.86	1.40	1.60	1.80
21	3.88	1.78	1.98	....	1.43	1.60	1.80
22	8.21	1.83	2.03	2.60	1.53	1.72	1.80
23	6.88	1.78	2.08	2.40	1.52	1.36	1.78
24	5.88	1.88	1.88	2.30	1.56	....	....
25	4.88	2.08	1.88	2.20	1.76	1.19	....
26	4.13	2.38	1.98	2.20	1.50	1.19	....
27	3.88	2.71	8.48	2.20	1.50	1.30	....
28	3.68	2.58	9.03	2.10	1.60	1.37	....
29	3.03	....	8.38	2.15	1.44	1.40	....
30	2.88	....	8.18	2.10	1.47	1.57	....
31	....	....	8.03	....	1.84	....	....

*Water Supply Paper U. S. Geol. Survey, No. 205, page 61.

RATING TABLE FOR WABASH RIVER AT LOGANSPORT, IND., FOR 1906.

Gage Height, Feet.	Dis-charge, Sec. Ft.	Gage Height, Feet.	Dis-charge, Sec. Ft.	Gage Height, Feet.	Dis-charge, Sec. Ft.	Gage Height, Feet.	Dis-charge, Sec. Ft.
1.20	310	2.30	1,900	3.40	4,690	5.00	9,770
1.30	400	2.40	2,110	3.50	4,980	5.20	10,480
1.40	500	2.50	2,330	3.60	5,270	5.40	11,210
1.50	610	2.60	2,560	3.70	5,570	5.60	11,950
1.60	730	2.70	2,800	3.80	5,870	5.80	12,710
1.70	860	2.80	3,050	3.90	6,170	6.00	13,500
1.80	1,000	2.90	3,310	4.00	6,480	7.00	17,600
1.90	1,160	3.00	3,580	4.20	7,110	8.00	22,100
2.00	1,330	3.10	3,850	4.40	7,750	9.00	26,800
2.10	1,510	3.20	4,130	4.60	8,410	9.10	27,280
2.20	1,700	3.30	4,410	4.80	9,080	....	....

NOTE.—The above table is applicable only for open channel conditions. It is based on discharge measurements made during 1903 to 1906. It is well defined.

On July 16, 17, 18, 1910, a gaging station was established by the writer on the Cicott Street bridge in Logansport. A discussion of this gage is given on page 77 of the Thirty-fifth Annual Report. The following data has been collected at this station:

Discharge Measurements on Wabash River at Logansport, Ind., for 1910-11.

Date.	Hydrographer.	Gage Height, Feet.	Discharge, Sec. Ft.
July 18, 1910	W. M. Tucker	5.4	442.72
April 15, 1911	W. M. Tucker	9.0	8,865.96
July 6, 1911	Tucker and Clark	5.6	545.23

These three readings are not sufficient data to formulate a rating table, but taken with the United States Geological Survey rating tables shows that the base of this gage is approximately 4.1 feet lower than the base of the United States Geological Survey gage was. Thus the gage readings can be used with the United States Geological Survey rating tables if 4.1 feet be subtracted from the gage reading in each case and the discharge for that gage height be taken from the rating table.

Current Readings on Wabash River at Logansport, Ind., from July 18, 1910, to July 17, 1911, Inclusive.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	......	5.2	5.3	5.9	5.4	8.3	9.0	9.9	6.5	6.0	7.7	6.1	5.9
2	......	5.2	5.2	5.8	5.4	8.1	9.4	8.0	6.4	6.0	8.1	6.1	5.8
3	......	5.2	5.2	5.7	5.5	7.5	e	7.9	6.4	6.0	7.2	6.1	5.7
4	......	5.2	5.3	5.8	5.6	6.0	e	7.9	6.3	6.3	6.8	6.1	5.6
5	......	5.2	5.4	5.9	5.8	5.8	e	7.8	6.2	10.2	6.6	6.1	5.6
6	......	5.2	6.0	6.0	5.8	5.7	e	7.7	6.1	10.6	6.3	6.2	5.6
7	......	5.1	6.4	6.2	5.8	5.7	e	7.6	6.1	9.3	6.2	6.2	5.5
8	......	5.1	6.2	10.3	5.7	5.7	e	7.5	6.1	8.7	6.2	6.3	5.4
9	......	5.1	5.9	10.6	5.7	5.8	e	7.3	6.0	7.9	6.2	6.0	5.4
10	......	5.1	5.9	9.5	5.7	5.9	e	6.4	6.0	7.9	6.2	6.9	5.4
11	......	5.1	5.8	9.4	5.6	5.9	e	6.6	6.2	6.2	6.2	5.8	5.5
12	......	5.1	5.8	8.5	5.6	5.8	e	6.4	6.3	6.7	6.2	5.6	5.4
13	......	5.1	6.3	7.9	5.6	5.8	e	6.6	6.9	6.8	6.2	5.6	5.4
14	......	5.1	7.2	7.5	5.5	5.6	e	6.7	6.5	8.0	6.1	5.6	5.4
15	......	5.1	6.6	7.3	5.5	5.6	e	9.2	6.3	8.9	6.1	5.6	5.4
16	......	5.1	6.5	6.0	5.5	5.5	e	10.7	6.2	8.6	5.9	5.7	5.4
17	......	5.1	6.2	5.9	5.5	5.5	e	9.0	6.1	8.1	5.7	6.1	5.6
18	5.4	5.2	6.1	5.9	5.4	5.5	e	8.5	6.2	7.3	5.8	6.1	......
19	5.3	5.2	6.2	5.7	5.4	5.5	e	8.5	6.1	7.2	5.8	6.1	......
20	5.3	5.5	6.1	5.7	5.3	5.5	e	8.2	6.0	10.0	5.8	6.1	......
21	5.3	5.6	6.1	5.7	5.3	5.6	e	8.1	5.9	10.1	5.9	5.7	......
22	5.2	5.5	6.0	5.6	5.3	5.7	e	8.0	5.9	9.3	5.9	5.8	......
23	5.2	5.5	6.0	5.7	5.3	5.8	7.0	7.2	5.9	8.6	5.9	5.9	......
24	5.2	5.5	6.0	5.7	5.4	6.0	6.8	7.0	5.9	8.8	5.8	6.0	......
25	5.2	5.5	6.0	5.5	5.4	5.8	6.7	6.8	5.9	7.2	5.7	6.1	......
26	5.2	5.5	6.2	5.6	5.4	5.8	6.6	6.7	5.9	7.2	5.6	7.6	......
27	5.2	5.5	6.2	5.6	5.5	5.8	7.4	6.6	6.0	7.2	5.6	6.9	......
28	5.2	5.4	6.1	5.5	5.5	7.3	11.9	6.5	6.0	7.2	5.6	6.0	......
29	5.4	5.3	6.0	5.5	8.4	8.1	11.7	......	6.0	7.1	5.6	6.0	......
30	5.4	5.3	5.9	5.5	8.8	9.0	11.5	......	6.0	7.0	5.5	5.9	......
31	5.2	5.3	......	5.4	......	9.0	11.3	......	6.0	......	5.5	......	......

eNo records taken.

From the foregoing data, a fair idea of the discharge of the stream can be gained. The lowest discharge in 1903 was 345 second-feet on July 14, and the highest about 33,000 second-feet on July 2. The lowest discharge in 1904 was 260 second-feet on August 13, and September 8, and the highest was 56,140 on March 27. In 1905, the lowest discharge was 345 second-feet on August 4, and the highest was 56,140 second-feet on March 27. In 1905, the lowest discharge was 345 second-feet, on August 4, and the highest estimated at 33,750 second-feet on May 12. In 1906, the lowest was 294 second-feet, on February 3, and the highest 26,900 second-feet on March 28. In 1910-11, the lowest was less than 310 second-feet, from August 7 to August 17, 1910, and the highest 21,200 second-feet on January 28, 1911. This shows the high discharge to be practically one hundred times the low discharge. Since this station is situated one mile below the mouth of Eel River, the discharge from it must be subtracted in each case to determine the discharge of the Wabash above the junction of the two streams. The discharge of Eel River is not known for the years prior to 1910 and 1911. Between August 7 and 17, 1910, it is found from the data of the Third Street Gaging Station to have varied from 125 second-feet to 210 second-feet, which indicates that the discharge on the Wabash was less than 100 second-feet during part of this time. On January 28, 1911, the discharge of Eel River was 1,895 second-feet, which indicates that the discharge of the Wabash was 19,305 second-feet. Thus the maximum discharge of the Wabash at the mouth of Eel River is approximately two hundred times the minimum. The United States Geological Survey maintained a gage on the Wabash River at Terre Haute, Indiana, from February 25, 1905, to July 20, 1906. The following data is taken from the United States Water Supply Papers:

WABASH RIVER AT TERRE HAUTE, IND.*

This station was established February 25, 1905. It is located at the Vandalia Line railway bridge near the city waterworks. There are no tributaries nor any islands, falls or dams in the river near the station.

The channel is practically straight for 700 feet above and below the station. There is a considerable angle of approach on the right bank, but practically none at the left bank. The right bank is comparatively low and alluvial, but is protected by a levee that does not overflow. The left bank is high, covered with buildings and does not overflow. All of the water passes between the abutments of the bridge. The bed of the stream is composed of hard permanent material, is clean of vegetation, and always consists of but one channel. The current has a medium-swift velocity at low stages.

* Water Supply Paper, U. S. Geol. Survey, No. 169, page 77.

Discharge measurements are made from the downstream lower chord of the bridge. The initial point for soundings is the center of the truss pin through the left end of the downstream lower chord of the left span of the bridge.

A standard chain gage is fastened to the downstream side of the bridge on the first span from the left bank; length of chain, 42.97 feet. During 1905 the gage was read by Albert Shewmaker. The gage is referred to bench marks as follows: (1) The Terre Haute city bench mark at the northeast corner of First and Chestnut streets; elevation 0.33 feet. (2) The southeast corner of the left abutment of the Vandalia Line railway bridge; elevation 36.40 feet. (3) The base of the railroad rail immediately opposite the pulley at the gage box; elevation 42.51 feet. Elevations refer to the datum of the gage. This is 0.33 foot below the city datum, which is 438.72 feet above mean sea level.

DISCHARGE MEASUREMENTS OF WABASH RIVER AT TERRE HAUTE, IND., IN 1905.*

DATE.	Hydrographer.	Gage Height, Feet.	Discharge, Sec. Ft.
May 12	M. S. Brennan	6.90	15,750
June 25	M. S. Brennan	3.74	7,367
July 29	M. S. Brennan	1.42	2,648
August 25	M. S. Brennan	2.00	3,700
September 11	M. S. Brennan	1.81	3,311
October 15	M. S. Brennan	1.00	2,066

*Water Supply Paper U. S. Geol. Survey, No. 169, page 77.

DAILY GAGE HEIGHT, IN FEET, OF WABASH RIVER AT TERRE HAUTE, IND., FOR 1905.**

DAY.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	13.7	5.1	8.6	6.4	2.2	1.72	1.5	1.42	1.9	9.55
2	......	14.3	7.0	8.0	6.2	2.02	1.58	1.75	1.4	1.82	9.85
3	......	14.4	7.2	6.7	6.6	2.88	1.38	1.75	1.3	1.85	8.62
4	......	14.7	6.2	5.8	5.2	3.8	1.28	1.6	1.22	1.8	7.05
5	......	15.0	5.2	5.3	4.6	2.78	1.22	1.85	1.18	1.88	6.02
6	......	13.3	4.4	4.9	4.05	2.48	1.15	1.95	1.18	2.85	5.88
7	......	10.6	3.9	4.7	4.7	2.28	1.3	1.88	1.18	3.4	5.3
8	......	9.0	3.6	4.5	6.0	1.98	1.22	1.7	1.32	3.9	4.88
9	......	8.2	3.3	4.9	5.6	2.35	1.48	1.5	1.3	3.98	4.4
10	......	7.3	3.1	5.6	4.9	2.58	1.82	1.4	1.28	3.88	4.05
11	......	6.6	3.0	5.3	4.6	4.0	1.68	1.92	1.18	3.62	3.8
12	......	6.5	3.05	6.8	4.7	4.75	1.45	3.0	1.1	3.32	3.62
13	......	6.2	3.1	12.7	5.2	4.25	1.28	3.1	1.02	3.05	3.42
14	......	5.6	2.95	14.1	5.4	4.4	1.52	2.72	1.0	3.75	3.18
15	......	5.0	2.72	15.1	5.1	4.4	2.62	2.4	1.0	2.52	2.85
16	......	4.6	2.55	16.3	5.0	3.85	2.8	3.32	.95	2.38	2.65
17	......	4.3	2.4	17.0	4.6	3.4	2.62	3.95	.9	2.22	2.48
18	......	4.0	2.32	16.8	4.2	3.0	2.55	4.6	2.0	2.12	2.52
19	......	4.35	2.15	15.7	4.8	2.68	2.25	5.0	3.4	2.02	2.55
20	......	5.1	2.02	12.8	5.4	2.75	2.1	5.1	4.15	1.92	2.48
21	......	5.6	2.82	9.5	7.3	4.6	2.38	4.8	4.92	1.82	2.62
22	......	5.6	5.9	7.8	4.8	3.4	2.58	4.2	4.68	1.75	3.2
23	......	5.5	9.2	6.6	4.1	2.65	a2.15	3.6	4.12	1.65	4.9
24	......	5.3	10.9	5.7	3.9	2.28	1.72	3.2	3.68	1.65	7.08
25	......	4.8	10.6	5.0	3.7	1.98	1.68	2.72	3.3	1.6	7.4
26	9.7	4.8	9.4	4.6	3.3	1.78	1.78	2.32	2.95	1.65	6.7
27	12.3	5.0	8.4	4.3	2.9	1.6	2.1	2.05	2.7	1.58	6.0
28	11.3	5.0	7.5	4.1	2.65	1.5	2.38	1.8	2.45	1.42	5.3
29	......	4.5	8.0	3.9	2.5	1.42	2.3	1.68	2.2	2.1	4.9
30	......	4.1	8.2	6.7	2.4	1.78	2.02	1.5	1.12	8.0	4.5
31	......	4.5	......	7.1	......	1.68	1.75	......	1.95	......	4.48

aGage height interpolated.
**Water Supply Paper U. S. Geol. Survey, No. 169, page 78.

STATION RATING TABLE FOR WABASH RIVER AT TERRE HAUTE, IND., FROM FEBRUARY 25 TO DECEMBER 31, 1905.

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
0.90	1,945	2.50	4,670	4.20	8,430	7.40	17,200
1.00	2,065	2.60	4,870	4.40	8,910	7.60	17,800
1.10	2,195	2.70	5,080	4.60	9,390	7.80	18,400
1.20	2,335	2.80	5,290	4.80	9,890	8.00	19,000
1.30	2,485	2.90	5,505	5.00	10,400	8.20	19,600
1.40	2,643	3.00	5,720	5.20	10,920	8.40	20,300
1.50	2,808	3.10	5,940	5.40	11,450	8.60	21,000
1.60	2,978	3.20	6,160	5.60	11,990	8.80	21,700
1.70	3,152	3.30	6,380	5.80	12,540	9.00	22,400
1.80	3,330	3.40	6,605	6.00	13,100	9.50	24,150
1.90	3,513	3.50	6,830	6.20	13,660	10.00	25,900
2.00	3,700	3.60	7,055	6.40	14,240	10.50	27,800
2.10	3,890	3.70	7,280	6.60	14,820	11.00	29,800
2.20	4,080	3.80	7,510	6.80	15,400	11.50	31,800
2.30	4,275	3.90	7,740	7.00	16,000	12.00	33,800
2.40	4,470	4.00	7,970	7.20	16,600		

NOTE.—The above table is applicable only for open-channel conditions. It is based on six discharge measurements made during 1905. It is well defined between gage heights 1 foot and 4 feet. The table has been extended beyond these limits, being based on one measurement at 6.9 feet and also on well-defined area and mean-velocity curves to 12 feet. Above this point the curve is more uncertain as the river overflows.

DISCHARGE MEASUREMENTS OF WABASH RIVER AT TERRE HAUTE, IND., IN 1906.

DATE.	Hydrographer.	Width, Feet.	Area of Section, Sq. Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
February 16a	Brennan and Kriegsman	482	3,790	4.40	6,710
March 28	E. F. Kriegsman	606	10,700	15.84	40,600
March 31	E. F. Kriegsman	714	13,000	19.20	62,800
April 18	E. F. Kriegsman	580	8,520	12.02	25,500
April 19	E. F. Kriegsman	564	7,740	10.80	22,200
April 20	E. F. Kriegsman	557	6,790	9.30	19,300
April 20	E. F. Kriegsman	557	6,650	8.92	18,200
April 21	E. F. Kriegsman	552	6,210	7.95	16,800
April 21	E. F. Kriegsman	549	5,950	7.65	16,200
April 23	E. F. Kriegsman	541	5,190	6.35	13,200
June 9	E. F. Kriegsman	535	4,500	4.98	11,400

a Partial ice conditions.

DAILY GAGE HEIGHT, IN FEET, OF WABASH RIVER AT TERRE HAUTE, IND., FOR 1906.

Day	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	4.68	8.22	5.02	19.8	3.88	5.72	1.08
2	4.72	7.28	4.88	19.22	3.8	4.22	1.22
3	4.85	6.0	7.38	18.45	3.78	3.5	1.35
4	5.88	5.88	9.9	17.7	3.75	2.88	1.32
5	6.5	5.15	10.78	16.8	3.78	2.88	1.38
6	7.35	4.55	10.48	15.22	3.52	3.2	1.7
7	7.85	2.45	9.28	12.9	3.3	3.12	1.72
8	7.18	2.35	8.48	10.75	3.1	2.52	1.62
9	5.82	2.7	8.3	14.22	2.95	4.22	1.6
10	4.78	2.78	8.18	15.02	2.9	5.55	1.52
11	3.85	2.92	7.82	15.1	2.82	4.52	1.42
12	4.02	3.02	7.28	15.3	2.72	4.08	1.35
13	3.62	3.2	6.75	15.42	2.62	3.38	1.32
14	3.58	3.72	6.38	14.95	2.52	2.92	1.32
15	3.55	4.42	5.98	12.85	2.45	2.6	1.25
16	3.75	4.15	5.58	12.52	2.35	2.32	1.22
17	3.82	3.4	5.28	12.75	2.28	2.12	1.4
18	3.88	3.12	4.98	12.25	2.15	1.98	1.75
19	3.95	3.6	4.82	10.7	2.12	1.82	1.7
20	4.65	4.02	4.55	9.1	2.08	1.75	1.42
21	5.72	4.2	4.35	7.9	2.02	1.75	....
22	13.68	3.78	4.42	6.95	1.92	1.7	....
23	15.95	3.82	4.6	6.28	1.9	1.68	....
24	16.82	3.78	4.52	5.72	1.85	1.6	....
25	17.12	4.18	4.48	5.38	1.9	1.5	....
26	17.38	5.0	6.35	5.05	1.98	1.42	....
27	17.22	5.22	14.28	4.78	1.9	1.3	....
28	16.25	5.3	15.88	4.48	2.12	1.28	....
29	14.12	....	16.42	4.25	2.08	1.2	....
30	11.18	....	17.02	4.05	1.88	1.15	....
31	9.3	....	18.95	....	4.32	....	....

NOTE.—Ice gorge at railroad bridge, a short distance above the gaging section, February 7 to 18. The flow at the gaging section was probably affected by ice on only February 15 and 16.

RATING TABLE FOR WABASH RIVER AT TERRE HAUTE, IND., FOR 1905 AND 1906.

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
1.00	2,050	2.50	4,510	4.00	7,620	7.00	14,700
1.10	2,180	2.60	4,700	4.20	8,060	8.00	17,200
1.20	2,320	2.70	4,900	4.40	8,500	9.00	19,800
1.30	2,460	2.80	5,100	4.60	8,940	10.00	22,500
1.40	2,610	2.90	5,300	4.80	9,380	11.00	25,300
1.50	2,770	3.00	5,500	5.00	9,830	12.00	28,400
1.60	2,940	3.10	5,700	5.20	10,300	13.00	31,800
1.70	3,110	3.20	5,900	5.40	10,780	14.00	35,500
1.80	3,280	3.30	6,100	5.60	11,260	15.00	39,500
1.90	3,450	3.40	6,310	5.80	11,740	16.00	43,700
2.00	3,620	3.50	6,520	6.00	12,220	17.00	48,100
2.10	3,790	3.60	6,740	6.20	12,700	18.00	52,700
2.20	3,970	3.70	6,960	6.40	13,200	19.00	57,400
2.30	4,150	3.80	7,180	6.60	13,700	20.00	62,100
2.40	4,330	3.90	7,400	6.80	14,200		

NOTE.—The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1905 and 1906. It is well defined.

On July 21 and 22, 1910, the writer visited the Terre Haute waterworks station and found that daily gage readings had been kept at that point since 1901. These gage readings were secured through the kindness of Mr. Taylor, chief engineer of the Terre Haute Water Works Company, and will be given in this report. Two current readings were taken from the Wabash avenue bridge in Terre Haute, and these will be used with the readings of the United States Geological Survey to determine a rating table to accompany the gage readings:

DISCHARGE MEASUREMENTS ON WABASH RIVER AT TERRE HAUTE, IND., FROM 1905 TO 1911.

DATE.	Hydrographer.	Gage Height, Feet.	Discharge, Sec.-Ft.
May 12, 1905	M. S. Brennan	6.00	15,750
June 25, 1905	M. S. Brennan	2.84	7,367
July 29, 1905	M. S. Brennan	.52	2,648
August 25, 1905	M. S. Brennan	1.10	3,700
September 11, 1905	M. S. Brennan	.10	2,066
February 16,*a* 1906	Brennan and Kriegsman	3.50	6,710
March 28, 1906	E. F. Kriegsman	14.94	40,600
March 31, 1906	E. F. Kriegsman	18.30	62,800
April 18, 1906	E. F. Kriegsman	11.12	25,500
April 19, 1906	E. F. Kriegsman	9.90	22,200
April 20, 1906	E. F. Kriegsman	8.40	19,300
April 20, 1906	E. F. Kriegsman	8.02	18,200
April 21, 1906	E. F. Kriegsman	7.05	16,800
April 21, 1906	E. F. Kriegsman	6.75	16,200
April 23, 1906	E. F. Kriegsman	5.45	13,200
June 9, 1906	E. F. Kriegsman	4.08	11,400
July 23, 1910	W. M. Tucker	.67	2,962
August 28, 1911	Tucker and Clark	.25	2,249

a Partial ice conditions.

NOTE.—The readings taken by Messrs. Brennan and Kriegsman were based on the government gage which was placed .9 ft lower than the waterworks gage. Thus the reduction of each gage reading by .9 ft. gives data for a rating table for the waterworks gage. The reduction has been made in this table.

GAGE READINGS ON WABASH RIVER AT TERRE HAUTE WATERWORKS STATION FOR 1901.

DAY.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.0	3.7	1.4	1.3	1.5	1.0	1.2
2	6.0	3.0	1.4	1.3	1.5	1.0	1.2
3	5.0	2.8	1.5	1.5	1.5	1.2	1.2
4	4.0	2.5	1.5	1.5	1.5	1.2	1.2
5	3.5	3.0	1.5	1.5	1.5	1.2	1.2
6	4.0	2.0	1.5	1.5	1.5	1.2	1.2
7	6.0	2.0	1.5	1.5	1.5	1.3	1.2
8	4.5	1.8	1.5	1.5	1.5	1.3	1.2
9	4.0	1.5	1.5	1.5	1.5	1.3	1.2
10	3.5	1.0	1.5	1.5	1.5	1.3	1.0
11	3.0	1.0	1.5	1.5	1.5	1.5	1.0
12	2.5	.5	1.5	1.5	1.5	1.3	1.0
13	2.0	.0	1.5	1.5	1.0	1.3	.9
14	1.8	.0	1.5	1.5	1.0	1.3	3.5
15	1.5	.0	1.5	1.5	1.2	1.3	6.7
16	1.5	.5	1.5	1.5	2.0	1.3	6.0
17	1.5	.8	1.5	1.5	2.5	1.3	*a*
18	1.5	.8	1.5	1.5	2.3	1.3	*a*
19	1.5	1.0	1.5	1.5	1.8	1.3	*a*
20	1.0	1.0	1.3	1.5	1.3	1.3	*a*
21	1.5	1.0	1.3	1.5	1.0	1.3	5.0
22	4.0	1.0	1.3	1.5	.5	1.3	5.3
23	5.5	1.0	1.3	1.5	.5	1.2	5.5
24	10.0	1.3	1.3	1.5	.0	1.2	6.0
25	7.0	1.3	1.3	1.5	.0	1.2	6.0
26	5.5	1.3	1.3	1.5	.5	1.2	6.3
27	8.0	1.3	1.3	1.5	.5	1.2	6.3
28	6.0	1.3	1.3	1.5	.7	1.2	6.3
29	5.0	1.3	1.3	1.5	.8	1.2	6.5
30	4.5	1.4	1.3	1.5	1.0	1.2	6.5
31	....	1.4	1.3	....	1.0	....	6.3

a Ice conditions.

GAGE READINGS ON WABASH RIVER AT TERRE HAUTE WATERWORKS STATION FOR 1902.

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.3	1.5	10.0	8.7	2.7	1.7	15.5	3.8	.6	5.0	1.0	4.0
2	6.0	1.5	12.0	8.5	2.5	2.0	17.0	3.5	.6	5.0	1.0	4.4
3	6.0	1.5	12.5	9.0	2.3	5.5	18.7	5.3	.4	5.0	1.0	6.0
4	6.0	1.5	10.0	8.0	1.8	4.7	19.1	5.0	.4	5.5	1.0	7.0
5	6.0	1.5	8.0	6.5	1.5	5.5	18.9	4.0	.4	6.7	1.2	7.8
6	5.8	1.5	5.5	5.5	2.0	7.0	18.2	5.0	.8	7.3	1.3	8.4
7	5.5	1.5	5.0	5.3	3.0	6.3	17.4	4.3	.8	7.8	1.7	8.6
8	5.0	1.5	4.5	5.0	3.0	6.7	16.2	4.0	.8	8.5	2.3	7.3
9	4.5	1.5	5.7	4.4	3.3	6.7	15.0	3.6	.6	8.3	3.2	6.0
10	3.5	1.5	5.9	4.0	3.0	8.0	11.2	3.2	.4	7.0	3.2	5.0
11	3.0	1.5	5.5	3.8	2.7	8.0	8.8	3.0	.4	5.8	3.0	4.5
12	2.5	1.5	5.7	3.5	2.3	6.3	7.6	2.6	.2	4.5	3.9	5.3
13	2.0	1.5	7.0	3.3	1.8	6.3	6.4	2.3	1.0	4.0	4.0	5.8
14	1.5	1.5	8.2	3.0	1.5	5.5	5.4	2.3	.5	5.8	3.8	6.5
15	1.0	1.5	8.5	2.8	1.2	5.3	4.6	2.6	.4	4.5	3.7	5.7
16	1.0	1.5	8.2	2.5	1.0	5.2	4.0	2.8	.4	4.0	3.4	7.8
17	.5	1.5	8.7	2.0	.8	5.8	3.7	2.7	.4	3.8	3.4	8.9
18	.5	1.5	8.3	2.0	.7	5.8	3.3	2.8	.4	3.0	3.7	9.0
19	.0	1.5	8.0	1.7	.5	5.5	3.2	2.3	.4	2.8	4.2	9.8
20	.5	1.5	7.0	1.5	.3	4.8	4.2	2.6	.3	2.5	5.0	10.2
21	.8	1.5	6.0	1.5	1.0	3.6	4.8	2.8	.3	2.3	5.7	12.3
22	1.0	1.5	5.0	1.5	2.3	2.5	5.8	2.8	.3	2.7	5.3	14.5
23	1.5	1.5	4.5	1.3	3.2	2.0	5.7	2.6	.3	2.7	4.8	15.2
24	2.0	1.5	4.2	1.2	2.7	1.7	5.5	2.3	.3	2.6	4.3	15.5
25	2.0	1.5	3.7	1.2	2.5	1.5	4.6	2.0	2.0	2.2	3.8	15.8
26	2.0	1.2	3.5	1.2	4.0	1.5	4.4	1.6	3.8	1.8	3.4	16.0
27	2.0	.0	3.3	1.0	4.2	1.7	3.6	1.2	2.8	1.5	3.3	15.1
28	1.5	5.0	3.0	1.0	4.0	1.8	3.2	1.2	4.0	1.5	3.4	14.0
29	1.5	......	4.3	1.0	3.3	5.0	3.2	1.0	5.0	1.4	2.8	10.0
30	1.5	......	6.0	1.3	2.7	13.5	3.8	.8	3.5	1.3	3.5	8.0
31	1.5	......	6.3	......	1.9	......	3.8	.8	......	1.2	......	7.0

GAGE READINGS AT TERRE HAUTE WATERWORKS STATION ON WABASH RIVER FOR 1903.

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.0	14.5	15.0	3.8	5.2	5.5	1.8	1.2	1.5	—.1	—.4	—.3
2	5.5	15.2	15.8	3.4	4.7	5.0	1.5	1.0	1.7	—.1	—.5	—.3
3	6.3	15.5	16.0	3.4	4.7	4.7	1.5	1.0	1.7	—.1	—.5	—.3
4	7.7	15.7	17.0	6.5	4.2	5.7	5.5	1.0	1.5	—.1	—.6	—.4
5	8.0	15.8	18.0	9.0	3.9	5.5	9.8	5.0	1.0	.1	—.6	—.4
6	8.5	15.8	18.7	10.8	3.8	5.8	9.7	4.3	.8	.2	—.5	—.4
7	9.0	15.8	18.2	12.5	3.3	7.5	7.8	3.0	.8	.1	—.5	—.4
8	8.5	15.9	17.5	12.7	3.1	8.8	6.2	2.0	.7	.4	—.5	—.5
9	8.0	15.7	17.2	12.0	2.8	9.3	5.0	1.7	.7	.5	—.6	—.5
10	6.5	15.0	16.6	10.3	2.8	9.0	4.0	1.6	.4	1.0	—.6	—.5
11	3.5	13.5	16.7	8.8	2.7	7.8	3.7	1.4	.3	1.5	—.6	—.5
12	3.0	14.0	16.7	11.7	2.6	6.5	3.7	1.3	.1	1.7	—.6	—.6
13	2.7	14.3	16.2	13.5	2.4	5.5	3.8	1.3	.0	1.7	—.5	—.5
14	2.5	15.9	15.4	15.7	2.2	4.0	3.3	1.1	.0	1.5	—.5	—.5
15	2.5	16.7	15.0	18.0	2.3	3.5	2.0	.8	.0	1.0	—.4	—.5
16	2.2	17.3	13.5	19.5	2.3	3.0	2.0	.8	—.5	.7	—.4	—.2
17	2.7	17.3	13.3	20.0	2.3	2.5	1.8	.7	—.2	.5	—.4	1.0
18	4.3	16.9	12.4	19.8	2.1	2.3	1.8	.5	.0	.3	—.2	1.3
19	4.6	15.2	10.4	19.2	1.9	2.0	1.7	.4	.0	.3	—.1	1.6
20	4.7	11.0	9.4	18.2	1.8	2.0	1.6	.4	—.3	.2	—.2	1.6
21	4.0	8.2	8.7	16.6	1.7	2.0	1.6	.3	—.3	.1	—.0	2.7
22	4.2	7.1	8.2	14.0	5.5	2.2	1.8	.2	—.4	.0	—.1	3.0
23	3.5	6.6	7.6	11.3	7.7	2.1	1.8	.2	—.4	.0	.0	3.6
24	3.4	6.8	7.2	9.0	4.5	2.3	1.8	0.0	—.3	—.1	.0	3.5
25	3.3	7.0	6.3	7.9	4.0	2.3	1.7	.0	—.3	—.1	—.1	3.6
26	3.1	6.5	5.6	7.3	4.3	2.3	1.6	—.1	—.3	—.2	—.1	4.0
27	3.2	7.1	5.3	7.2	4.5	2.3	1.4	—.2	—.2	—.2	—.2	4.0
28	5.3	12.8	5.2	6.8	5.3	2.2	1.3	—.3	—.1	—.3	—.3	3.8
29	8.0	......	4.8	6.3	5.6	2.0	1.3	2.0	.0	—.3	—.3	3.5
30	14.0	......	4.4	5.8	5.7	1.8	1.3	1.8	.0	—.3	—.3	3.5
31	14.3	......	4.2	......	6.0	......	1.3	1.5	......	—.4	......	3.5

Gage Readings on Wabash River at Terre Haute Waterworks Station for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.3	9.0	12.8	23.1	14 3	3 9	2.0	.3	.6	1.8	—.3	—.5
2	2.3	7.5	14.7	23.7	12.7	4.0	2.3	.0	.5	1.5	—.3	—.5
3	2.5	6.5	15.8	23.1	10.3	4.0	2.0	.0	.0	.8	— 4	—.5
4	2.0	6.0	17.2	22.6	8.3	4.0	2.0	—.1	.0	.8	—.4	—.6
5	2.0	5.0	17.8	22.0	7.1	3.9	1.9	— 1	—.2	.7	—.3	—.6
6	1.7	4.7	17.5	21.3	6.1	3.8	2.3	—.2	—.3	.5	—.3	—.6
7	1.5	12.0	17.3	20.3	5.9	3.8	3.6	—.3	—.4	.4	—.3	—.6
8	1.5	15.6	17.0	19.2	5.7	3.5	9.7	—.3	—.5	.3	—.3	—.7
9	1.3	16.7	16.9	17.8	5.5	3.3	10.4	—.3	—.6	.3	—.3	—.7
10	1.3	17.1	16.7	16.4	5.5	3.0	9.8	—.3	.2	.2	—.3	—.7
11	1.2	17.3	16.6	15.3	5.4	3.0	8.8	—.3	.3	.2	—.3	—.7
12	1.0	17.4	16.3	14.8	5.3	2.5	8.0	—.4	.3	.3	—.3	—.7
13	1.0	16.6	15.3	14.2	4.8	2.2	7.8	—.4	.3	.4	—.3	—.8
14	.7	14.0	13.5	13.5	4.0	2.2	6.8	—.5	.3	.7	—.3	—.8
15	.7	10.4	12.0	12.0	4.0	2.0	5.7	—.5	.2	.6	—.3	—.9
16	.6	7.2	10.4	10.8	3.9	1.8	4.5	—.6	.2	.4	—.3	—.9
17	.7	6.3	9.0	9.5	3.9	1.9	4.0	—.6	.1	.3	—.3	—.9
18	.7	5.1	12.3	8.7	3.8	1.9	3.7	—.7	.5	.3	—.3	—.9
19	.6	4.0	13.5	7.8	3.7	1.9	3.0	—.6	.4	.2	—.3	—.9
20	1.0	3 3	13.8	7.1	3.6	2.0	3.0	—.4	.4	.2	—.3	—1.0
21	4.1	3.0	14.3	6.5	3.7	1.9	2.3	3.8	.3	—.1	—.3	—1.0
22	15.5	4.5	14.8	6.1	4.0	2.1	1.8	2.8	.3	—.2	—.3	—1.0
23	17.3	4.8	16.3	6.0	4.0	2.2	1.7	2.2	.3	—.2	—.4	—1.0
24	19.0	6.5	17.3	5.7	4.4	3.0	1.5	1.8	.3	—.3	—.4	—.7
25	20.2	6.8	17.8	5.8	4.3	3.7	1.3	1.8	.3	—.3	—.4	.0
26	20.6	6.8	19.9	9.6	4.1	3.7	1.0	1.5	.6	—.3	—.4	.2
27	20.5	6.9	25.1	13.0	4.1	3.0	1.0	1.3	1.5	—.3	—.4	.5
28	20.0	6.9	24.9	13.9	4.1	2.6	.7	1.0	1.7	—.3	—.5	.2
29	18.3	9.5	24.0	14.3	4.0	2.2	.7	1.0	2.3	—.3	—.5	.2
30	16.0	......	23.3	14.5	4.0	1.9	.7	.7	2.4	—.3	—.5	.3
31	12.5	......	22.8	......	4.0	......	.5	.6	......	—.3	......	.3

Gage Readings on Wabash River at Terre Haute Waterworks Station for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.5	.7	13.5	3 8	8.2	5.6	1.3	.9	.7	.7	.8	8.5
2	.7	.3	14.0	5.8	7.8	5.6	1.3	.8	.7	.5	.8	9.2
3	.7	.3	14.5	6.0	6.7	5.8	1.4	.8	1.0	.5	.7	8.2
4	.0	.2	14.5	5.2	5.5	5.0	3.5	.8	.8	.4	.6	6.5
5	.0	.2	15.2	4.8	4.8	4.2	1.5	.7	.8	.3	.6	5.0
6	.0	.2	14 0	4.2	4.4	5.2	1.3	.6	.9	.3	2.0	5.0
7	.2	.2	11.2	3.2	4.2	5.4	1.2	.6	1.0	.3	2.5	4.7
8	.3	.3	9.1	2.7	3.8	4.8	1.0	.4	.8	.3	3.0	4.0
9	.4	.3	8.2	2.2	4.0	4.8	1.2	.4	.7	.3	3.0	3.8
10	.5	.3	7.5	1.8	4.8	4.0	1.5	1.0	.7	.3	2.9	3.3
11	.5	.5	6.7	1.8	4.8	5.7	1.9	.8	1.0	.0	2.8	3.0
12	1.0	.5	6.3	1.7	4.6	5.6	4.0	.8	2.0	.0	2.5	2.8
13	1.1	.7	6.0	1.9	10.8	4.1	3.3	.6	2.5	.0	2.3	2.8
14	2.0	.7	5.5	1.7	13.6	4.4	5.4	.5	2.0	.0	1.9	2.6
15	1.8	.7	4.8	1.5	14.7	4.3	4.3	1.2	1.6	.0	1.8	2.3
16	1.7	.7	4.0	1.3	15.9	4.1	3.0	2.0	2.3	.0	1.7	2.0
17	1.6	.8	3.5	1.2	16.9	3.8	2.8	1.8	2.8	.2	1.6	1.8
18	1.6	.8	3.0	1.0	17.0	3.3	2.3	1.7	3.7	.2	1.4	1.7
19	1.8	.8	3.0	.6	16.2	3.4	2.0	1.5	4.2	2.7	1.3	1.7
20	1.8	.8	3.0	.8	13.6	4.3	1.7	1.2	4.2	3.0	1.0	1.6
21	1.8	.8	5.0	1.1	10.0	7.0	3.7	1.5	4.0	4.0	.8	1.6
22	2.0	.8	4.8	3.8	7.8	4.3	3.0	1.5	3.5	4.0	.8	2.0
23	2.0	.5	4.8	6.9	6.1	3.2	2.0	1.8	2.8	3.5	.8	3.5
24	1.7	3.7	4.7	10.2	5.1	2.8	1.6	1.5	2.3	3.0	.8	6.0
25	2.0	5.0	4.4	10.3	4.3	2.8	1.3	1.2	2.0	2.5	.7	6.8
26	2.0	7.0	4.2	9.3	3.8	2.4	1.1	.8	1.7	2.2	.7	6.0
27	1.7	11.0	4.2	8.3	3.5	2.0	.8	.8	1.2	2.0	.7	5.3
28	.9	11.5	4.3	7.2	3.3	1.8	.7	1.3	1.0	1.7	.7	4.7
29	.9	......	3.8	7.3	3.1	1.6	.5	1.5	.7	1.5	.6	4.0
30	.8	......	3.3	7.7	3.9	1.5	.4	1.3	.7	1.2	6.7	3.8
31	.7	......	3.3	......	7.7	......	.3	.8	......	1.0	......	3.8

GAGE READINGS ON WABASH RIVER AT TERRE HAUTE WATERWORKS STATION FOR 1906.

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.7	7.5	4.2	19.0	3.0	5.5	.3	—.3	.8	.0	—.5	3.6
2	3.9	6.7	4.0	18.6	3.0	3.7	.3	—.3	.5	.0	—.5	3.1
3	4.0	5.7	5.8	17.8	3.0	2.8	.4	—.3	.3	.7	—.3	2.8
4	5.0	5.0	8.8	17.1	3.0	2.0	.3	—.3	.2	.7	—.3	2.6
5	5.5	4.7	10.0	16.2	3.0	2.0	.3	—.3	.0	.7	—.3	2.4
6	6.3	3.8	9.9	15.0	2.8	1.8	.7	—.3	—.2	.8	—.3	4.1
7	7.0	2.7	8.8	12.5	2.8	2.5	.8	—.3	—.3	.6	—.3	9.3
8	6.8	1.5	7.8	10.8	2.8	1.8	.8	—.2	—.3	.3	—.3	10.3
9	5.7	1.5	7.5	13.0	2.8	1.9	.7	.3	—.3	.1	—.2	11.3
10	4.5	1.3	7.3	14.0	2.3	5.0	.6	.3	—.3	—.1	—.2	11.0
11	3.7	1.2	7.0	14.0	2.0	4.0	.6	.3	—.3	—.1	—.2	9.8
12	3.7	1.2	6.5	14.2	1.8	3.5	.5	.7	—.4	—.3	—.2	8.7
13	3.5	1.3	6.0	14.5	1.8	2.8	.5	.5	—.3	—.3	—.2	7.8
14	2.7	2.0	5.5	14.4	1.7	2.0	.5	.4	—.3	—.3	—.2	6.3
15	2.7	3.7	5.3	13.0	1.7	1.8	.4	.2	—.4	—.5	—.2	8.0
16	3.0	3.2	4.8	11.5	1.5	1.5	.4	.0	—.4	—.5	—.2	10.2
17	3.0	2.7	4.5	11.8	1.3	1.3	.4	—.2	—.4	—.5	—.2	10.6
18	2.8	1.8	4.0	11.8	1.3	1.2	.6	—.2	—.5	—.5	—.2	10.8
19	3.0	2.3	3.8	10.2	1.3	1.1	.8	.2	—.5	—.4	.0	10.0
20	3.7	3.0	3.8	8.7	1.2	.8	.7	.0	—.5	—.4	.0	8.7
21	4.0	3.7	3.6	7.5	1.0	.8	.7	.5	—.5	—.4	1.5	7.0
22	11.5	3.0	3.4	6.6	1.0	.8	1.5	.4	—.5	—.4	.5	5.8
23	14.9	3.0	3.7	5.7	1.0	.8	.9	.4	—.3	—.5	8.8	5.0
24	16.0	3.0	3.7	5.0	1.0	.7	.7	.6	—.2	—.5	10.0	4.0
25	16.3	3.0	3.7	4.7	1.0	.6	.2	1.0	—.3	—.5	9.3	3.0
26	16.7	4.0	4.3	4.3	1.0	.5	.0	1.0	—.3	—.5	8.3	3.0
27	16.7	4.3	12.5	3.8	1.2	.5	.0	1.0	—.3	—.5	7.0	2.9
28	15.0	4.5	15.0	3.7	1.3	.4	—.1	1.8	—.4	—.5	5.5	3.0
29	13.8	......	15.7	3.5	1.3	.3	—.2	1.6	—.4	—.5	4.6	3.0
30	11.0	......	16.0	3.3	1.0	.3	—.2	1.0	—.2	—.5	3.8	3.0
31	8.8	......	17.4	......	2.0	......	—.2	.8	......	—.5	......	5.5

GAGE READINGS ON WABASH RIVER AT TERRE HAUTE WATERWORKS STATION FOR 1907.

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.9	7.3	2.8	12.8	3.4	7.5	4.5	2.4	1.2	.8	.3	1.3
2	9.8	6.5	2.8	12.8	4.0	11.3	3.7	2.3	2.0	.8	.7	1.3
3	12.2	6.5	3.0	11.6	5.0	13.0	3.0	2.0	2.9	1.0	1.1	.9
4	15.0	5.5	3.2	9.3	5.0	13.3	2.8	2.0	2.8	2.9	1.1	.8
5	16.0	4.8	3.7	7.7	4.9	13.8	2.4	2.0	2.3	3.6	2.2	.6
6	16.3	3.7	3.8	6.7	4.3	14.0	2.3	2.2	1.9	3.5	2.8	.6
7	16.2	3.5	3.7	5.8	3.0	14.0	2.0	2.3	1.3	2.9	2.8	.5
8	16.2	3.5	3.5	5.7	3.7	13.7	2.0	4.0	1.3	2.8	2.5	.4
9	17.3	3.5	3.3	5.5	3.9	12.7	2.2	3.9	1.3	2.7	2.0	.5
10	17.5	3.5	3.2	5.2	3.8	11.0	2.2	3.0	1.7	2.1	1.9	1.1
11	17.4	3.8	3.2	4.9	3.8	9.5	2.9	2.8	1.5	1.9	1.7	1.2
12	17.2	3.8	4.0	4.8	3.5	8.9	4.2	2.3	1.2	1.8	1.3	2.3
13	16.3	3.8	10.5	4.5	3.4	7.9	5.4	2.1	1.0	1.3	1.0	3.5
14	16.0	3.8	14.3	4.3	3.2	6.9	6.9	2.0	.9	1.2	.9	3.9
15	15.0	4.0	15.2	4.0	3.0	6.0	6.9	1.8	.7	1.0	.8	3.8
16	14.6	4.0	16.3	4.0	3.0	6.0	6.7	1.7	.7	.8	.8	3.3
17	15.0	4.0	16.7	3.9	2.9	5.8	6.0	1.7	.7	.8	.8	2.8
18	15.7	4.0	17.1	3.9	2.8	5.3	10.5	2.7	.5	.8	.8	2.8
19	16.4	4.4	17.3	3.8	2.8	4.8	12.2	2.8	.4	.7	.7	2.8
20	18.7	4.7	16.8	3.7	2.8	4.8	12.2	2.3	.3	.7	.7	2.7
21	21.2	4.7	15.7	3.3	2.8	4.5	10.0	2.0	.3	.7	1.0	2.3
22	24.0	4.5	13.8	3.1	2.1	4.3	7.9	1.9	1.8	.7	1.2	2.0
23	24.6	4.0	11.7	3.0	2.0	4.8	6.4	1.9	2.0	.6	1.3	2.3
24	23.3	3.5	9.6	3.0	1.9	4.9	5.6	1.7	1.8	.6	1.7	4.5
25	21.2	3.2	8.1	3.0	4.0	5.4	4.9	1.3	1.5	.6	2.0	5.3
26	20.0	3.0	7.2	2.9	4.8	6.3	4.0	1.2	1.2	+.6	2.0	8.5
27	19.8	3.0	6.3	2.9	6.7	7.0	3.6	1.0	.8	+.6	1.8	10.0
28	15.0	3.0	6.1	2.9	7.3	6.7	3.3	1.1	.7	+.6	1.7	11.5
29	11.5	......	7.0	2.9	7.0	6.0	3.3	.8	.7	+.7	1.5	13.8
30	8.6	......	9.9	3.0	6.7	5.2	2.9	.8	.6	+.4	1.5	14.9
31	7.3	......	11.8	......	5.8	......	2.6	.8	......	.3	......	15.5

Gage Readings on Wabash River at Terre Haute Waterworks Station for 1908.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	16.5	2.7	12.8	9.4	7.0	5.8	1.7	1.0	.9	—.1	—.3	.3
2	17.3	2.0	15.0	11.2	6.6	5.5	1.6	.8	0	—.2	—.3	.3
3	17.3	1.7	16.4	10.5	5.8	5.5	1.5	.8	.0	—.2	—.3	.3
4	16.8	1.4	17.3	8.9	7.0	5.0	1.6	.2	—.1	—.2	—.3	.3
5	15.8	2.0	17.4	7.8	11.2	4.7	1.5	.2	—.2	—.2	—.3	.3
6	14.1	7.5	18.6	7.8	13.5	3.5	1.5	.2	—.2	—.2	—.3	.3
7	11.6	8.8	19.0	7.0	15 5	3.5	1.7	.2	—.2	—.2	—.3	.3
8	9.3	8.3	19.3	7.5	18.7	2.8	2.0	.3	—.2	—.2	—.3	.3
9	7.8	8.3	20.9	12.0	19.5	2.8	1.9	.3	—.2	—.2	—.3	.2
10	6.8	7.0	22.8	13.0	20.0	2.8	1.7	.4	—.2	—.2	—.3	.2
11	6.0	7.0	22.8	13.9	19.2	2.7	1.3	.3	—.2	—.2	—.3	.2
12	6.3	8.0	21.8	14.5	18.3	2.5	1.3	.3	—.2	—.2	—.3	.2
13	9.2	12.3	20.5	14.6	18.1	2.8	1.1	.3	—.2	—.3	—.3	.2
14	10.4	12.8	19.3	14.6	18.2	2.7	1.0	.3	—.2	—.3	—.3	.2
15	10.7	14.5	18.2	13.8	18.0	2.5	1.0	1.7	—.2	—.3	—.3	.2
16	10.7	15.9	16.8	11.8	17.9	2.5	1.0	2.8	—.2	—.3	—.3	.2
17	9.7	17.0	15.2	9.5	17.8	2.3	1.0	2.0	—.2	—.3	—.3	.2
18	8.1	17.7	13.5	8.4	17.6	2.3	1.0	1.6	—.2	—.3	—.3	.2
19	6.8	18.3	11.9	7.8	17.0	2.0	.9	1.0	—.2	—.3	—.3	.2
20	6.0	18.8	13.7	7.3	16.8	2.3	.8	.8	—.2	—.3	—.3	.2
21	5.3	18.0	14.5	6.8	16.3	2.5	1.5	.7	—.2	—.3	—.3	.2
22	5.2	16.8	15.1	6.0	15.8	2.0	1.0	.5	—.2	—.3	—.3	.2
23	5.1	14.5	15.8	5.7	15.0	1.9	1.0	.4	—.2	—.3	—.3	.2
24	4.8	11.3	16.5	6.0	13.0	1.9	1.0	.4	—.2	—.3	—.3	.2
25	4.7	9.7	16.7	7.9	10.5	2.0	1.3	.3	—.2	—.3	—.3	.2
26	4.2	13.6	15.9	9.1	8.8	2.2	2.3	.6	—.2	—.3	.3	.2
27	4.5	14.3	14.0	8.8	7.9	2.0	2.0	.6	—.2	—.3	.3	.2
28	4.3	14.0	11.0	7.9	7.5	1.8	1.8	.7	—.1	—.3	.3	.2
29	3.9	13.5	9.7	7.7	7.0	1.8	1.8	.7	—.1	—.3	.3	.2
30	3.5	......	9.0	7.0	6.4	1.7	1.5	.8	—.2	—.3	.3	.2
31	2.5	......	9.4	......	6.0	......	1.3	.8	......	—.3	......	.2

Gage Readings on Wabash River at Terre Haute Waterworks Station for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.2	1.1	17.7	5.3	11.0	7.9	6.0	2.0	1.0	2.0	1.8	4.6
2	.2	1.1	17.0	4.7	13.0	6.7	5.0	2.0	1.0	1.0	1.8	4.1
3	.2	.9	16.4	4.1	13.5	5.9	4.2	1.9	.9	.8	1.5	3.9
4	.2	.9	14.2	3.8	14.2	7.8	3.6	1.8	.8	.8	1.4	3.5
5	.2	.9	10.8	3.4	15.0	10.2	3.0	2.2	.8	.7	1.3	3.1
6	.2	2.3	8.3	3.3	14.9	11.2	3.0	2.0	.7	.7	1.1	3.5
7	.0	2.8	6.8	10.2	13.7	11.3	6.5	1.8	.7	.7	1.1	3.7
8	.0	3.0	5.0	14.0	10.8	10.0	5.9	1.5	.7	.7	1.1	3.5
9	.0	3.7	7.2	14.4	10.0	8.3	5.0	1.3	.9	.5	1.0	Ice
10	.0	4.0	9.8	14.8	11.0	9.2	4.7	.9	.7	.5	1.0	Ice
11	.0	4.0	8.8	15.0	10.8	11.2	3.8	.9	.5	.3	1.0	1.0
12	.0	4.2	9.0	15.1	10.8	12.4	4.1	.9	.5	.2	1.0	2.0
13	.0	4.7	10.3	14.4	11.2	13.8	8.2	2.2	.9	.2	1.0	5.0
14	.0	4.3	10.2	13.8	11.2	15.0	11.0	4.0	.9	.2	1.3	8.9
15	.0	6.4	8.8	14.8	10.3	15.0	10.7	3.9	.7	.0	1.3	10.8
16	.0	7.7	7.2	13.6	9.0	13.7	8.8	3.5	.8	.0	1.3	12.3
17	.0	7.0	6.0	12.3	7.8	11.0	7.1	3.0	.6	.0	1.5	13.0
18	.0	6.0	5.0	9.8	7.3	10.9	5.8	2.5	.6	.3	2.3	12.8
19	.0	6.5	4.7	8.2	6.7	8.3	6.3	2.3	.6	.2	3.4	11.0
20	.0	11.2	4.1	7.2	5.8	6.7	7.0	2.0	.5	.2	3.5	Ice
21	.0	13.0	4.0	6.7	4.8	5.7	6.3	1.8	.5	.3	3.5	Ice
22	.1	13.7	4.0	8.0	4.3	4.8	5.0	1.7	.5	.2	3.3	Ice
23	.8	14.3	4.0	9.6	3.8	4.2	4.3	1.5	.7	.7	5.4	2.0
24	.9	15.1	3.9	9.1	3.5	4.0	3.5	1.2	2.2	1.0	7.2	2.0
25	.8	16.3	3.9	7.9	3.3	2.8	2.9	.8	4.3	1.3	9.8	2.0
26	.8	16.9	3.9	6.8	3 3	11.0	2.5	1.2	4.7	2.0	11.0	1.5
27	.9	17.5	4.9	5.8	4.7	12.4	2.3	2.0	4.1	3.0	10.8	2.0
28	.9	17.7	6.6	5.8	8.5	11.0	2.0	1.5	3.3	3.3	9 0	2.0
29	1.1	......	6.9	4.8	10.0	10.0	1.9	1.2	2.7	2.9	7.2	*
30	1.1	......	6.9	4.8	9.3	7.8	1.8	.9	2.0	2.3	6.5	2.0
31	1.1	......	6.0	......	8.8	......	1.7	.8	......	2.0	......	2.3

*No record.

GAGE READINGS ON WABASH RIVER AT TERRE HAUTE WATERWORKS STATION FOR 1910.

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.3	7.0	14.8	1.9	4.0	2.7	.7	—.2	—.2	.8	.3	1.0
2	2.3	6.0	15.5	1.8	3.7	2.5	.5	—.3	—.3	.8	.3	1.0
3	2.3	5.5	16.0	1.8	4.5	2.3	.3	—.3	—.3	.7	.2	1.0
4	2.5	5.3	16.3	1.8	5.2	2.0	1.0	—.3	—.3	.8	.2	1.0
5	2.5	6.0	16.5	1.8	4.7	1.8	.9	—.3	—.3	1.9	.2	1.5
6	2.7	7.2	16.3	1.8	4.6	1.8	.8	—.3	+.2	4.8	.2	.8
7	2.7	6.5	15.5	1.8	4.3	1.8	.5	—.3	4.3	3.3	.2	.8
8	2.7	5.5	14.5	1.8	4.3	1.7	.5	—.3	2.8	3.0	.2	.7
9	2.7	4.8	12.5	1.8	4.1	1.5	.4	—.3	4.7	2.8	.2	.3
10	4.9	4.3	10.7	1.8	3.8	1.3	.4	—.3	4.7	4.2	.2	.3
11	4.3	4.0	8.8	1.8	3.3	1.3	.3	—.3	3.0	6.3	.2	.3
12	3.8	3.8	7.5	1.7	3.7	1.0	.5	—.3	2.0	6.0	.2	.3
13	6.0	3.3	6.5	1.7	3.8	.9	1.0	—.3	1.6	4.8	.2	.3
14	12.0	2.8	5.8	1.6	3.4	.8	.6	—.4	1.3	3.5	.0	.3
15	12.5	2.7	5.3	1.5	2.8	.8	.4	—.4	1.0	2.8	.0	.3
16	13.2	2.7	4.9	1.7	2.5	.7	2.0	—.4	1.0	2.0	.0	.3
17	13.5	3.0	4.5	1.8	2.3	.6	5.7	—.4	1.7	1.8	.0	.3
18	14.7	3.0	4.0	1.8	2.3	.5	4.5	—.3	1.5	1.2	.0	.3
19	17.5	2.7	3.8	1.9	2.0	.4	2.8	—.3	1.2	1.0	.0	.3
20	18.5	2.7	3.7	2.0	1.8	.4	2.0	—.3	1.0	.9	.0	.3
21	17.5	5.0	3.4	2.5	1.5	.3	1.5	—.3	1.2	.8	.0	.0
22	19.0	4.3	3.1	3.7	3.0	.3	1.0	—.3	1.1	.8	.0	.0
23	19.3	4.9	3.0	4.8	5.8	.3	.7	—.3	1.0	.7	.0	.0
24	18.8	5.0	2.9	4.6	4.5	.3	.5	—.3	.9	.7	.0	.0
25	17.8	4.0	2.8	4.2	5.7	.2	.4	.2	.8	.6	.0	.0
26	16.5	4.3	2.8	4.2	5.6	.1	.3	.2	.8	.5	.0	.0
27	14.5	8.0	2.6	4.0	5.0	.1	.2	.1	.8	.5	.0	.0
28	11.0	14.5	2.5	3.8	4.0	.5	.2	.1	.8	.4	1.7	.0
29	9.7	......	2.3	3.8	3.3	1.0	.0	.0	.8	.4	1.8	4.2
30	9.7	......	2.2	4.0	3.0	.8	.0	—.1	.8	.3	1.2	8.2
31	7.8	......	2.0	......	2.8	......	.0	—.1	......	.3	......	6.0

GAGE READINGS ON WABASH RIVER AT TERRE HAUTE WATERWORKS STATION FOR 1911.

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.3	13.6	4.9	2.5	4.3	.6	1.8	—.3	......	......	......	......
2	8.8	13.6	3.8	2.2	4.3	.6	1.5	—.3	......	......	......	......
3	9.0	12.3	3.5	4.0	4.8	.8	1.2	—.3	......	......	......	......
4	7.3	9.5	3.3	4.2	5.2	1.0	.8	—.3	......	......	......	......
5	7.0	7.7	2.9	6.7	5.0	1.0	.7	—.3	......	......	......	......
6	4.5	6.7	2.8	7.7	4.3	1.2	.5	—.3	......	......	......	......
7	4.0	6.5	2.8	8.7	3.8	1.0	.4	—.3	......	......	......	......
8	3.0	5.8	5.4	10.3	3.0	1.0	.4	—.3	......	......	......	......
9	7.0	5.1	5.0	9.8	2.8	1.0	.3	—.3	......	......	......	......
10	7.0	4.6	4.7	8.0	2.7	.8	.3	—.4	......	......	......	......
11	6.5	4.0	4.5	6.5	2.5	.8	.3	—.4	......	......	......	......
12	6.3	3.3	4.1	5.3	2.3	.8	.2	—.4	......	......	......	......
13	3.3	3.3	3.8	5.0	2.0	.8	.3	—.5	......	......	......	......
14	5.0	3.5	3.8	10.0	1.8	.5	.2	—.5	......	......	......	......
15	9.5	4.0	3.8	12.4	1.7	.3	.0	—.5	......	......	......	......
16	11.5	5.5	3.8	11.9	1.6	.2	.0	—.5	......	......	......	......
17	12.0	9.0	3.8	10.4	1.4	.2	—.1	—.1	......	......	......	......
18	11.3	10.4	3.8	10.0	1.3	.2	—.2	—.3	......	......	......	......
19	8.9	10.0	3.2	8.5	1.2	.2	—.1	—.3	......	......	......	......
20	6.5	9.8	3.0	9.5	1.3	.2	.0	—.3	......	......	......	......
21	5.3	9.8	2.8	8.7	1.4	.3	—.2	—.3	......	......	......	......
22	5.3	9.2	2.5	9.0	1.0	.5	.0	—.3	......	......	......	......
23	5.0	8.0	2.2	10.3	1.3	.5	—.2	—.3	......	......	......	......
24	4.3	6.5	2.0	9.5	1.3	.4	—.2	—.3	......	......	......	......
25	3.9	5.8	1.7	8.0	1.3	.4	—.3	—.3	......	......	......	......
26	4.0	5.0	1.7	7.7	1.2	.4	—.3	—.3	......	......	......	......
27	4.5	4.8	1.5	5.7	1.3	.4	—.3	—.3	......	......	......	......
28	9.5	4.3	2.0	5.0	1.0	.7	—.3	—.3	......	......	......	......
29	12.0	......	2.0	4.7	.8	2.0	—.3	—.3	......	......	......	......
30	13.0	......	2.3	4.3	.8	2.2	—.3	......	......	......	......	......
31	13.5	......	2.5	......	.7	......	—.3	......	......	......	......	......

RATING TABLE FOR WABASH RIVER AT TERRE HAUTE, IND., FOR 1901-11 INCLUSIVE.

Gage Height, Feet.	Discharge, Sec. Ft.	Gage Height, Feet.	Discharge, Sec. Ft.	Gage Height, Feet.	Discharge, Sec. Ft.	Gage Height, Feet.	Discharge, Sec. Ft.
0.0	1,930	1.5	4,330	3.0	7,400	5.9	14,200
0.1	2,050	1.6	4,510	3.1	7,620	6.1	14,700
0.2	2,180	1.7	4,700	3.3	8,060	7.1	17,200
0.3	2,320	1.8	4,900	3.5	8,500	8.1	19,800
0.4	2,460	1.9	5,100	3.7	8,940	9.1	22,500
0.5	2,610	2.0	5,300	3.9	9,380	10.1	25,300
0.6	2,770	2.1	5,500	4.1	9,830	11.1	28,400
0.7	2,940	2.2	5,700	4.3	10,300	12.1	31.800
0.8	3,110	2.3	5,900	4.5	10,780	13.1	35,500
0.9	3,280	2.4	6,100	4.7	11,260	14.1	39,500
1.0	3,450	2.5	6,310	4.9	11,740	15.1	43,700
1.1	3,620	2.6	6,520	5.1	12,220	16.1	48,100
1.2	3,790	2.7	6,740	5.3	12,700	17.1	52,700
1.3	3,970	2.8	6,960	5.5	13,200	18.1	57,400
1.4	4,150	2.9	7,180	5.7	13,700	19.1	62,100

The data contained in these tables gives a very good idea of the nature of the river at Terre Haute. The data is not entirely accurate. The readings were recorded in the Terre Haute Waterworks record as feet and inches. The inches were reduced to tenths by letting each equal the nearest tenth. However, the error due to this cause is small. An examination of this data shows that the Wabash is a very erratic river. The following table shows some striking features:

TABLE SHOWING ANNUAL FLUCTUATIONS OF WABASH RIVER AT TERRE HAUTE AND RATIO BETWEEN MAXIMUM AND MINIMUM DISCHARGE.

YEAR.	Minimum.		Maximum.		
	Date.	Discharge, Sec.-Ft.	Date.	Discharge, Sec.-Ft.	Times Minimum.
1901	October 24	1,930	June 24	25,000	13
1902	February 27	1,930	July 4	62,100	32
1903	November 4	1,200	April 17	66,330	55
1904	December 20	900	March 27	90,300	100
1905	January 4	1,930	May 18	52,000	26
a	October 17	1,920	May 17	50,000	....
1906	October 15	1,300	April 1	61,630	47
a	July 1	2,160	April 2	61,200	....
1907	September 20	2,320	January 23	87,950	37
1908	October 13	1,530	March 10	79,490	52
1909	January 7	1,930	February 28	55,520	29
1910	August 14	1,410	January 23	63,040	45
1911	August 13	1,300	February 1	37,500	21

*a*U. S. G. S. data.

This table shows the maximum annual discharge to have occurred twice in each of the first four months and once in each of the next three during the past eleven years. The minimum discharge is also distributed among seven months with October three, August and January two each, and September, November, December and February one each. The lowest ratio between the minimum and maximum discharge of any year in which complete data is recorded is 1 to 26 in 1905 and in the previous year the ratio was 1 to 100. Both the absolute minimum and maximum discharges occurred in 1904. The profile of the Wabash shows a much more uniform gradient than any of the smaller streams of the State. The fall is slight throughout its course. The profile is taken from Water Supply and Irrigation Paper No. 169, U. S. Geological Survey, page 74. Several of the altitudes have been checked by the writer:

TABLE OF ALTITUDES AND DISTANCES ALONG WABASH RIVER.

LOCATION.	Estimated Distance, Miles.	Altitude, Feet.	Fall Per Mile, Inches.
Source	0.0	1,000.0	0.0
Huntington	100.0	699.0	36.0
Mouth of Salamonie River	15.0	667.0	25.6
Mouth of Mississinewa River	20.0	633.0	20.4
Logansport	20.0	583.0	30.0
Lafayette	50.0	506.0	18.5
Attica	25.0	487.0	9.1
Covington	20.0	470.0	10.2
Terre Haute	55.0	447.7	4.9
State Line	14.6	440.6	5.8
Hutsonville, Ill	29.0	424.6	6.6
Vincennes	46.4	398.8	6.7
Mouth of White River	32.5	376.5	8.2
Grayville, Ill	28.0	365.0	4.9
Mouth of Little Wabash River	46.0	323.0	11.0
Mouth of Wabash River	16.0	311.0	9.0

POWER SITES ON WABASH RIVER.

But one power site is now in use on the part of the Wabash River which has been investigated. This site is at Markle. It has been developed about fifty years. The dam is part concrete and part wood. The wood is being replaced by concrete in sections. The dam is 212 feet long, including the forebay, and six feet high. The head on August 31 was but 4.5 feet, due to a slight rise of the river. The dam is situated on limestone. The mill is situated on the north end of the dam. Three wheels are employed, one 20, one 15, and one 12 H. P. They are all old style wheels. The power is used entirely for mill purposes. It is very inconstant and is supplemented by steam power. This power is owned and operated by A. R. Thomas and Son.

Site One Mile Below Markle.—At a point one mile below Markle is an old wood and brush dam. It is 200 feet long and two feet high. It was built thirty-five years ago. A race leads to the mill which is one-fourth mile down stream on the north side. The race increases the head to six feet. The mill is fast falling into decay. Two wheels have been in use at this mill and are still used occasionally during the winter for grinding feed. The mill was abandoned because of long seasons of insufficient water for operation. The site is owned by Jacob Hite.

Logansport.—A stone dam is located at Logansport at the east line of the city. It is a stone dam 700 feet long and six feet high. It is situated on bed rock and is in first class condition. The water from this dam has been used on the south side of the river but is not used at the present time. The interference of low and high water make the site practically worthless. This site is owned by the Standard Oil Company.

It is not feasible to develop power upon the Wabash River in any part which has been investigated. The features which make it impracticable are: the irregular discharge, wide valley, low banks, and slight fall. The only point in favor of development is the presence of solid rock in the bed. This does not occur in the lower part of the course. The only plan which the writer can suggest for the development and control of this stream is a series of high dams which would flood the lowlands and develop storage. With the present low price of coal and the high price of Wabash bottom land, such an enterprise is entirely out of the question. However, at some remote period when the coal is exhausted, the Wabash may be harnessed on a grand scale.

THE PLEISTOCENE PERIOD AND ITS VERTEBRATA

BY OLIVER P. HAY

Mr. Edward Barrett, State Geologist:

In the preparation of the following report on the Pleistocene Vertebrata of Indiana I am indebted to so many persons that it is impossible to name them all. Obligations are here acknowledged to various museums for use of materials and assistance: to the U. S. National Museum; the American Museum of Natural History, New York; the Academy of Natural Sciences, Philadelphia; Princeton University; the University of Ohio; Earlham College, Indiana; the University of Indiana; Field Museum of Natural History; the Academy of Sciences, Chicago; the Public Museum, Milwaukee; and the University of Nebraska. I have endeavored in the body of the report to express my obligation to individuals who have furnished me with information, specimens, photographs and drawings. Several of the drawings are published here with the permission of the Carnegie Institution of Washington.

It is the hope of the writer that the report may stimulate the collection and study of the abundant materials that it is certain may be found within the limits of Indiana.

I must express my thanks to your predecessor for making it possible for me to prepare this report, and to yourself for assistance, but most of all for patience while awaiting the completion of the paper.

O. P. HAY.

U. S. Nat. Museum, Washington, D. C., March 30, 1912.

The Pleistocene Period and Its Vertebrata.

By Oliver P. Hay.

It is not the intention of the writer to enter into the details of Pleistocene geology, even of that pertaining to the State of Indiana. For extended information on this subject the reader ought to consult some general work on geology and the special treatises. Especially to be recommended is the concluding half of the third volume of Chamberlin and Salisbury's Geology, published in 1906. In this work are cited the most important papers which had appeared at that time. For details regarding important glacial deposits the reader should consult the two great treatises of Professor Frank Leverett, constituting Volumes XXXVIII and XLI of the Monographs of the U. S. Geological Survey. A third monograph by Professor Leverett dealing with the glacial epoch is shortly to appear.

Nevertheless, it seems proper to present here a general account of the Pleistocene period as shown by the records that it left in North America.

The Pleistocene is that period of geological time which immediately preceded that in which we live and which is called the Recent period. Its limits are hard to define and are not wholly agreed upon. The mammals, those animals on which we must especially depend as the biological means of distinguishing the deposits of the Pleistocene from those of the preceding period, the Pliocene, and from those of the succeeding period, the Recent, and the divisions of the Pleistocene from one another, in most respects resembled closely those that are found on the earth today; but they differed from those of today often specifically and sometimes generically. The lower animals and the plants of the Pleistocene were identical with those now living; although in some cases the distribution of the species was different.

But the chief characteristic of the Pleistocene period is the record made by certain phenomena of the physical world; that is, by the glaciation of a considerable portion of the northern hemisphere and of restricted portions of the southern. In North America, during the Pleistocene, sheets of ice of vast but unknown thickness covered the continent as far south as a line beginning at the east end of Long Island, thence extending to the headwaters of the Alleghany River; along this river and the Ohio to Louisville; across Indiana and Illinois to the mouth of the Missouri River; thence following in a general way this river into Montana and from there westward to the northwestern corner of Washington. These ice-sheets, or at least the later ones, proceeded from three centers, one, the Labradorian, lying east of Hudson Bay, another, the Kewatin, situated immediately west of Hudson Bay, and a third, the Cordilleran, in British Columbia. From these centers the ice streamed out in all directions, even toward the north, but especially toward the south. In the passage of these ice-sheets vast amounts of rock were broken up and most of it ground to powder; and the materials were borne onward and at length deposited over the glaciated areas. This material consists of clays, sands, gravels, and bowlders of widely varying sizes. The gravels and the bowlders were to a large extent derived from igneous and metamorphic rocks, such as trap, granite, syenite, etc. Such rocks could have been transported only from regions situated toward the north. Often the larger stones and the bowlders are scratched and striated, the result of movement over other stones while held in the grasp of the flowing ice.

Usually the clays and sands are unstratified. However, where water has acted on them, as where streams issued from the borders of the ice-sheet or flowed beneath them or where lakes and ponds were formed, there may be found more or less stratification of the materials. The thickness of the deposits, known usually as the *drift,* varies from a few inches to more than 500 feet. It may rest on any of the older formations. The surface of the drift is often not level and sometimes very uneven. The unevenness may be due to the erosion of flowing waters that have acted on the materials since the disappearance of the ice; but in large part it resulted from the irregular way in which the materials were laid down, or dumped down, by the glacial sheet. Where the foot of the ice-sheet rested for any considerable time there may be found long ridges that are largely composed of coarse materials. Such ridges are called *moraines.* In the depressions of the surface, after the ice retired, were formed lakes and ponds. After that time many of these became more or less filled up and formed marshes and low wet meadows.

The Pleistocene was, in general, a time of elevation and of extension of the borders of the continent beyond these present limits.

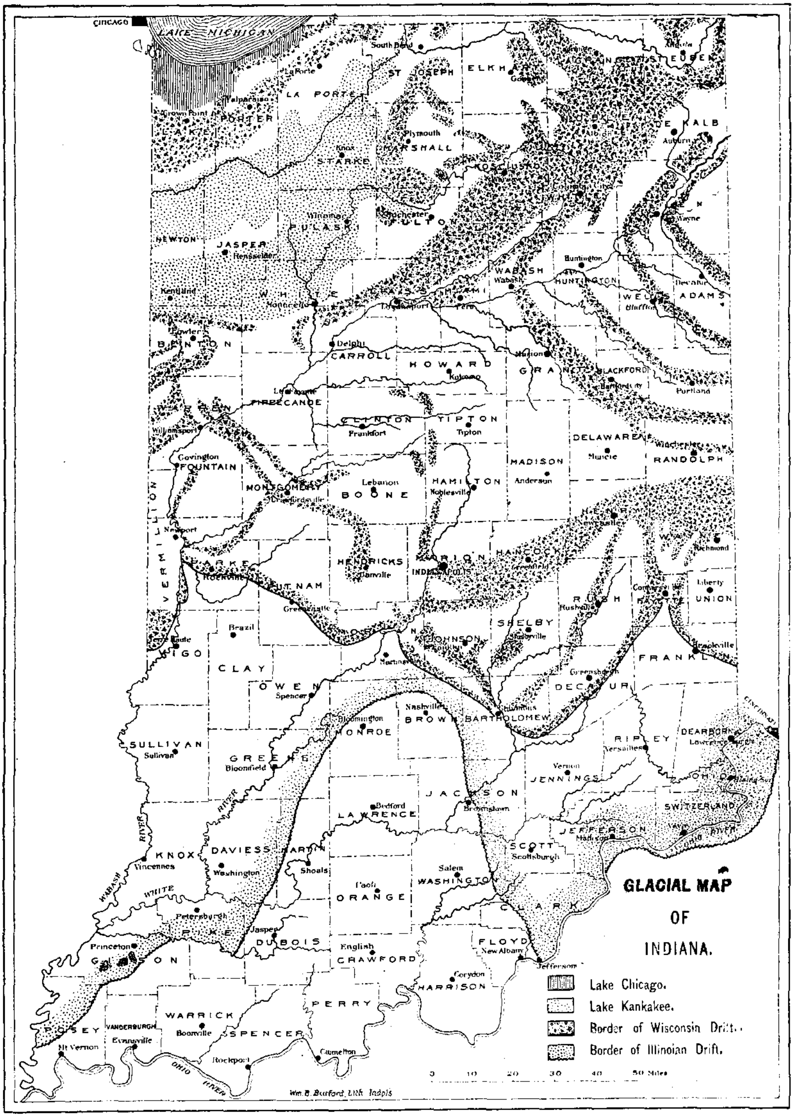
The changes in elevation and in the climate during that time had a profound influence on the animal life and on the history of mankind. For these reasons the Pleistocene is regarded as a period distinct from the Pliocene, with which, as Chamberlin and Salisbury say it would otherwise be united.

The glacial epoch was so far as we yet know the most important part of the Pleistocene period. It is not unusual to have the name Glacial applied to the whole of Pleistocene time, as Chamberlin and Salisbury have applied it. Whether or not the Pleistocene period began with the glacial epoch is uncertain. Preceding the glacial epoch was a time known as the Ozarkian or Sierran, an epoch of elevation of the continent, or parts of it, and of great erosion and redeposition. The duration, the importance, and the position of this epoch are as yet undecided. Chamberlin and Salisbury (III, p. 315) place it at the end of the Pliocene. Osborn (Age of Mammals, p. 435) refers it to the beginning of the Pleistocene and preceding the Glacial epoch.

There are similar differences of opinion as to what is to be regarded as the end of the Pleistocene period. After the final clearing away of this ice-sheet there occurred a depression of the region north and south of the St. Lawrence River and extending westward to the Great Lakes. The effect of this was to allow the sea to invade Lake Champlain and probably the valley of the Hudson and Lake Ontario. To this time is given the name Champlain stage. By Chamberlin and Salisbury this stage is placed at the close of the Pleistocene; by Osborn it is referred to the Recent epoch.

In the preceding remarks the glacial epoch and its awful millstone, the ice-sheet, and its product, the drift, have been spoken of as an undivided epoch, a unique machine, a single grist. Such for a long time was the prevailing view, and this view is still held by a few geologists. However, it seems now to be quite demonstrated that during the Glacial epoch there were several glacial stages and that they were separated by a corresponding number of interglacial stages, during which mild climates prevailed. The investigations made by various geologists in North America have shown that there were either four or five glacial and three or four interglacial stages. The names of these are given in the following section in the order of their age. The Glacio-lacustrine stage is included as being equivalent to an interglacial stage. This and the interglacial stages are printed in italics; the glacial stages in roman. It must also be stated here that there is yet some question whether or not the Iowan glacial stage is distinct from the Illinoian. If it is not, the

PLATE I.


GLACIAL MAP
OF
INDIANA.
Lake Chicago.
Lake Kankakee.
Border of Wisconsin Drift.
Border of Illinoian Drift.
0 10 20 30 40 50 Miles
Wm. B. Burford, Lith. Indpls.

Peorian and Sangamon interglacial stages must be merged into one, and there will remain four glacial and three interglacial stages.

10. Glacio-lacustrine.
9. Wisconsin.
8. Peorian.
7. Iowan.
6. Sangamon.
5. Illinoian.
4. Yarmouth.
3. Kansan.
2. Aftonian.
1. Nebraskan.

The glacial map of Indiana, Plate I, is intended principally to show the southern limits of the two ice-sheets which left deposits in the State and to show the positions of the principal moraines of the Wisconsin stage. This map is based on Leverett's maps found in the monographs already mentioned. The southern edge of the Illinoian drift lies south of or along the Ohio River from Cincinnati to Jeffersonville, then runs northwest to north of Nashville, then southwest to the southwestern corner of the State. The southern edge of the Wisconsin enters the State north of Cincinnati; runs northwest to Connersville, southwest to the northwest corner of Jennings County, then runs northwest to near Newport, and leaves the State west of Terre Haute. It is to be taken that the State north of this line is covered with Wisconsin drift, and that that part of the State south of it to the other line is covered with Illinoian drift.

THE GLACIAL STAGES.

1. The *Nebraskan.* The deposits of this stage have been recognized in Nebraska and Iowa. The Kansan drift sheet overlies it, except where the former has been removed by erosion or otherwise. It is sometimes seen where the Kansan is cut through by streams or in the construction of railroads. In Pennsylvania and New Jersey, south of the border of more recent drift deposits, some remnants of a very old drift appear, which may belong to the Kansan stage; but the age of this Jerseyan drift has not been definitely determined. While this eastern drift lies within the Labradorian field, the western Kansan drift is believed to have been deposited by ice from the Kewatin center.

2. The *Kansan.* This drift sheet occupies a restricted area in eastern Kansas and Nebraska, the greater part of Iowa, and the

northern part of Missouri. If it occurs farther eastward it is concealed beneath later formed drift-sheets. It is believed to have had as its center of departure the Kewatin, west of Hudson Bay.

3. The *Illinoian.* This drift sheet, whose point of radiation was Labrador, is found at the surface over a limited area in Wisconsin; in eastern Iowa along the Mississippi River; over nearly the whole of western and southern Illinois; and as a band across southern Indiana and a part of southern Ohio. East of Columbus, in the latter State, its southern border turns north and disappears under the Wisconsin.

4. The *Iowan.* This sheet of drift is recognized in the northeastern corner of Iowa and northwestern Illinois, extending into Minnesota. It is supposed to have been deposited by an ice flow from the Kewatin center.

5. The *Wisconsin.* This, the drift sheet occupying the largest surface because not covered up by later ones, may be regarded as covering the northern half of North America, coming down on the map to, or close to, the line which marks the southernmost extension of glacial drift, the terminal moraine, in the eastern part of the United States as far west as central Ohio; then passing north of the terminal moraine across southern Ohio, across the northern part of southern Indiana, west to central Illinois; thence north to Wisconsin and Minnesota, back into Iowa, forming a long lobe in the north-central part of the State; thence, in a general way, northwestward. Better than any of the other sheets it exhibits the typical features of a glacial deposit. Its southern border is marked by a heavier moraine; and as the ice-sheet receded it left several more or less concentric moraines in front of each of its lobes.

The Interglacial Stages.

1. The *Aftonian.* The deposits of this interglacial interval, which lie between the Nebraskan and the Kansan drifts, have been recognized with certainty only in Iowa and Nebraska; but here at numerous points, especially in the western part of the former State. Here besides gravel and deposits of sand, there have been observed old beds of peat and muck, containing stumps and branches of trees. In these Aftonian beds there have been discovered several species of vertebrates, elephants, mastodons, the common and the giant beaver, horses, camels, a moose-like ruminant, a goat-like ruminant, species of large ground-sloths and a bear. These discoveries are of prime importance, inasmuch as they give us a glimpse at the life of the early Pleistocene.

2. The *Yarmouth*. The only deposits known to belong to the interval between the Kansan and the Illinoian drift sheets are found in eastern Iowa. At various points there have been observed old soils containing peaty matter and sometimes considerable amounts of wood. At Yarmouth, Iowa, where the peat has a thickness of 15 feet, there were secured also the bones of a rabbit and of a skunk.

3. The *Sangamon*. This interglacial interval followed the Illinoian glacial stage and preceded the Iowan. It is represented by old soils and beds of muck and by leached surfaces at many points in Illinois, where it is overlain by Iowan till or more commonly by loess deposits, which are believed to represent the Iowan stage. What is thought to be a Sangamon deposit of peat is found at Davenport, Iowa (Leverett, XXXVIII, p. 127), and other exposures of Sangamon are stated by Leverett (op. cit., p. 126) to occur in Indiana and western Ohio, just outside of the border of the Wisconsin drift moraines. It is found, also, within the border of the Wisconsin when this has been penetrated by diggings and borings (Leverett, op. cit., p. 200, seq.), in northeastern Illinois, northern Indiana, and southern Michigan.

4. The *Peorian*. The deposits of this interval lie theoretically between the drift deposits of the Iowan and the Wisconsin stages; but it seems not to be certain that both drifts are anywhere present where supposed Peorian is found. It is not always possible to distinguish the Peorian from the Sangamon, and in his recent writings Prof. Leverett regards the two as the same. Where an old soil occurs below Wisconsin drift and above a loess deposit, it probably belongs to the Peorian. Such a case occurs east of Peoria, Illinois, where a soil containing some wood was found between the loess and the lowest sheet of the Wisconsin drift. Some important fossiliferous beds supposed to be of the same age as the Peorian, but possibly older, have been discovered near Toronto, Canada. They contain a considerable number of forest trees, insects, mollusks, and some vertebrates.

Soils met with below Wisconsin drift in wells and borings may belong to this stage or to the Sangamon.

The loess is an extremely fine deposit which has a wide extension in the Mississippi Valley and on the Plains region. The prevailing opinion at present is that it had its origin in wind-blown dust. In places it may reach a thickness of 100 feet, but it is usually much thinner. It is found especially along the larger streams

THE LOESS.

and is thicker on the eastern side of these. It extends eastward somewhat beyond the Wabash River, even to West Virginia; but in Indiana it attains no great thickness, a depth of 10 feet being rarely found. It often contains fossil snail shells belonging to species that are yet living and which inhabit dry land. This loess is closely associated with the Iowa drift sheet. It seems always to lie above the Sangamon soil, and, for the most part, beneath the Wisconsin drift; although it is probable that to some extent a similar deposit has continued to be formed down to the present day.

DEPOSITS OUTSIDE OF THE GLACIATED AREA.

During the glacial stages erosion and deposition were proceeding in the unglaciated regions in the usual way. Of most interest in the present connection are those deposits made along the larger streams which carried off the water that came from the foot of the ice-sheets. This was naturally heavily charged with fine sediments, which were at length dropped farther down the streams. The valleys of all the larger streams of Indiana contain water-formed deposits that owe their origin to the ice-sheet. There may be expected to occur in these valleys deposits representing each of the glacial stages, but it will require much investigation in order to distinguish them. Leverett in his map (Monograph U. S., Geol. Survey XXXVIII, plate VI), recognizes glacial valley deposits of two periods, those that were formed during the Wisconsin stage and those that were made before the Wisconsin.

GLACIO-LACUSTRINE DEPOSITS.

In Chamberlin and Salisbury's Geology may be found a condensed account of the geological and geographical changes that took place between the time when the glacial sheet had withdrawn its lobes to within the beds of the present lakes Michigan, Erie, and Ontario, and the time when the St. Lawrence River was opened to permit the discharge of the lakes through its channel. For a considerable period the waters that collected in the ice-free part of what is now Lake Superior escaped southward into the head of the Mississippi; those of Lake Michigan, into the Illinois River; those of Lake Erie into the Wabash; and, when the ice had to a considerable extent withdrawn from the present bed of Lake Ontaria, the water was discharged by the Mohawk into the Hudson. For a considerable time the waters of these lakes stood at a much higher level than at present. To these bodies of water, standing at varying levels from time to time and reaching southward varying but increasing distances from the ice-front, geologists have given other names than those applied to the present lakes.

The borders of these ancient lakes are now marked by old beaches, some of which are found many miles outside of the present beaches and at higher levels. Naturally the higher beaches are the older ones.

In this connection may be considered deposits formed on the top of the Wisconsin drift in northern Indiana. Some of these were made before the glacial sheet had retired from the beds of the Great Lakes; some of them afterwards. Doubtless in many localities deposits have continued to be made down to the present time or nearly so. In northwestern Indiana, in the region along the Kankakee River, the Iroquois River, and the upper portion of the Tippecanoe, there is an area of somewhat more than 3,000 square miles that is more or less covered with sand and where sand dunes occur too abundantly. In the basin of the Kankakee River the sand-covered tract surrounds the present Kankakee marshes. The explanation offered for this region by Prof. Leverett (Mon. XXXVIII, p. 338) is that after the ice-sheet had withdrawn just north of the Kankakee River, the water was ponded south of it so as to form a broad shallow lake. Into this lake sands were washed by waters from the foot of the ice-sheet. Probably not all the region was covered with water at the same time, and the sand may have been more or less moved about by winds since the glacial epoch.

After the ice-sheet had permanently withdrawn from the State, the surface was, in general, very uneven and not well drained. This gave rise to numerous lakes and ponds. As time went on many of these became filled, so as to be converted into swamps or even dry land; while others have continued down to our day. Artificial drainage is rapidly converting much of the swampy area of northern Indiana into dry, cultivable land. In many cases it will be impossible to say when certain deposits were laid down, whether in Pleistocene or in Recent times. While these deposits, whether Pleistocene or Recent, were accumulating, the country was inhabited by vertebrate animals. If at any level there are found remains of extinct animals, such as elephants, mastodons, giant beavers, musk-oxen, etc., we may conclude that we have Pleistocene deposits. If, on the other hand, there are found only the bones of living species, as elk, deer or beaver, we are likely to conclude that the deposit is recent. We must, however, recollect that probably all these species lived in Indiana back as far, at the least, as the close of the Pleistocene period. The depth at which the bones and the teeth occur gives little or no clue to their age; for in some basins deposits may accumulate rapidly, while in others they are laid down very slowly or not at all. Elephant and mastodon remains are sometimes found very near the surface.

The Collecting of Fossil Bones.

Before taking up the consideration of the fossil vertebrates of Indiana, it may be profitable to say a word about the collection and preservation of the materials that furnish us our knowledge.

When fossil bones or teeth have been found they should, in the first place, be carefully taken from the earth; a careful observation ought to be made of the depth at which they occur, the nature of the earth in which they are buried, and the kinds and the thickness of the overlying soils passed through. Every part should be kept in the possession of the person to whom they properly belong, so that the find may be of as high scientific value as possible. If the remains are given or sold to any institution, complete information ought to be furnished that institution as to matters mentioned above and the exact place where they were found, indicated in the way that is employed in making deeds of land. This will enable persons at any time afterwards to go to that spot and make such observations as they may wish. In this way important questions may sometimes be settled.

When the remains are turned over to any museum or college or university, the obligation should be exacted that a permanent record of the information furnished shall be made. In almost every museum materials have been gathered, often at much expense, and then carelessly left without label or record and nearly, often wholly, thus deprived of their value. In case the bones are large enough, a permanent label, giving the locality, ought to be put on each one.

Sometimes fossil bones and teeth are so well preserved that they may easily be taken from the earth by any unskilled person; but even then the smaller parts may be overlooked; and these may be the very ones that have never before been found and are the ones most desired.

On the other hand, the bones are very likely to be soft and easily broken. It is not unknown that a skull of an exceedingly rare and valuable mammoth has been drawn out of the earth by hitching a span of horses to it; when in reality it ought to have been lifted from its bed as tenderly as a baby from its cradle. Hardly one of our extinct animals is completely known, and every part discovered ought to be preserved in order that knowledge may be increased. Moreover, what may most appeal to many persons, the money value of a specimen increases rapidly as the completeness of the skeleton is approached. In case the prospects are fair for a complete or nearly complete skeleton, it will be better in many cases to leave it in the ground and allow it to be exhumed by an expert. Most museums prefer to exhume their own skeletons. It is not unusual, when some large bones have been found, to announce the discovery widely, so that crowds flock in from all sides, in great excitement. The bones are dug out in feverish haste, broken and separated from those with which they were connected. Part of them are given away as keepsakes to people who know nothing about them and to whom they are of no value; and after a few years they are destroyed or lost. Many specimens of mastodons have been found in Indiana; but there is probably not a good mastodon skeleton in any Indiana institution. Fortunately, however, some of them have been preserved in outside museums. There is hardly a State that furnishes so many interesting extinct forms as Indiana; and it is time for its intelligent inhabitants to learn to appreciate scientific knowledge and materials as they appreciate literature and politics.

THE PLEISTOCENE VERTEBRATE ANIMALS OF INDIANA.

The Pleistocene fossil Vertebrata known to have lived in Indiana belong almost wholly to the class known as *Mammalia.* There were living within the limits of Indiana, without doubt, during the whole of Pleistocene times, numerous freshwater fishes, amphibians, reptiles, and birds. The hard parts of many of these, we may be sure, were covered up in the deposits laid down during interglacial times here and there over the State and at all times in deposits left in lakes and rivers; but for many reasons they are not collected. The bones of the smaller animals do not attract as much attention as do those of elephants and mastodons. The earth in which the bones are buried, not being consolidated into a firm rock, crumbles in being disturbed and permits the skeleton to fall apart. The bones themselves are not well mineralized and break up readily. When, on the other hand, a fish skeleton is enclosed in a hard rock, the latter is likely to split in such a way as to reveal the skeleton with all its bones firmly retained in the position which they had when buried.

Nevertheless, we may expect in time to secure specimens even of the fishes and reptiles. Some of the Pleistocene clays are compact and stratified so that they will separate in thin layers. Prof. Frank Baker, of the Chicago Academy of Science, has shown me a considerable part of the skeleton and scales of a bow-fin which he found in a Pleistocene clay near Chicago. There is described here the shell of a box-tortoise that was found in a cave near Bloomington; and we may expect that some of the numerous caves that occur in southern Indiana will yet furnish many valuable examples of the creatures that lived during the geological period that preceded our own.

Class **REPTILIA.**

THE REPTILES.

Cold-blooded vertebrates, which breathe air by means of lungs, whose eggs are laid on land, whose young do not pass through a tad-pole stage, whose skull has a single occipital condyle, and whose lower jaw articulates with the skull by means of a quadrate bone.

Fossil reptiles are poorly represented in the known Pleistocene fauna of Indiana. The writer knows of none except the box-tortoise that is described below. There can be little doubt, however, that careful search in the deposits of caves and in peat and muck beds still other species of turtles might be found, as well as of snakes and perhaps lizards.

Order TESTUDINES.

THE TURTLES.

Short and thick reptiles, the internal organs of whose bodies are enclosed in a more or less perfect armor, composed of an upper portion, the carapace, and a lower portion, the plastron.

Family EMYDIDÆ.

RIVER AND SWAMP TURTLES AND BOX-TURTLES.

Carapace articulated at the sides with the plastron. No mesoplastron. Quadrate open behind.

Genus TERAPENE Merrens.

THE BOX-TURTLES.

Shell short and broad. Plastron as broad as the carapace; composed of two parts movable on each other and on the carapace, so that the shell may be completely closed.

TERRAPENE CAROLINA (Linnæus).

This is the common box-tortoise of the eastern part of the United States, and it is abundant in Indiana.

Prof. J. W. Beede, of the State University of Indiana, sent the writer some bones which he collected in a limestone cave which had been discovered and destroyed in some quarrying operations at the Rock Cliff quarry, just northwest of Williams, in Lawrence County, Indiana. Among the bones and teeth, the writer has recognized two species of peccaries and a box-tortoise that seems to differ in no way from individuals now living in Indiana. Only the upper shell is present and this is somewhat damaged (Fig. 1.). All the

bones are united so closely that all the sutures are closed and invisible. The length of the shell in a straight line was close to 140 mm.; the greatest width was about 105 mm. The figure will enable comparisons to be made with recent specimens.

It is impossible to determine the geological age of this turtle. It is not at all unlikely that it lived before the oncoming of the Wisconsin glacial stage. It belongs, however, to the Pleistocene.

Class MAMMALIA.

The Mammals.

The Mammalia get their name from the fact that the females of all the species possess organs for the production of milk for the nourishment of the young. The mammals are, too, the only animals that possess a more or less complete covering of hair. There are many other features which characterize the group, but it is unnecessary to note them here.

The Mammalia are divided into a few groups called Superorders and these again into Orders. Only a few of these orders are represented by remains that have up to this time been found in Indiana.

Superorder EDENTATA.

The Sloth-like Mammals.

For this superorder the name Edentata is more commonly employed, but Bruta is sometimes used. In the fauna of the present world the order is represented by the sloths, ant-eaters, and armadillos of South America. Some species of armadillos extend their range as far north as Texas. In Asia and Africa are other genera which differ so much from the New World forms that they are by many authors regarded as representing a separate group, the Pholidota. We need not here trouble ourselves about them. To the New World division there is often given also the name *Xenarthra.*

The Edentata may be defined as claw-bearing animals, with the body covered with hair, or horny scales or bony plates, and having the teeth either missing entirely or at a low stage of development. They are, when present, column-like in form, without roots; and they continue to increase in length at the base as they are worn away at the crown, having a persistent pulp. These teeth have no enamel, but are composed principally of dentine; but often there is a layer of cement. The dentine of the interior is less dense and softer and wears away more rapidly than the very hard outer layer.

As to their mode of life, the living New World forms vary greatly. The sloths live among the branches of trees, hanging by means of their great claws with the back downward, and devouring the foliage. The armadillos are burrowing animals that live on roots, worms, insects and carrion. The ant-eaters of the New World include some terrestrial and some arboreal species, and they all nourish themselves on insects.

During Tertiary times there existed in South America an enormous number of genera of this group, Edentata or Xenarthra. During the Pliocene and Pleistocene periods some of these migrated into North America and spread over the larger part of the United States. It must be said, however, that representatives of the Edentata existed in North America as far back as the middle Eocene and probably yet in the middle Miocene. It is probable that the group became extinct in North America before the invasion on the part of South American forms, in Pleistocene times.

The New World Edentata have been divided into what may be regarded as two orders, the Pilosa, or hairy Edentates, and the Loricata, or armored Edentates. Inasmuch as none of the latter are known to have occurred within or near the limits of Indiana, it will not be necessary to consider further the differences between the two orders. It suffices to say that the Loricata include the armadillos and the extinct glyptodons, while the Pilosa include the sloths and ant-eaters. These are again sub-divided into two divisions, which may be regarded as superfamilies, the *Gravigrada*, the extinct ground-sloths, and the *Tardigrada*, the tree-sloths. Our affair is with the Gravigrada.

Superfamily GRAVIGRADA.

THE GROUND-SLOTHS.

Edentata having usually a heavily built skeleton and a relatively small skull; size small to medium in early Tertiary forms, large in those of the Pleistocene. Number of presacral vertebræ varying from 26 to 32. Posterior dorsals and the lumbars furnished with pairs of articular processes in addition to those of the anterior vertebræ. Skull elongated and low, nearly cylindrical, with the part in front of the orbits short. Zygomatic arches sometimes complete; sometimes with a gap between the jugal and the squamosal. Jugal usually with a strong descending process. Lower jaw with broad ascending and horizontal rami. Upper teeth five or four on each side; lower teeth four or three on each side $\left(\frac{5-4}{4-3}\right)$. Radius and ulna not coössified; tibia and fibula sometimes coössified at the extremities. Digits five in each foot in front and behind, or only four behind; clawed. Tail usually large. Habits herbivorous.

Under the superfamily Gravigrada are included three families, the Megalonychidæ; the Megatheriidæ and the Mylodontidæ. So far no remains representing the second of these families has been found in Indiana or near its borders.

Family MEGALONYCHIDÆ.

Ground-sloths of small to large size, with a long and cylindrical skull, more or less constricted behind the orbits. Tooth formula $\left(\frac{5}{4}\right)$. In section the teeth are 4-sided or elliptical, sometimes slightly triangular; never lobate; in section the anterior upper one more or less distant from the second; hinder one not differing greatly from the others in size. Fore and usually hind feet with five digits, the median ones most strongly developed.

Genera belonging to this family are known from the Santa Cruz beds of the older Tertiary, of South America. Descriptions and numerous illustrations may be found in Prof. W. B. Scott's Mammalia of the Santa Cruz Beds. In North America the family is represented by *Megalonyx* and *Morotherium.*

Genus MEGALONYX Jefferson.

Large North American late Pliocene and Pleistocene sloths, with teeth $\frac{5}{4}$, the anterior both in the upper and the lower jaw considerably in front of the succeeding one, and much larger. The four hinder molars roughly quadrate or triangular in section, with rounded angles and straight or convex sides; not fluted.

This genus was proposed by President Thomas Jefferson in 1799 on parts of a skeleton including some claws that had been found in a cave in Greenbrier County, West Virginia. From the form of the claws he concluded the animal was carnivorous.

MEGALONYX JEFFERSONII Desmarest.

Although Jefferson gave name to the genus, he did not name the species. This was done in 1822 by Desmarest, who assigned it to the genus Megatherium and in honor of President Jefferson named it *Megatherium jeffersonii.*

Jefferson had in his possession only a part of a femur, a radius, an ulna, three claws and a few other foot bones. Since his time portions of the animal have been found in various parts of the country, from Big Bone Cave, Van Buren County, Tenn.; Memphis, Tenn.; Big Bone Lick and Henderson, Ky.; Natchez, Miss.; Tuscumbia, Ala.; Wythe County, W. Va.; Peace Creek, Fla.; Holmes County, Ohio; Evansville, Ind.; Galena and Urbana, Ill.; Dubuque and Mills counties, Iowa; McPherson and Clark (or Meade) counties, Kan.; Huerfano County, Col.; and Hardin

County, Tex. Inasmuch as the finds have often consisted of meager remains, a single tooth or claw or little more, it may be that one or more other species are included; for six other Pleistocene species have been described and two from the Pliocene. None except *M. jeffersonii* has been found in Indiana or neighboring States.

The remains of the species which have been found in Indiana were collected long ago by Mr. Francis A. Lincke, in the banks of the Ohio River, near the mouth of Pigeon Creek, a mile or two below Evansville. The materials were reported by Dr. Joseph Leidy, in the Proceedings of the Academy of Natural Sciences, in 1854, page 199. They consisted of the shafts of two tibiæ of a young individual, an axis, a piece of a calcaneum, one metacarpal, one metatarsal, and one claw phalanx.

In the same deposits were found what were regarded as parts of possibly American bison (*Bison bison*), the white-tailed deer (*Odocoïleus virginianus*), an extinct horse (*Equus complicatus*), the extinct tapir (*Tapirus haysü*), and the Indiana wolf (*Canis dirus*).

An examination of the map of this region given by Leverett, (Monog. XXXVIII, U. S. Geol. Survey, Pls. VI and VIII) will show that the Ohio Valley at this point is occupied by glacial terraces that are older than the Wisconsin glacial stage. This seems to be confirmed by the occurrence there of the fossil horse, the tapir, and the wolf. The bison may belong to some extinct species, rather than to the living species *Bison bison*.

Our knowledge of this species depends principally on the remains found near Henderson, Kentucky, and near Millersburg, Holmes County, Ohio. Neither lot of bones furnishes a complete skeleton, but, to a considerable degree they supplement each other and between them furnish us with the greater part of the framework.

Henderson is situated on the Kentucky side of the Ohio River about nine miles below Evansville, Indiana. This side of the valley is undoubtedly filled with glacial deposits like those on the Indiana side, and the bone bed is, as stated by D. D. Owen in a letter to Leidy (Smithson. Contrib. Knowl., VII, art. p. 7), only about five or six feet below the ordinary low stage of water. We may therefore conclude that the remains are of pre-Wisconsin times. From this same bone bed Owen collected many horns and bones of the deer. The parts of the skeleton of *Megalonyx* found here will be mentioned below.

The partial skeleton found in Holmes County, Ohio, was discovered on the farm of Mr. Drushell, about six miles east and a little north of Millersburg. According to Claypole, who described these remains, they were lying on a layer of shell marl, and this was overlain by six feet of peat. The terminal moraine of the Wisconsin drift-sheet runs through the county in an east by northeast direction, and this had led to the formation of a small lake north of it, which finally became a swamp filled up with peat. By some means the megalonyx had left his remains in the lake after the formation of the shell marl and before the growth of the peat. It is evident that this sloth existed after the retirement of the Wisconsin drift-sheet and long enough after it for the climate to become sufficiently warm to permit this animal to wander into Ohio. This post-Wisconsin existence of the megalonyx is, in a measure, confirmed by the finding of a claw near Urbana, Illinois, on early Wisconsin drift; but still more satisfactorily by the discovery of megalonyx bones in a dry cave in Tennessee, to which bones there were yet attached remnants of articular cartilage, and even in one case the horny sheath of the claw. The partial skeleton discovered at Henderson, Kentucky, is now in the collection of the State University, at Bloomington, Indiana, where the writer has examined it. It was studied and described by Joseph Leidy in volume VII of he Smithsonian Contributions to Knowledge, issued in 1855. Leidy's treatise took into consideration all the materials known to him and was beautifully illustrated with 16 finely engraved plates. From these plates some of the illustrations here used have been prepared. It is not certain that the bones found at Henderson all belong to the same individual, for they were picked up at various times from year to year. Leidy thus enumerates the bones: "A nearly entire skull and lower jaw; the atlas, axis, and three other cervical vertebræ; two dorsals, one sacral and two caudal vertebræ; both clavicles; the glenoid articulation of the right scapula; the left humerus; the articular extremities of the right ulna and those of both radii; five carpal bones; four metacarpals; 11 phalanges of the forefeet; fragments of several ribs; one sternal bone; both thighs, broken; both patellæ; both tibae; seven tarsal bones; five metatarsals; and five phalanges of the hind feet.

The Millersburg, Ohio, specimen was described by Prof. E. W. Claypole (Amer. Geologist, vol. VII, pp. 122-132; 149-153), but no figures were given. He gave the following list of bones secured: three teeth, one hyoid, three lumbar vertebræ, one caudal, probably one broken cervical; three ribs and some pieces; one clavicle; one radius, both femora, one tibia, both fibulæ, both patellæ, both calcanea, 22 carpals and tarsals, five metacarpals and metatarsals, 20 phalanges, including 11 claws.

A comparison of the two lists shows that many bones are represented in neither of these skeletons or only partially represented.

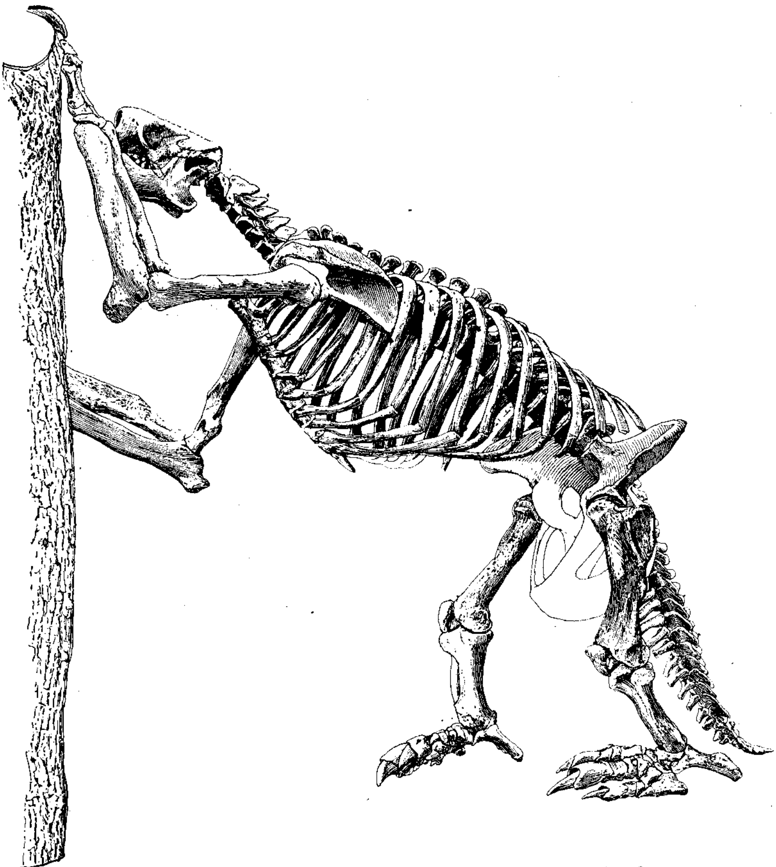


FIG. 2. *Megalonyx jeffersonii.* View of skeleton greatly reduced.

Many vertebræ are missing, including the sacrum; few ribs have been secured; the pelvis is present in neither and besides is quite unknown, except that Harlan in 1835 described an ilium from a cave in Tennessee. Neither of the two specimens mentioned offers a complete scapula; the humerus is represented in the Henderson specimen by a bone without the epiphyses.

The Henderson specimen is mounted without restoration of missing parts. The Millersburg specimen has the missing parts represented in plaster, following probably *Mylodon* where not known in *Megalonyx*. The work was done by the Ward establishment, Rochester, N. Y., and the artificial parts have been made to resemble so closely the bones that it is very difficult in some cases to distinguish the real and the fictitious. A line drawing of this specimen is here presented (Fig. 2), prepared from a photograph taken by the writer. It is impracticable to indicate the parts that are restored artificially, and it may be taken as representing the

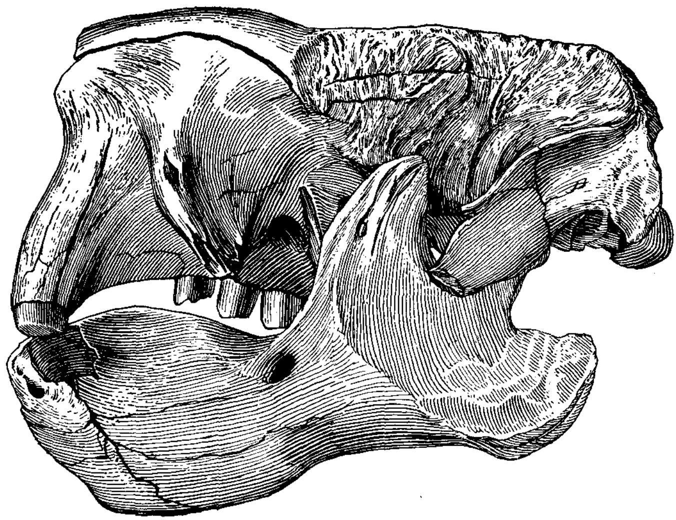


FIG. 3. *Megalonyx jeffersonii.* Side view of the skull, × ¼.

general form of the animal and, for the most part, of its elements as determined from all known materials.

The total length of the specimen as mounted in 3,510 mm. (11 ft. 6 in.). The height of the sacral region from the floor is 1,500 mm. (4 ft. 11 in.), and this is likewise the length of the fore and of the hinder limbs, following the front of the bones. The description of the more important portions of the skeleton will be taken from both skeletons and from other known materials.

The Skull. Figures are presented of this skull, prepared from those made for Dr. Leidy and published in Vol. VII, of the Smithsonian Contributions to Knowledge. Figure 3 shows the skull from the left side and of one-fourth the natural size. It is nearly complete, but the malar bones are gone and the pterygoid processes.

The lower jaw is mostly present. The teeth of the upper jaw are all present, except the second of the left side and the fifth one of the right side. As will be seen, the skull is long, low, and, leaving out of view the zygomatic arches, narrow. (Fig. 4.) The anterior region is higher than the brain-case. The upper border is nearly straight. The rear forms nearly a semicircle, whose center is just below the upper border of the foramen magnum. The length from front of first tooth to the rear of the occipital condyles is 355 mm.; from the hard palate to the highest part of the snout is 152 mm.; breadth at the rear of the orbits, 125 mm. The orbits are shallow and are indicated above and in front by a high ridge ascending from the root of the molar process; behind by a slight ridge which separates it from the rough temporal fossa. In front of the malar

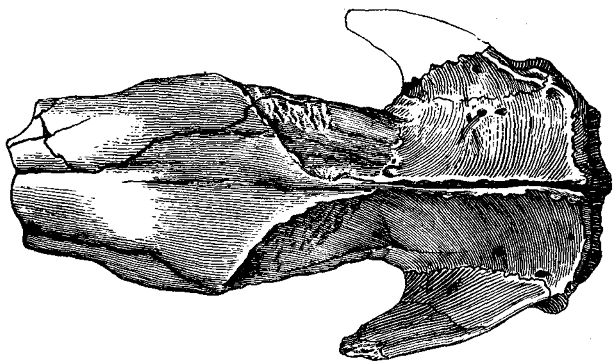


FIG. 4. *Megalonyx jeffersonii.* View of the skull from above. × ¼.

process on each side is a groove which extends downward on the sides of the upper jaw between the first and second teeth. It will be observed that the part of the face in front of the orbit is extremely short, and it narrows towards the nasal openings. The anterior nares form a very large opening, about 75 mm. in diameter.

In front of the hinder roots of the zygomatic arches the skull is constricted. The rear of the skull slopes rapidly downward to the occipital condyles. There is a low but well-defined sagittal crest; whereas, in *Mylodon* there is a broad, smooth surface between the two temporal fossæ.

As shown by the skull of another species, *Megalonyx leidyi*, found in Kansas, the zygomatic arch was quite certainly complete. In the living sloths and in *Mylodon* there is a gap about its middle. In *M. leidyi* there runs downward and backward from the anterior root a long process which would reach quite to the lower border of the lower jaw at the middle of the latter. From the middle of the arch another shorter process extends upward and backward. These processes offered an extensive attachment for the muscles which moved the lower jaw.

On the lower surface of the skull (Fig. 5), there are to be seen behind the occipital condyles, various openings for nerves and bloodvessels, processes for muscles, the auditory processes, and at the root of each zygomatic arch, the articulation for the lower jaw. This is about 28 mm. long and 50 mm. wide, the long diameter being directed outward and forward. The hard palate begins at the hinder border of the last molars. Here it is about 33 mm. wide and is still narrower between the third molars. Between the three hinder pairs of molars it is convex and with the middle of its width

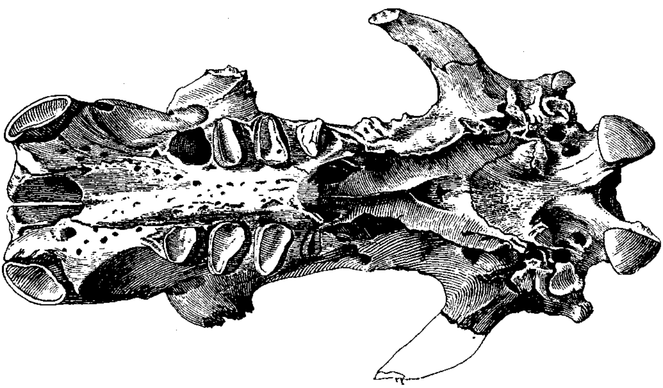


FIG. 5. *Megalonyx jeffersonii.* View of the skull from below. × ¼.

about on a level with the worn surfaces of the teeth. Further forward it rises, flattens and widens to about 110 mm. near the anterior teeth. Between the teeth just mentioned is a large anterior palatine foramen.

Five teeth are found in each row above. Those of the anterior pair are considerably larger than the others and somewhat caninelike. They extend high up in the jaw to the root of the malar process, having a length of 125 mm. and being strongly curved. The section is elliptical, with a swelling on the inner face. The diameters are 38 mm. and 19 mm. Between the teeth of this pair is a distance of 60 mm.; while between them and the second molars there is an equal space. The hinder four molars of each side have only a slight space between the adjoining ones. Figure 6, taken from Leidy, presents the sections and positions of these teeth. The length of the row of four hinder teeth is 80 mm. From the front of the first tooth to the rear of the fifth is 172 mm. In the figure this distance is less than in nature. The triturating surface is worn so as to present a concavity surrounded by a border of harder dentine. It is most worn towards its hinder border.

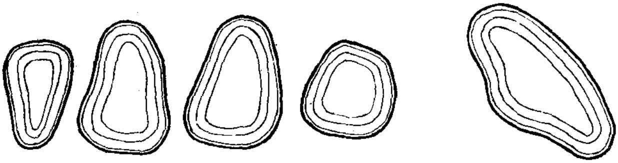


FIG. 6. *Megalonyx jeffersonii.* Teeth shown in section; the anterior one at the right hand. × ⅔.

The premaxillaries are consolidated with the maxillæ, but not with each other on the midline. They measure about 19 mm. in width and 50 mm. in height.

The lower jaw (Fig. 7) is high in front; much lower at the midline of its length and provided behind with three processes. The length from front to extreme rear is 317 mm. The height of the symphysis is 105 mm., and this symphysis is directed strongly downward and somewhat backward. The height of the bone a little behind the anterior tooth is 100 mm.; at the third tooth, 90 mm.; at the coronoid process, 158 mm.; at the condyle, 105 mm. The outer face of the body of the bone is convex; the inner face, flat. In the upper border were placed the four teeth, of which only the second and the fourth were present. Between the first and the second is a diastema of 42 mm. At the rear of the jaw is the strong angular process. The condyles for union with the skull are about 50 mm. from side to side. The alveolus for the first tooth has a depth of about 88 mm., and its diameter shows that this tooth was of a size

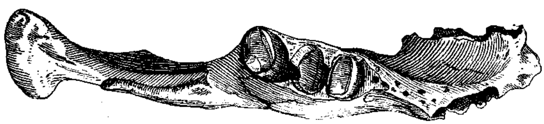


FIG. 7. *Megalonyx jeffersonii.* Lower jaw seen from above. × ¼.

fully as large as the corresponding upper tooth. It was directed upward, forward, and outward. The last three teeth formed a row about 75 mm. long. The second and fourth teeth measured, in section, 18 mm. from front to back; 24 mm. from side to side. These sections are quadrate with rounded angles and somewhat convex sides. The worn face of each is concave, bounded by a sharp border which bounds a valley running somewhat obliquely across the tooth.

The atlas is present in the Henderson skeleton and was figured by Leidy in two positions. The greatest width is 170 mm.; the width of the lower arch, 32 mm.; the width of the spinal canal, 43 mm. There is a very tortuous canal for the vertebral artery.

Leidy figured the axis. The body of the bone with the odontoid process is 88 mm. long. On the lower surface of the obtuse odontoid is a surface for union with the atlas. Behind the anterior zygaphysis is the opening of the canal for the vertebral artery.

There are three cervical vertebræ, being, as Leidy thought, the third, the fifth, and the seventh. The fifth, measured from the

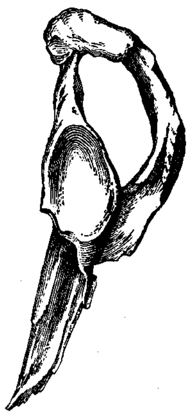


FIG. 8. *Megalonyx jeffersonii.* Part of scapula, showing the glenoid cavity. $\times \frac{2}{11}$ nearly.

lower surface of the body to the tip of the spine is about 140 mm.; the seventh, about 175 mm. An anterior vertebra has the hinder end of the body transversely elliptical and with a diameter of 38 mm. and 50 mm. A posterior dorsal has the hinder end of the body 75 mm. high and 88 mm. wide.

Leidy described a part of a sacrum to which he had access. In the Henderson specimen there is present only the last of the five sacrals. The body measures from side to side 85 mm.; up and down, over 50 mm. From the extremity of one lateral process to that of the other is 260 mm. These processes extend outward and backward and are rough on their front border for union with the processes of the preceding sacral. There are two caudals present. The hyoid bone is described and figured by Leidy. It is not present in either of the two skeletons here described. It is a V-shaped bone, which articulated to the skull by its apex. The length of each arm is about 65 mm. In the skeleton at Columbus the writer recognized one actual rib, but Claypole stated that there were three of them. A rib on the specimen at Indiana State University has a width of 46 mm. and a thickness of 26 mm. Harlan described what he regarded as one of the anterior false ribs, and this had a length of 29 inches. It is remarkable that a greater number of such thick and strong ribs has not been preserved.

Neither scapula is present in the Millersburg, Ohio, specimen; and in the Henderson specimen there is present only the region about the glenoid cavity of one scapula. Leidy figures (op. cit. Pl. VIII, Fig. 2) the articular region of a scapula that was found in the vicinity of Natchez, Mississippi. This figure reproduced here (Fig. 8) shows the glenoid cavity which measured 83 mm. in length and 60 mm. in width. It shows also that there was an arch of bone that connected the acromion process with the coracoid process of the scapula. Furthermore, the anterior border of the scapula sent forward a process that joined the coracoid process so as to form a foramen in the front portion of the bone. These structures are found in some of the now living sloths.

Richard Harlan figured a scapula of *Megalonyx* which had been found in a cave in Tennessee. (Med. and Phys. Res., Pl. XIII, Fig. 12.) In this bone the acromion had no connection with the coracoid, but this may have been due to injury to the bone or to the youth of the animal. The distance from the glenoid cavity to the middle of the suprascapular border was about 310 mm.

Both clavicles are present in the Henderson specimen; only one in that from Millersburg. This bone in the former specimen has a length of 220 mm. and a width of 70 mm. It is a compressed bone, with one surface convex lengthwise, the other concave. The end that joined the sternum is larger and presents an articular head.

Both humeri are lacking in the Ohio specimen and the right one in that from Henderson, Ky. The left one of this specimen was figured by Leidy and his figure has furnished the one presented here (Fig. 9). The bone is large, with a nearly cylindrical shaft and a greatly expanded lower end. The total length is 520 mm.; the greatest diameter of the head, fore and aft, 100 mm.; the other diameter, 85 mm. The two tuberosities are of about the same size and are placed one on each side of the front of the head. The bicipital groove is shallow. The shaft is slightly flattened in front. At the middle of the length of the bone the diameter from side to side is 85 mm.; from front to rear, 62 mm. Figure 10 gives a section at this part. The expanded lower end of the bone measures 258 mm. across the condyles. The inner condyle projects farther beyond the corresponding trochlea than does the outer condyle beyond the trochlear surface for the radius. At the upper part of its base is the entepicondylar foramen. The outer condyle has its upper border convex. The hinder face of this lower end is slightly concave and there is a shallow depression for the anconeal process

FIG. 9. *Megalonyx jeffersonii.* Left humerus seen from front. × 1/6.

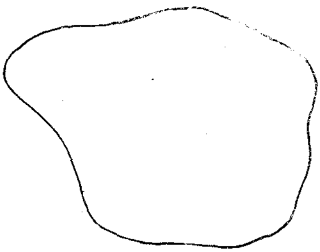


FIG. 10. *Megalonyx jeffersonii.* Section across the middle of the humerus. The front of the bone is above, the radial border toward the left.

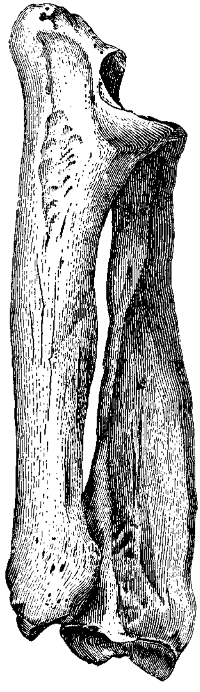


FIG. 11. *Megalonyx jeffersonii.* Left radius and ulna seen from front. × 1/6.

of the ulna. The articular surface for the radius is much larger than that for the ulna.

Figure 11, after Leidy, represents a front view of the left radius and ulna. This is a composite figure. The skeleton found at Henderson furnished only the articular extremities of the right ulna and that of both radii. The figure is probably based on bones that were in the collection made by Jefferson. The extreme length of the ulna in a straight line is given as 20 inches, 500 mm. The breadth from the summit of the coronoid process to the opposite side was 128 mm.; the breadth at the middle of the shaft, 75 mm.; that at the distal end, 75 mm. At the upper end are concave articular surfaces for the humerus and the radius. The distal end articulated at the side with the radius and at the extremity with the cuneiform. Neither ulna was present in the Millersburg specimen. The radius that Leidy described and figured was 17.56 inches (445 mm.) long; the greatest breadth at the distal end was 89 mm.; at the middle of the shaft, 81 mm. This bone is present in the right arm of the Millersburg skeleton, and it is considerably larger than that of the Jefferson specimen, having a length of 520 mm.: diameter of the head, 65 mm.; width at the middle of the shaft, 87 mm.; thickness at this point, 35 mm.; width, near the distal end, in the humerus. At the distal end the bone articulated with the humerus, and on the rim of this is a smooth surface for the notch in the humerus. At the distal end the bone articulated with the scaphoid and the lunar. The palmar face of the bone is concave on the upper half, flat on the lower portion. The opposite face is convex, there being a ridge that runs the whole length of the bone at the middle of the surface. The border on the side of the first digit is thin; the ulnar border is thick and rounded.

For the description of the bones of the wrist the reader may consult Dr. Leidy's monograph, which has already been cited.

In the Henderson specimen there were and are present the metacarpals of the second, third and fourth digits of the left arm, and the fourth of the right. None of his specimens furnished the first metacarpal. This is represented on the right arm of the restoration of the Millersburg skeleton and appears to be actual bone. Its length is 46 mm. and its breadth is the same. The second metacarpal in the Henderson skeleton is 95 mm. long and 44 mm. wide. Its distal end has a prominent vertical median ridge which fitted into a corresponding groove on the proximal end of the first phalanx. The third metacarpal has a length of 100 mm., and the shaft is 38 mm. wide. The distal end has a vertical articular ridge quite like that of the second digit.

The fourth metacarpal is the largest of all, having a length of 125 mm. Its distal end has the usual vertical ridge. The fifth metacarpal is not present in the Henderson specimen, but it is found in the Millersburg skeleton. It has a length of 120 mm. and a width of 26 mm. at the middle of the shaft. Leidy gives a figure of one of these bones which was in the Jefferson collection. The phalanges of the first row, so far as known, are short thick bones, varying in length from 41 mm. in the third digit, to about 37 mm. in the fifth.

As mounted, all the first phalanges are present in the right hand of the Millersburg specimen.

In the Henderson specimen there were present the second phalanges of the second, third, and fourth digits. Those of digits three and four are present in the right hand of the Millersburg specimen. That of the second digit has a length of 58 mm.; that of the third digit, 62 mm.; that of digit three, 67 mm. The terminal phalanges are each modified to support a claw. In the Henderson specimen all these were present, except that of the thumb; but a few are apparently now missing. Leidy figures a thumb claw bone that belonged to the Jefferson collection. It was small in comparison with the others, being 88 mm. long. Leidy's figure appears to be only

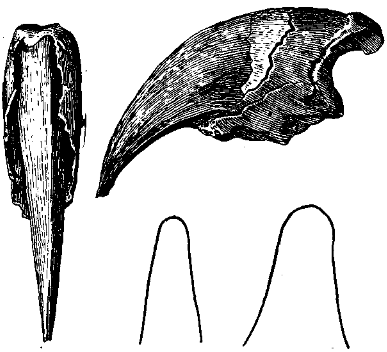


FIG. 12. FIG. 13. FIG. 15. FIG. 14.

FIGS. 12-15. *Megalonyx jeffersonii*. Lateral and upper views of a claw of the front foot, with sections. × ½.

2-5 the natural size. Each terminal phalange consists of a compressed claw-core, with an upper convex border and a concave lower face (Figs. 12, 13). From the tuberosity which occupies the hinder half or more of the lower face of the bone, there rises and surrounds about the hinder half of the claw-core a bony sheath which enclosed and protected the base of the horny claw. This sheath is also attached to the base of the bone on the sides and above. The base of the phalange is occupied by an articular surface which consists of two vertical grooves separated by a prominent ridge. Each groove forms a vertical semicircle. The tuberosity on the underside of the bone is pierced near its middle by a pair of foramina for blood-vessels. The length of the ungual phalange of the second digit is given by Leidy as 150 mm.; its depth, 62 mm. The third digit is 175 mm. long; 81 mm. deep. The fourth ungual phalange is 144 mm. long; 62 mm. deep. In the case of this phalange in the fifth digit, the length is 62 mm.; the height, 37 mm.

The core for the claw is, toward the base, obtuse on the upper border, but farther forward it becomes rather acute. Figure 14 represents a section of the claw-process of the third digit, taken at the middle of its length; while figure 15 is a section taken at the same place in the second digit.

The forefoot had a length of nearly 300 mm. The horny claws would doubtless have made the length fully that much.

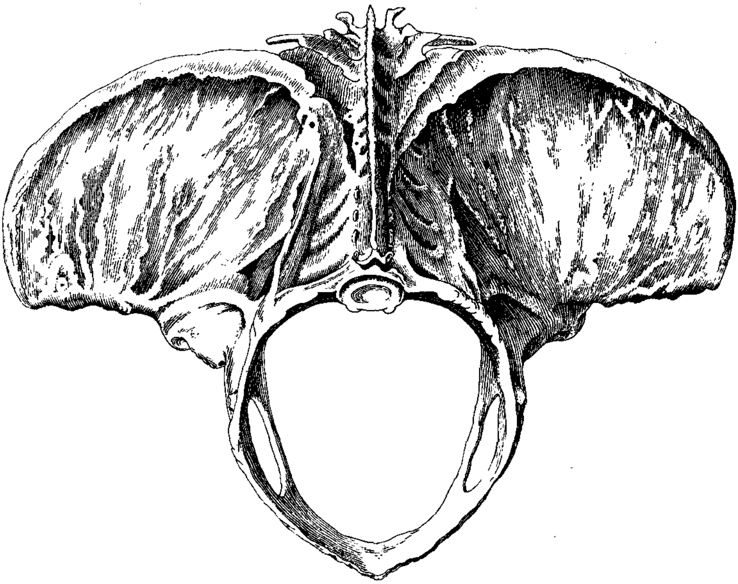


FIG. 16. *Mylodon robustus*. View of pelvis as seen from behind. $\times \frac{1}{11}$, nearly.

The pelvis of this animal is not yet well known. The last sacral bone has been mentioned above. Dr. Leidy seems to have had no part of the innominate bones for study. The pelvis was wholly lacking in the Henderson specimen and likewise in that found at Millersburg. Harlan (Med. and Phys. Res., p. 336, pl. XVI) mentions and figures an ilium that had been found in Big Bone cave, Tennessee; but he gave little description and no measurements. The pelvis in the restoration of the Millersburg specimen has been modeled probably after that of *Mylodon,* as figured by Owen. In this animal (Fig. 16) the ilium stands out at nearly right angles with the vertebral column, like that of an elephant, thus making the basin very shallow. In the *Mylodon* described by Owen, an animal about the size of the megalonyx, the greatest breadth of the pelvis was three feet five inches, 1,031 mm. As in the elephants, the acetabulum, for articulation with the head of the femur, looked nearly directly downward.

The femur (Fig. 17) of *Megalonyx jeffersonii*, as that of the other great ground-sloths, is a powerful bone. It is broad and flat,

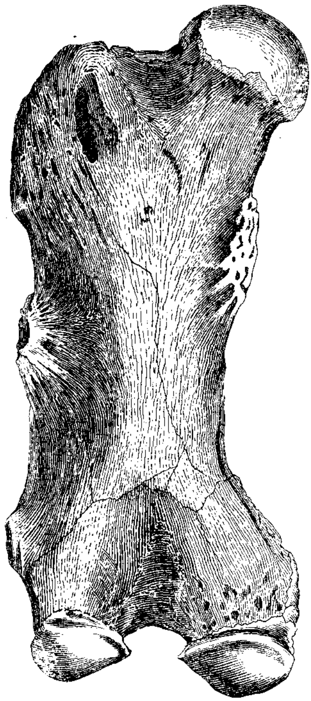


FIG. 17.

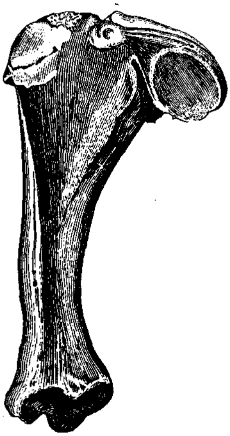


FIG. 18.

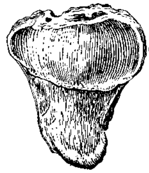


FIG. 19.

FIGS. 17–19. *Megalonyx jeffersonii.* × 1/6.
Fig. 17—Left femur seen from behind. Fig. 18—Left tibia seen from left side. Fig. 19—Patella, showing the hinder face.

with the head directed nearly upward. Both of the femora were rescued in the Henderson specimen, and both in that found at Millersburg. Figure 17 is taken from that furnished by Leidy. He gives the length as 21.5 inches, 546 mm., which agrees with my own measurement. The head of the bone has a diameter of 120 mm.; the breadth across the middle of the shaft is 180 mm.; and here the thickness is 62 mm. The breadth of the lower end, across the articular surfaces, is 260 mm.

The greater trochanter does not rise as high as the head. On the hinder face of this is a deep slit-like pit. The lesser trochanter is on the inner border of the bone, about 75 mm. below the head. On the outer border there is a tuberosity which represents the third trochanter. At the lower end there are two smooth surfaces for articulation with the tibia, and between these, more on the front of the bone, a smooth surface for the patella.

The tibiæ are both preserved in the Henderson specimen, and the left one in the Millersburg specimen. Figure 18 presents an outer view of the left one of the Henderson specimen. The tibiæ are short bones with relatively slender shaft and much expanded ends. The length of the bone is 310 mm., taken along the inner border; but the greatest length, taken obliquely, is 370 mm.; the greatest breadth at the upper end is 205 mm.; the greatest breadth of the lower end, 150 mm. At the upper end are articulatory surfaces for the femur, and on the hinder face of the outer extension of the bone, a surface for the fibula. At the distal end there is a surface 88 mm. wide for union with the astragalus, and another one, adjoining it on the outer side, forms an oblique surface for the end of the fibula. The tibia of the Millersburg specimen is 40 mm. longer along the inner border than the same bone in the Henderson megalonyx. The lower end is likewise wider, about 180 mm.

The patella is a triangular bone (Fig. 19), 125 mm. long and 100 mm. wide at the upper end. The broader end, on the hinder face, is occupied by a smooth surface for movement on the femur. The anterior face is convex and rough.

The fibula is a relatively slender bone, articulating above with the tibia, and below with both the tibia and the astragalus. The bone is not present in the Henderson specimen, but both the right and the left are in the Millersburg skeleton. The bone, in the middle of its length, stands out so as to leave a wide space between it and the tibia; but its enlarged lower end is bent inward so as to join the tibia by a surface looking upward and inward, and the astragalus by a large surface which looks inward. The bone is 350 mm. long; 87 mm. wide, fore and aft; at the upper end, 67 mm. transversely. Where slenderest the two diameters of the shaft measure 31 mm. At the lower end the fore and aft diameter is 87 mm.

Neither of the tarsi of the Henderson specimen is complete, and some bones are lacking from both; the right foot presented the astragalus, the external cuneiform, and the cuboid; the left foot furnished the calcaneum, the astragalus, and the navicular. Of the metacarpals there were the second of the left foot, and the fourth and fifth of both feet. Of the phalanges there were preserved the first and second of the third digit consolidated into a single bone, the claw phalange of the same toe, the claw phalanges of either the second or fourth toe of both feet; and the first phalange of the last toe.

It will be impossible here to describe all these bones. The reader will have to consult Leidy's monograph.

Neither are all the bones of the ankle and feet present in the Millersburg specimen. Both calcanea are represented, one astragalus, both naviculars, all four of the bones of the distal row of tarsals in the right foot, four metacarpals, and three ungual phalanges. On account of the manner of restoration of lost bones and parts of them it is sometimes difficult to decide between the real and the fictitious.

The extreme length of the hind foot, as shown in the Millersburg specimen, is 670 mm., nearly 27 inches. The presence of the

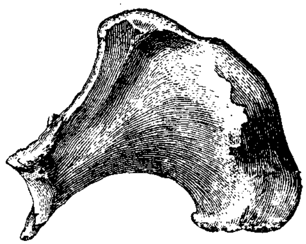


FIG. 20. *Megalonyx jeffersonii.* Left heel bone seen from left side × $\frac{1}{6}$.

internal cuneiform bone seems to indicate that the foot has been correctly restored with five digits.

The most remarkable bone of the foot is the heel-bone, the calcaneum. Figure 20, taken from Leidy, gives a view of the one of the left side seen from the outside. The broad end is directed backward in the position represented. This part is relatively thin. The anterior end of the bone is thickened, and is furnished with two smooth surfaces for articulation with the astragalus and a smaller one for union with the cuboid.

The fifth metatarsal has a process standing directly out from its outer edge, and this process, more than half as long as the body of the bone, is also broader than the rest of the bone. Probably the fifth digit had only two phalanges. The first was described by Leidy as a 4-sided nodule which had a smooth surface for the second phalange, which was not preserved.

The claw phalanges seem to have resembled closely those of the fore feet. Leidy figures the one of the third, or median, digit. The tip is missing. This phalange in the Millersburg specimen is 230 mm. long, along the upper curve, and the sheath at the base occupies nearly one-half of the length of the bone, being 108 mm. long above. It is likewise 105 mm. high and 60 mm. thick, from side to side. Where the core of the claw emerges from the sheath, it is 70 mm. high and 25 mm. thick below. The upper border is obtuse posteriorly, but becomes more acute towards the distal end.

As to the habits of these animals, it is certain that, like modern sloths, they devoured vegetable matter, probably the foliage of trees; but their more powerful teeth doubtless enabled them to crush and eat likewise the smaller branches. Their weight made it impossible for them to climb trees, but they were probably able to pull down trees of considerable size and possibly, in case of need, to uproot them.

Family MYLODONTIDÆ.

Ground-sloths with teeth i. $\frac{0}{0}$, c. $\frac{0}{0}$, m. $\frac{5}{4}$; the teeth of the upper jaw, especially the hinder ones, more or less triangular in section, with some of the sides concave; the front tooth usually planted near the second; the hinder tooth of the lower jaw larger than the others and with one or more wide grooves along its inner face, making the section lobate. Humerus with foramen above the inner condyle. Hinder feet with four digits.

Genus MYLODON Owen.

Skull rather elongated; snout longer and broader than in *Megalonyx*. Zygomatic arch interrupted. Front upper tooth not larger than the second. Fore foot with five digits; hind foot with four.

MYLODON HARLANI Owen.

This species is not well-known, for only scanty remains of its skeleton have up to this time been found. The species was based on a part of the right side of a lower jaw which was found many years ago, before 1831, at Big Bone Lick, Kentucky. The specimen is now probably at the American Museum of Natural History, having been a part of the collection of the Lyceum of Natural History of New York. Inasmuch as Big Bone Lick is separated from Indiana by only the Ohio River, it seems not unreasonable to describe the species here. Other meager portions of this animal have been found in various parts of the country. Among these are parts of the skeleton of a half-grown animal that were discovered near Natchez, Mississippi; a tooth found near Charlestown, S. C.; some bones and teeth found in Benton County, Missouri; a humerus and a tooth from Oregon, which, however, may belong to another species. Two other closely related species have been described from the Pleistocene of Louisiana and a third from the same epoch in Oregon.

FIG. 21. *Mylodon harlani.* Part of right side of lower jaw, showing the three hinder teeth and the socket of the front one. × ⅘.

Figure 21 represents a view of the fragment of a jaw found at Big Bone Lick. The jaw is seen from above, so that the forms of the crowns of the teeth are represented. The figure is four-fifths of the natural size. The length of the fragment is 210 mm.; the height, at the front of the hinder tooth, 84 mm.; the thickness, 37 mm. The figure indicates that the jaw from front to rear of the tooth-line was somewhat concave on the outside. There were originally, as in *Megalonyx*, four teeth in the jaw, but the front one was lost from its socket. The tooth-line measured 142 mm.

The size and form of the first, or front, tooth may be determined sufficiently well from the socket. A section of it is somewhat like that of a kidney. The long diameter is directed fore and aft and is 25 mm.; the transverse, 16 mm. The second has a section more irregular in form, somewhat quadrate, with rounded angles, and with the outer and the hinder sides concave. The long axis, oblique to the jaw, measures 29 mm.; the one at right angles to this, 20 mm. The third tooth also has its long axis oblique to the jaw, and measures 33 mm. The axis at right angles to the middle of the long axis measures 16 mm. The fourth tooth is much the larger of the teeth, having a length of 56 mm. Its section is constricted in the middle, indicating a broad groove on the inner side and another on the outer side, running the length of the tooth. This tooth is very characteristic of *Mylodon*. As to the other teeth, it will be observed that they are likely to have more concave sides than those of *Megalonyx*. Figure 22 represents a palatal view of the skull of *Mylodon* *robustus,* and a comparison of this with the same view of *Megalonyx* will show important differences. In *Megalonyx* the rows of teeth are nearly parallel with each other; in *Mylodon,* they converge backward. In *Megalonyx* the front tooth is the largest and is placed far in front of the next one; while in *Mylodon* the front one is small and not far removed from the second, and the hinder one is the largest. In *Megalonyx* the hinder tooth is near the middle of the length of the skull; in *Mylodon,* near the hinder end of the front third.

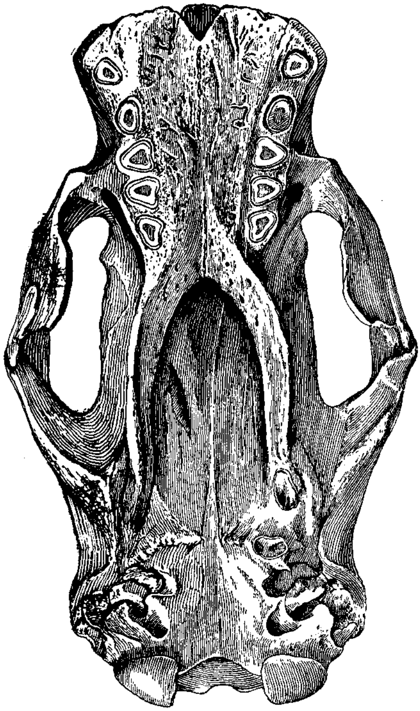


FIG. 22. *Mylodon robustus.* Shows the lower surface of the cranium and the palate. $\times \frac{1}{5}$.

Figure 22 shows the lower side of the skull, while Fig. 23 represents the lower jaw of *Mylodon robustus,* a species that once lived in Buenos Aires, South America. It will be observed that the teeth resembled closely those of the North American species, but that there were nevertheless differences. Figure 23 shows also the spout-like form of the front of the jaw.

In 1843 Harlan described some parts of the skeleton of this species under the name of *Orycterotherium missouriense* (Amer. Jour. Sci., XLIV, p. 69, pls. I-III). These had been found in Ben-

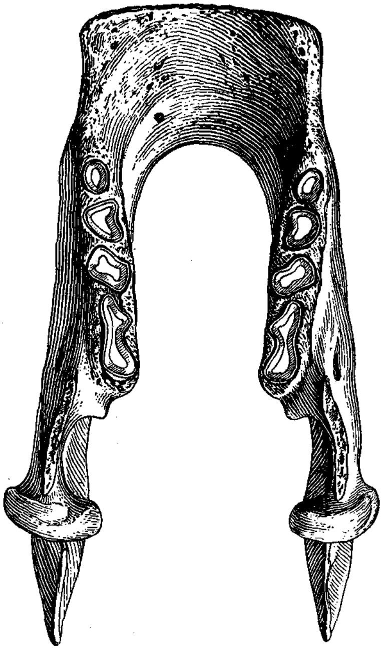


FIG. 23. *Mylodon robustus.* Lower jaw, seen from above. × $\frac{1}{5}$.

ton County, Missouri, by Albert Koch. Among these remains was one humerus. A copy of this rather crude drawing furnished by Harlan, is here presented (Fig. 24). The humerus had exactly

FIG. 24. *Mylodon harlani.* Humerus, after Harlan. × $\frac{1}{7}$, nearly.

the length of that of the megalonyx described and figured by Leidy, 20 inches (508 mm.). In the *Megalonyx*, the diameter across the condyles is 10.5 inches; in the *Mylodon*, it is 11 inches. In *Megalonyx* the shaft is much slenderer than in *Mylodon;* the diameter of the former, at the middle, being 3.25 inches (82.6 mm.); in the latter, five inches (128 mm.). The humerus of *Mylodon* has no foramen just above the inner condyle, while *Megalonyx* does have the foramen. Another large bone of *Mylodon* described by Harlan is the ulna. Compared with that of *Megolonyx*, it is shorter and a

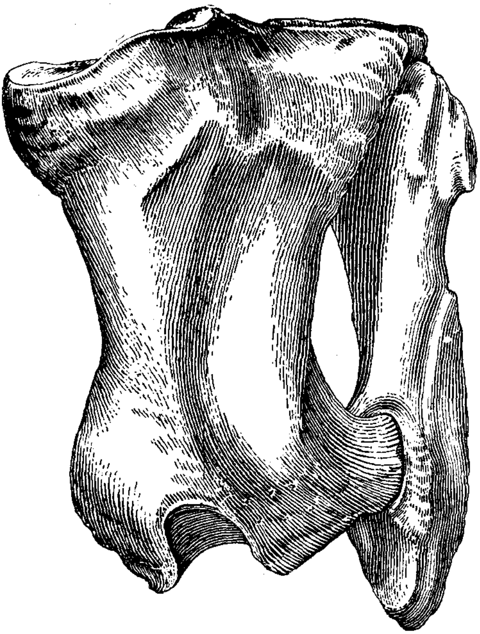


FIG. 25. *Mylodon robustus*. Left tibia and fibula, seen from in front. × ⅓.

stouter bone. Its total length was 16 inches (406 m.). According to Harlan's figure and his measurements, the distance from the coronoid process to the hinder end of the bone was a little more than .4 the whole length of the bone, while in *Megalonyx* this distance is only about .3 the length of the bone.

Harlan had also two tibias, and these contrast strongly with the same bone in *Megalonyx*, being much shorter and thicker. It agreed closely with that of the South American *Mylodon robustus*, of whose tibia and fibula a figure is here shown copied from Owen (Fig. 24). This was only 8.5 inches long. The larger tibia described by Harlan, had a length of 10½ inches (255 mm.); while the diameter at the middle of the shaft was one-fourth that of the length. In *Megalonyx* the tibia described by Leidy is a little over 13 inches (335 m.) in length, measured along the axis of the shaft; the diameter at the middle of the shaft is about one-fourth the length.

There were four claws in the collection examined by Harlan; but his figures do not give one a clear idea of the details. They seem to

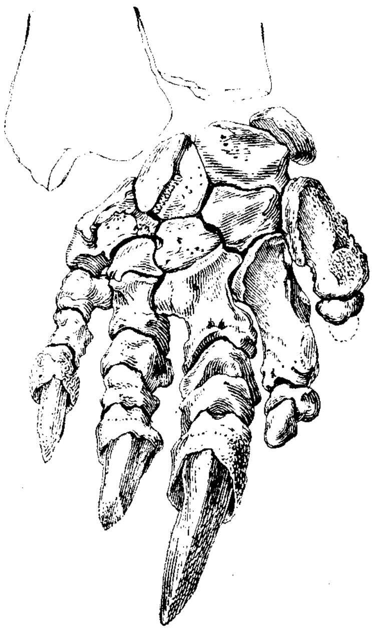


Fig. 26.

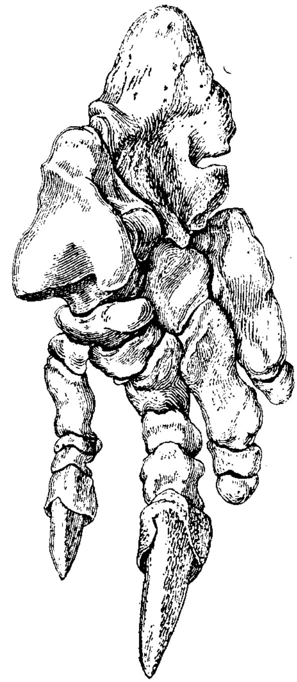


Fig. 27.

Figs. 27, 28. *Mylodon robustus*. Front and hind feet of left side; upper view. $\times \frac{3}{16}$.
Fig. 27. Forefoot. Fig. 28. Hind foot.

have been straighter than those of the *Megalonyx* and smaller. They appear, too, to have been less acute along the upper border of the core of the claw than in *Megalonyx*. Figures 26 and 27 give views of the fore and hind feet of *Mylodon robustus*.

It is evident that the fore-arm and the lower part of the hinder legs of *Mylodon* were shorter and heavier than in the case of *Megalonyx*.

Mylodon harlani resembled closely *Mylodon robustus*, but there were specific differences between them.

Megatherium is a genus of ground-sloths which was represented in North America during the Pleistocene; but no remains of it have been found in Indiana. It is known from South Carolina, Georgia, and Texas. Harlan states that remains belonging to it were found with *Mylodon* in Benton County, Missouri; but he does not state what parts of the skeleton were found.

Superorder MONODELPHIA.

This group includes all the Mammalia that are known to have lived in North America since the Tertiary times, except the opossums. With the exception of the Sirenia (manatees) and the Cetacea (whales, porpoises and dolphins), which inhabit the sea, the teeth are differentiated into four sorts, the incisors, the canines, the premolars, and the molars. The typical number is 44; that is, 11 in each side of each jaw, except in the Cetacea. The tooth formula, when all the teeth are present, is i. $\frac{3}{3}$, c. $\frac{1}{1}$, pm. $\frac{4}{4}$, m. $\frac{3}{3}$. However, the number of each kind may be reduced, even wholly suppressed; although all are never so, at the same time, except in the whalebone whales. In most of the groups the incisors, the canines, and the premolars, are preceded by what are known as milk teeth.

There are other characteristics which distinguish this great group from the Didelphia, but they need not be enumerated here.

Order UNGULATA.

THE HOOFED MAMMALS.

This order contains herbivorous animals whose feet, front and hinder, are developed for walking, and whose toes end in a hoof-like covering. There is a set of milk teeth which are retained until the animal reaches its maturity. The molars, and often the premolars, have broad crowns which are tuberculated, or variously ridged. Clavicles are not present. Sometimes, as in the swine-like forms, the diet may be of a mixed nature, animal matter not being rejected, and the teeth are modified for its preparation; but even in such cases, the bulk of the diet is of vegetable origin. As the superorder is here accepted, it is divided into two suborders, the Perissodactyla and the Artiodactyla.

Suborder PERISSODACTYLA.

Tapirs, Horses, Rhinoceroses, etc.

Ungulata which have the middle digit of all the feet most strongly developed; astragalus with the distal end flat; fibula usually not articulating with the heel-bone; femur with a third trochanter.

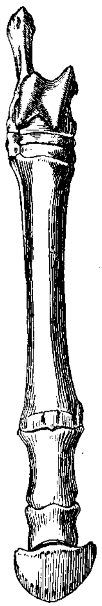


Fig. 28. *Equus caballus.* Right hinder foot of the domestic horse. × ⅛.

This group, or suborder, of hoofed animals is represented today by only the horses, the tapirs, and the rhinoceroses; but during Tertiary times there existed a host of related forms. The group may therefore be looked upon as a decadent one.

The characters which especially distinguish the animals of this suborder from other Ungulata is the relatively large size of the third or middle toe. In all specimens, fossil or living, the first toe is missing; in nearly all, the fifth also. Among living genera the tapirs have the fifth present in the fore feet, but it is much reduced in size; the middle toe is, however, much larger than any of the others. In the living and in the Pleistocene horses only the middle digit is present, but remnants of the second and fourth toes exist in the form of splintbones. Figure 28 represents the right hind foot of the domestic horse.

In all the Perissodactyla the femur has an outstanding process, the third trochanter on the outer side of the bone. That ankle bone on which the shin bone rests, the astragalus, is semicylindrical at the upper end, with a deep furrow, while the lower end is cut off squarely.

Family EQUIDÆ.

The Horses and Horse-like Ungulates.

Teeth $\frac{3}{3}$, $\frac{1}{1}$, $\frac{4}{4}$ or $\frac{3}{3}$, $\frac{3}{3}$; the cheek-teeth in the older forms low-crowned, in the most recent, high-crowned; the upper molars showing on the unworn grinding surface two outer, two inner, and two intermediate cusps, each inner cusp joined to the corresponding intermediate by an oblique ridge. The worn molars showing an internal column (protocone) and two inner crescents separated from two outer crescents by two "lakes" of cement; lower molars with two outer crescents, two inner cusps, and an inner median column (mesostylid). The premolars, except the first, of the higher genera, becoming molariform. Incisors chisel-like; the canines and first premolars often wanting, especially in the females.

The numerous relatives of the domestic horse that belong to other genera than *Equus* and which are now extinct need not be described here. It suffices only to say that as we go further and further backward in Tertiary times the species and genera lose gradually the distinctive characteristics of our horses. The feet come to have three functional toes, and the whole foot becomes shorter. The teeth come to have shorter and shorter crowns, the enamel is less complicated in its disposition, and the premolar teeth come to resemble less and less the true molars. The animals have no longer the great size of our horses; and the earliest forms may be no larger than a fox.

Of this family there have been found in the Tertiary deposits of North America a dozen or more genera and many species; but of these only *equus* and *Neohipparion,* so far as we now know, came into the Pleistocene.

Genus EQUUS Linn.

The True Horses.

Teeth high-crowned and prismatic; premolars like the molars; in the upper jaw the inner loop (protocone) attached by a slender neck to the anterior inner crescent. Feet each with only one digit.

Of the genus *Equus,* about a dozen species are known from the Pleistocene of North America, north of Mexico. At some time during the Pleistocene horses occupied the country from the Atlantic Ocean to the Pacific, and from the Great Lakes to the Gulf of Mexico and far down into Mexico. Even in Alaska their remains are not uncommon. Unfortunately, many of the species are known to us from their teeth only and, in many cases, the teeth of different species resemble one another so closely that it is difficult to distinguish the species from one another and from the domestic horse. The finding of bones of fossil horses, especially whole skeletons, or large parts of them is greatly desired.

Inasmuch as few bones of fossil horses have been found in Indiana, no attempt will be made here to describe the skeleton minutely. If bones have been found that are suspected to be those of a fossil horse, they may be compared with those of the domestic horse. Even in country localities, bones of this animal may usually be found for comparison. Figure 29 represents the skeleton

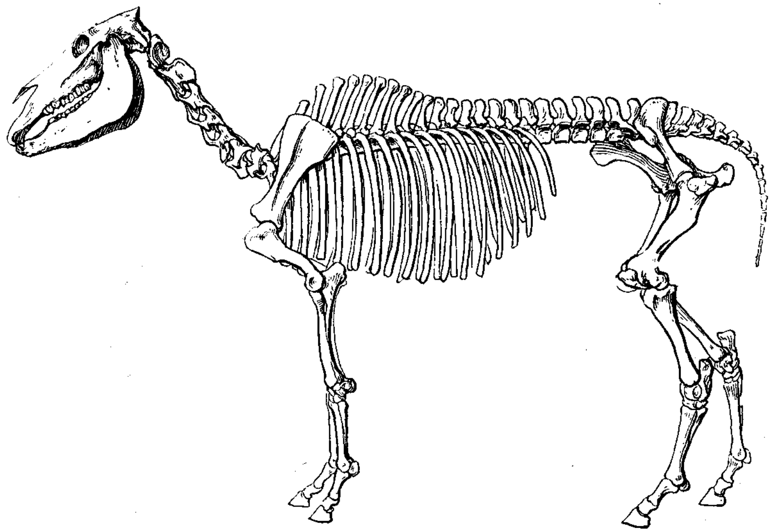


FIG. 29. *Equus scotti.* View of restored skeleton. After Gidley's illustration.

of a fossil horse *Equus scotti.* The drawing has been prepared from a figure published by Gidley. It differs only slightly from the skeleton of the domestic horse.

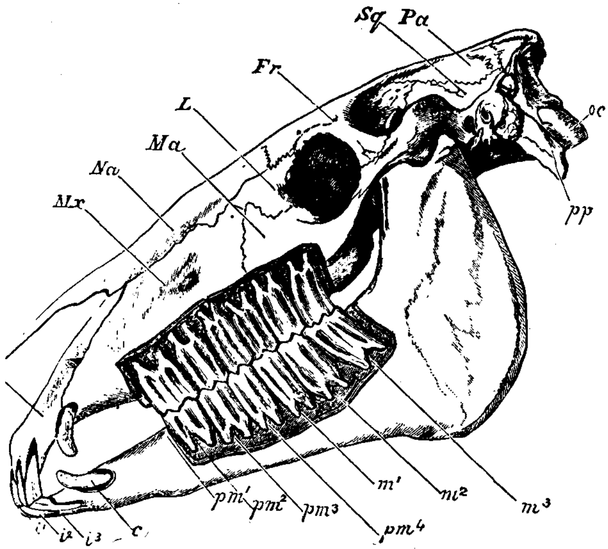


FIG. 30. *Equus caballus.* Side view of the skull of the domestic horse. *c*, canine; i^1, i^2, i^3, the incisor teeth, upper and lower; *Fr*, frontal bone; *L*, lachrymal; m^1, m^2, m^3, the molars, upper and lower; *Ma*, malar; *Mx*, maxilla; *Na*, nasal; *Oc*, occipital condyles; *Pa*, parietal; pm^1, pm^2, pm^3, the premolars, upper and lower; *pp*, paroccipital process. The lower first premolar is missing.

Figure 30 represents a side view of the skull of a horse. In this the bone has been cut away, so that the cheek-teeth may be seen in their full length. Of these great teeth there are six on each side of each jaw. All except the one in front and the one behind are long and nearly square prisms. A small first premolar is represented in this figure, but it is often absent.

Figure 30a reproduced from Gidley's illustration, shows the appearance of the grinding face of the upper teeth of *Equus scotti*. These and other figures show how complicated is the pattern assumed by the enamel of the teeth in horses, and the relatively small differences seen among the various species.

Figures 32, from Gidley, is lettered to show the various regions of the teeth, as seen on the worn face. The regions marked *pr.*, *pa.*, *me.*, *hy.*, *pl.* and *ml.* were, before the tooth began to wear down, projecting cusps. The space below *me.*, surrounded by the irregu-

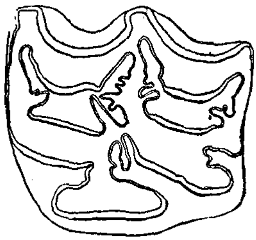


FIG. 30 *a*. *Equus scotti*. Left first upper molar.

lar wall of enamel in the worn tooth forms a "lake" of cement; that below *pa.*, forms another.

The three hinder premolars have, in the horses, assumed the form and structure of the true molars so thoroughly that they are almost indistinguishable from them. They are, however, slightly larger and the column at the outer anterior angle is a little broader and is somewhat channeled the whole length of the tooth. The hinder true molar is smaller than the others and its hinder border is not so squarely cut off as in the case of the other teeth. The second premolar (the anterior of the three so far considered), is the largest tooth and the anterior end of the grinding face is pointed. In front of this tooth there may sometimes be found a very small first premolar. It is the "wolf tooth" of veterinarians.

Far in front of the premolars are located the incisors, six in number (Figure 31). When not too much worn they display on the grinding face an outer and an inner ring of enamel. Within the inner ring is a cavity, the "mark" of veterinarians. At some distance behind the incisors a canine tooth may occur, but it is often missing.

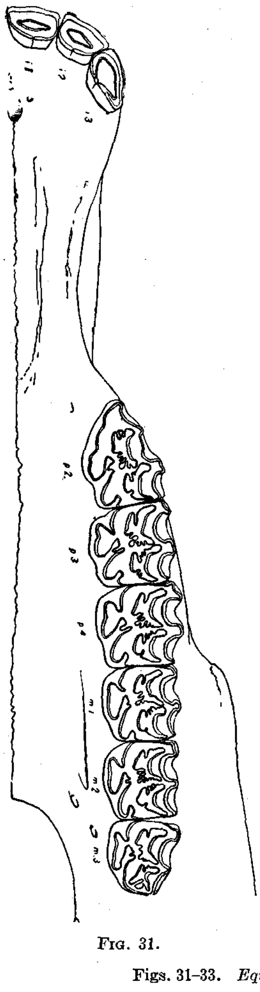


Fig. 31.

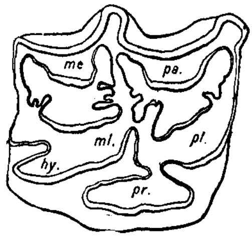


Fig. 32.

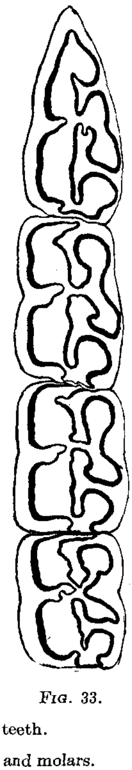


Fig. 33.

Figs. 31–33. *Equus;* the teeth.

Fig. 31. Palate, to show positions of incisors, premolars and molars.

Fig. 32. A right upper molar, to show the grinding surface. The outer face of the tooth is above; the front face to the right; *hy.*, hypocone; *me.*, metacone; *ml.*, metaconule; *pa.*, paracone; *pl* paraconule; *pr.*, protocone.

Fig. 33. Three premolars and the first molar of the left side of the lower jaw of a fossil horse from Idaho. The enamel shown by the heavy black lines.

The inferior molars (Fig. 33) are much narrower than are the upper ones, being nearly twice as long fore and aft as wide. The lower premolars also have the form and structure of the true molars, but are usually slightly larger. The hinder true molar is pointed behind, the second premolar is pointed in front. The first premolar is usually missing. There are six incisors and a pair of canines, the latter sometimes not developed.

The three hinder premolars, both above and below, are preceded by milk teeth, which have general structure of the permanent teeth but have a smaller transverse diameter; although the fore and aft diameter may be even greater than in the adult horse.

It may be desirable sometimes to identify and determine the position of teeth of the horse. They may be known from the teeth of other animals by a peculiar arrangement of the enamel walls. If the teeth have the grinding face nearly square, they belong to the upper jaw; if they are nearly twice as long on the worn face as broad, they are to be assigned to the lower jaw.

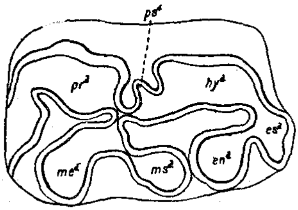


FIG. 33*a*. *Equus*. Right lower molar, enlarged from Osborn's figure. × 1⅓. *en*^{d}, entoconid; *en*^{d}, entostylid; *hy*^{d}, hypoconid; *me*^{d}, metaconid; *ms*^{d}, mesostylid; *pr*^{d}, protoconid; *ps*^{d}, protostylid. The front end of the tooth is at the left, the outer face above.

In both jaws the outer border of the tooth has a continuous wall of enamel; this wall bending inwards at only two points in the upper teeth (Fig. 32) and in the lower teeth more deeply at the middle of the length (Fig. 33). The enamel of the inner border of both upper and lower teeth bends inward to the very center of the tooth. In the upper, there is one such inlet, which lies behind the loop of enamel marked *pr* in figure. This inlet, or valley, is directed outward and forward toward the center of the tooth.

In each lower tooth (Fig. 33) there is, on the inner border, a double loop of enamel (metaconid and mesostylid). In front of this, starting at the inner anterior angle of the tooth, is an inlet of enamel, filled with cement, that runs backward nearly to the center of the tooth. Behind the double loop of enamel is another inlet of enamel that runs forward nearly meeting the anterior one. Observations of these features will lead to the placing of the teeth in the proper jaw and on the proper side. In Fig. 33 the outer thin line represents the outline of the face of the tooth; the meandering thick lines the enamel. The space between the thin and the thick lines is occupied by cement. The area enclosed by the thick line is filled by dentine.

In the upper jaw the second premolar may be distinguished by its large size and pointed front end; the hinder true molar by its small size and its narrower hinder end. The other four teeth are more difficult to locate and it is not usually necessary to do so. These same observations apply to the lower teeth.

There appear to be pretty well established ten species of the genus *Equus* that were inhabitants of the United States during the Pleistocene; although a number of others have been named. Much better materials of nearly all the species must yet be found and studied before our knowledge will be satisfactory.

Inasmuch as no authentic specimens of fossil horse remains have been reported from any deposits overlying the latest sheet of drift, the Wisconsin, the writer believes that at least in that region, so well fitted for the mammoths, the mastodon, peccaries, and the giant beaver, there existed no species of horse. It, further, seems extremely doubtful whether any remains of a fossil horse have been found in any late Pleistocene deposit in the region outside of that occupied by Wisconsin drift. However, future investigations must settle this question.

EQUUS COMPLICATUS Leidy.

This species of fossil horse was described in 1847 by Joseph Leidy under the name of *Equus americanus,* but this name had already been employed for a species of fossil horse found in South America. Therefore, Leidy, in 1858, chose for his species the specific name *complicatus.* The materials used by Leidy consisted of 12 teeth that had been discovered at Natchez, Mississippi. In 1901 Gidley selected as the type of the species the tooth which Leidy had figured.

This species has been reported from many States and even from Alaska; but the determinations cannot always be relied on. Teeth certainly belonging to this horse have been found at Big Bone Lick, on the Kentucky side of the Ohio River, about 20 miles below Cincinnati, in a straight line. Also a jaw was found many years ago in Illinois, about 75 miles northeast of St. Louis. In 1854 Leidy reported that he had examined some bones and teeth of various animals that had been found near Evansville, Indiana, and that among these bones was found the last dorsal vertebra of a horse. Whether or not this had belonged to *Equus complicatus* we cannot be certain; but since no other species has been found in the same region, the vertebra probably belonged to the one here described. With this bone there were found remains of a bison supposed then to be the one now living, but more likely to belong

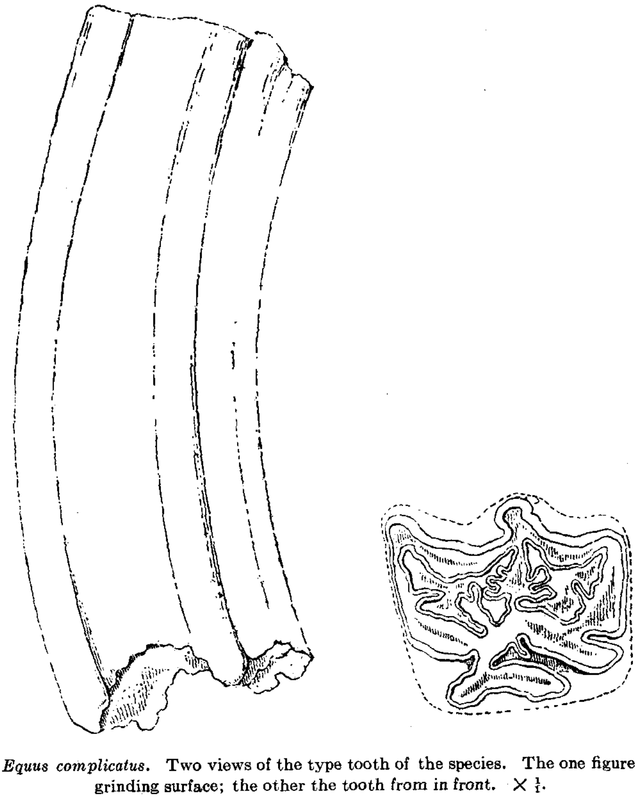


FIG. 34. *Equus complicatus.* Two views of the type tooth of the species. The one figure shows the grinding surface; the other the tooth from in front. × ½.

to some extinct species. There were also remains of the white-tailed deer *Odocoileus virginianus,* of the extinct tapir *Tapirus haysii,* of the megalonyx *Megalonyx jeffersonii* and of the dog, *Canis dirus.* It is very probable that all these were animals that had been buried there before the Wisconsin glacial stage. Figure 34 presents a front view of the tooth which has been chosen as the type of this species. The tooth is one of the true molars of the left side, probably the second one. The tooth is larger than the same tooth usually is in the common horse; but not larger than that of some large draught-horses. The height of the tooth in a straight line is 96 mm.; but it must be recollected that the height varies with the amount of wear. The length of the tooth, that is, its fore and aft extent, is 30 mm.; its transverse width is 27 mm. On observing the enamel wall that surrounds the two "lakes" it will be seen that this follows a very tortuous course; and this complication is what especially characterizes this horse, it being only rarely that teeth of this size have such strongly crimped enamel. In volume XXXIV of the Proceedings of the American Philosophical Society, pl. XI, Fig. 8, is represented a palatal view of a part of an upper jaw that was described by Cope and which was found at Petite Anse, in southern Louisiana. It can hardly be doubted that the jaw belonged to *E. complicatus*. Five teeth are represented, the third and fourth premolars and the three molars of the right side. It will be observed that the enamel is nearly as complicated as in the type tooth. The length of the row of five teeth, in a straight line, is 143 mm.; that of the three molars is 86 mm. The individual teeth measure as follows:

MEASUREMENTS OF CROWNS OF UPPER TEETH.

TOOTH.	Length of Grinding Face.	Width of Grinding Face.	Protocone.
Pm. ^{3}	30	31	15
Pm. ^{4}	29	30	18
M. ^{1}	26	29	16
M. ^{2}	28	27	15
M. ^{3}	34	23	16

Professor Cope's measurements are somewhat different, but he probably included the cement.

A considerable quantity of bones and teeth of this species have been found, especially in Louisiana, but it is to be regretted that not enough of the skull is yet known to enable us to characterize properly the species. While differences between the known bones and those of the common horse seem to exist, more and better materials are needed and a more detailed examination of them.

The jaw above mentioned as having been found in Illinois shows that the canine tooth was placed 82 mm. in front of the small first premolar. In a large specimen of the domestic horse examined this tooth is placed only 70 mm. in front of the premolar.

Leidy described five lower cheek-teeth from Petite Anse, La., which probably belong to this species, but they did not belong probably to the same individual. The following measurements of four of these teeth are here presented.

MEASUREMENTS OF CROWNS OF LOWER TEETH.

Tooth.	Length.	Width.
Pm. $_{\overline{3}}$	34	18
Pm. $_{\overline{4}}$	31.5	18
M. $_{\overline{1}}$	28	16
M. $_{\overline{2}}$	28	16

It will be seen that in length these teeth agree with those of the upper jaw of *E. complicatus*. Figure 35 represents the third

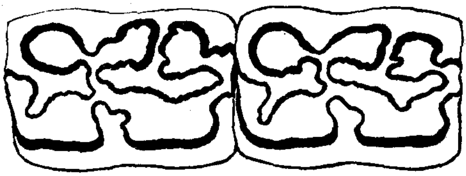


FIG. 35. *Equus complicatus*. View of the grinding surfaces of two left premolars. × $\frac{1}{1}$.

and fourth left premolars. In none of these cheek-teeth does the inlet of enamel from the outer face of the teeth press itself in between the contiguous ends of the two long bays which occupy the middle of the tooth. In some of the lower teeth of the common horse (molars) and of some of the extinct species, the outer inlet reaches to the middle of the tooth.

The limb bones, supposed to belong to *E. complicatus*, indicate a horse fully as large as the common horse, perhaps larger.

Family TAPIRIDÆ.

Heavily built and short-limbed Perissodactyla, with compressed skull. Teeth, i. $\frac{3}{3}$, c. $\frac{1}{1}$, pm. $\frac{4}{4}$ or $\frac{3}{3}$, m. $\frac{3}{3}$. Cheek-teeth short-crowned, the grinding surface crossed by two prominent ridges. In the upper jaw the two ridges of each tooth connected at their outer ends by a wall of enamel. Forefeet with four digits; the hinder ones, with three.

The tapirs of the present day inhabit two widely separated regions, tropical America and tropical Asia. Formerly, however, genera belonging to the family occupied large parts of both North America and Europe. The earliest known forms belong to the

Lower Eocene of both North America and Europe. The genus *Tapirus* is known first in Europe in the Miocene; in North America in the Pleistocene. Probably therefore it migrated hither from Europe by the way of Eastern Asia and Alaska. Figure 36 represents the right forefoot of the existing tapir; while Fig. 37 shows the structure of the right hind foot.

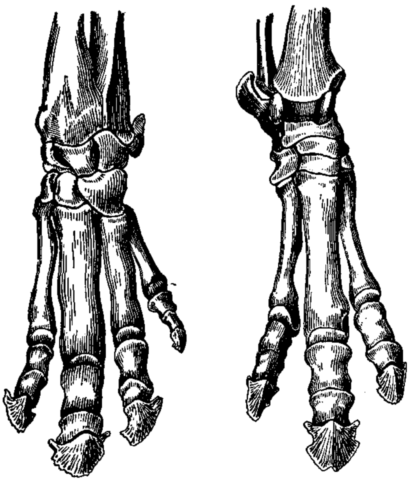


FIG. 36. FIG. 37.

Figs. 36, 37. *Tapirus*. Right fore and hind feet. *Fig.* 36, *forefoot*. *Fig.* 37, *hind foot*. Reduced.

Genus TAPIRUS Brisson.

Tapirs having a short flexible proboscis. Teeth, i.$\frac{3}{3}$, c.$\frac{1}{1}$, pm.$\frac{4}{3}$, m.$\frac{3}{3}$; the front lower premolar not present. The transverse crests of cheek-teeth crossing the crown perpendicularly to the axis.

Two species of fossil tapers have been accredited to the United States. One of them is believed to be the species *Tapirus terrestris* living now in the forests of South America; the other extinct species *Tapirus haysii*. The latter differs from the former in having teeth and probably skeleton of somewhat greater size. Although the smaller species cannot, by means of the scanty materials known, be distinguished from the South American tapir, it is probably, as Leidy long ago expressed his opinion, really a distinct species that no longer exists. Cope, in the last paper that he published, expressed the view that all remains of tapirs found fossil in the eastern United States belonged to *Tapirus haysii*. The solution of this problem must be left to the future.

TAPIRUS HAYSII Leidy.

Although Leidy had previously mentioned by this name the species here considered, it was not until 1860 that he described and

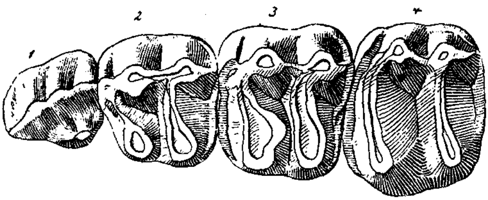
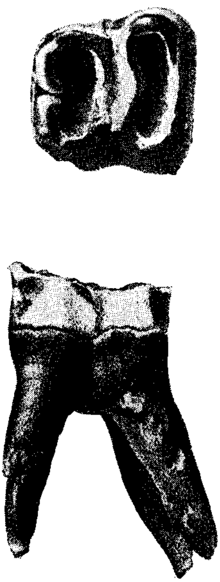


FIG. 37 *a*. *Tapirus terrestris*. Upper left promolars. $\times \frac{1}{1}$.

figured it in Holmes' Post-pliocene Fossils of South Carolina, page 106, pl. XVII, Figs. 7 and 8. The type is a single lower molar tooth, probably m.$_{\overline{2}}$, that was supposed to have been found at Big Bone Lick, Kentucky. This tooth is in the Academy of Natural Sciences, at Philadelphia. It is described as having a length of 12½ lines (26 mm.) and a width of 10¼ lines (21.3 mm.), being thus somewhat larger than those of the South American species. The corresponding tooth of a Brazilian tapir at hand measures only 23 mm. in length and 18 mm. in width. Leidy, in the same paper, describes and figures a lower molar that had been found on the banks of the Ohio River, near the mouth of Pigeon Creek, just below Evansville, Indiana. On this, up to the present, rests the claim of Indiana to having once been inhabited by tapirs. Two figures are here given of this tooth (Figs 38 and 39). It had been found by Mr. Francis A. Lincke and had been sent to Leidy by Dr. J. G. Norwood, the geologist. It is not known where this tooth now is.



FIGS. 38 AND 39. *Tapirus haysii*. Side and upper views of the type tooth. $\times \frac{1}{1}$.

Plate II represents, half the natural size, the upper and the lower jaws of a tapir which was found with a vast lot of bones and teeth of about 60 species of mammals, in Port Kennedy cave, a few miles from Philadelphia. The teeth were well preserved but the bones were very fragile, and the whole skull had been badly crushed. The incisors and the canine teeth are not well shown. The upper jaw is on the left; the lower on the right in the plate.

PLATE II.

Tapirus haysii. Upper and lower jaws. × ½.

The following are the measurements of these teeth:

Upper Teeth.			Lower Teeth.		
Teeth.	Length of Crown.	Width of Crown.	Teeth.	Length of Crown.	Width of Crown.
Pm. ^{1}	21	20	Pm. $_2$	26	18
Pm. ^{2}	20.5	26	Pm. $_3$	24	24
Pm. ^{3}	22.5	26	Pm. $_4$	25	26
Pm. ^{4}	26	28	M. $_1$	29	21
M. ^{1}	25	28	M. $_2$	31	22
M. ^{2}	26	31.5	M. $_3$	31	21
M. ^{3}	28	32			

The distance from the canine to the front of pm. ^{1} is 50 mm. In the lower jaw the distance between the two teeth is 69 mm. The length of the lower premolar-molar series, obtained here by adding the lengths of the various teeth, is 166 mm.; the premolar series, 75 mm.; the molar series, 91. In like manner the length of the upper premolar-molar series is 170 mm.; the length of the premolar series, 89 mm.; that of the molar series, 81 mm.

There are on each side of each jaw three incisors and a canine. In the lower jaw the distance from the canine to the first premolar present (pm. $_{\overline{2}}$), is 50 mm. The depth of the jaw at the hinder molar, is 68 mm. In the upper jaw this distance, the diastema, is 50 mm. It is to be noted that in the upper jaw the first premolar is present, while it is absent in the lower jaw.

This species has been reported from eastern Pennsylvania, Virginia, Tennessee, South Carolina, Mississippi, Kentucky, Indiana and Texas. It had therefore a wide range. Professor Cope stated (Jour. Phila. Acad., Vol. XI, 1899, p. 253) that some part of a tapir had been found near Richmond, Indiana; but the present writer has been unable to learn on what authority this statement was made. If we leave out of the account this very doubtful find, we may observe that no tapir remains have been discovered above the Wisconsin drift. From this the provisional conclusion may be drawn that the tapir or the tapirs that had once inhabited this region had either become extinct or had been driven out of the drift region and did not return.

The smaller form of tapir, referred to *Tapirus terrestris* has been reported from Pennsylvania (with doubt), Ohio, South Carolina, Florida, Louisiana and Texas. In size of its teeth it agrees more closely with the South American form than with *T. haysii;* although there seem to be teeth intermediate in size. To enable comparisons to be made the following measurements were taken from a specimen of *T. terrestris* from Brazil:

MEASUREMENTS OF TEETH OF *Tapirus terrestris*.

Upper Teeth.			Lower Teeth.		
Teeth.	Length of Crown.	Width of Crown.	Teeth.	Length of Crown.	Width of Crown.
Pm. ^{1}	17	15	Pm. $_2$	22	16.5
Pm. ^{2}	17.5	19	Pm. $_3$	20	16
Pm. ^{3}	20	22	Pm. $_4$	21	17
Pm. ^{4}	20	25	M. $_1$	21.5	17
M. ^{1}	21	24	M. $_2$	22.5	18
M. ^{2}	22	17	M. $_3$	23	18
M. ^{3}	22	26	....	....	....

Length of whole upper premolar-molar series, 137 mm.; of the premolar series, 74 mm.; of the molar series, 66 mm. The length of the lower premolar-molar series is 131 mm.; of the premolar series, 63 mm.; of the molar series, 66 mm. The distance between the third incisor and the first premolar in the upper jaw is 46 mm. In the lower jaw the diastema is 58 mm. It will be observed that these measurements differ markedly from those of the Port Kennedy specimen of *Tapirus haysii.*

Suborder ARTIODACTYLA.

THE EVEN-TOED HOOFED MAMMALS.

Hoofed mammals with the third and fourth digits of each limb equally developed. Second and fifth digits more or less reduced, sometimes ending in hoofed phalanges, sometimes wholly missing. Presacral vertebræ always 19. Femur without third trochanter, the astragalus with a grooved trochlear surface for the tibia and another for the navicular and cuboid. Fibula articulating with the calcaneum. Teeth variously modified; sometimes in full number, 44; sometimes with some of those in front of the second premolar wanting.

The Artiodactyla include, besides a considerable number of extinct families, the swine, the hippopotami, the camels, the deer, the giraffes, the antelopes, the sheep, the musk-oxen, the goats, and the oxen. All the continents have been occupied by members of the group; but Australia only through recent introduction by man. The oldest forms are found in the Lower Eocene. In the Upper Eocene and succeeding epochs the group is represented by increasing numbers.

As to their food habits, all nourish themselves on vegetable material; but some of them, as the swine, do not refuse animal matter.

In the Pleistocene of North America the following superfamilies are represented: Suoidea (pig-like ungulates), Tylopoda (camels), and Boöidea (deer, sheep, goats, and oxen).

Superfamily SUOIDEA.

The Hogs and Peccaries.

Even-toed ungulates with usually four functional digits in each foot; but in the recent peccaries there are only three in the hinder feet; and in *Platygonus* there are only two in each of the feet. Tooth formula, i. $\frac{2}{3 \text{ or } 2}$, c. $\frac{1}{1}$, pm. $\frac{4 \text{ to } 2}{4 \text{ or } 3}$, m. $\frac{3}{3}$. The molars furnished with four conical cusps and sometimes with more or less numerous intermediate cuspules. Canines usually large and trenchant.

Although remains of true hogs, Suidæ, have been reported from the Pleistocene deposits of the United States, the remains have probably in all cases belonged to the introduced domestic swine. On the other hand, the peccaries are numerously represented.

Family TAYASSUIDÆ.

The Peccaries.

Hog-like ungulates, with two or four digits in the forefeet and two or three in the hinder. The third and fourth metacarpals and metatarsals coössified at the upper end. Tooth formula, i. $\frac{2}{3 \text{ or } 2}$, c. $\frac{1}{1}$, pm. $\frac{3}{3}$, m. $\frac{3}{3}$. Lower incisors directed forward, the upper ones downward. Canines large, the upper ones with hinder border sharp; the lower ones with the anterior border subacute. Molars with four principal cones and often with intermediate cuspules and tubercules.

Analysis of Genera Here Described.

1 One premolar or none like the molars; cusps short and conical; diastema between canine and premolar not one-half the length of the premolar-molar series, and palate here wider than diastema. *Tayassu.*

2. No premolars like the molars; cusps high and those of each pair forming a crest across the tooth; diastema about two-thirds premolar-molar series; the palate here nearly as wide as length of diastema. *Platygonus.*

3. Two or three premolars like the molars; cusps very much as in *Tayassu;* diastema about two-thirds the length of the premolar-molar series; palate here about one-half as wide as length of diastema. *Mylohyus.*

Genus TAYASSU Fischer.

(The genus *Dicotyles* of older authors.)

Peccaries with four digits in front, three behind. Metatarsals 3 and 4 coössified in the upper half. Teeth, i. $\frac{2}{3}$, c. $\frac{1}{1}$, pm. $\frac{3}{3}$, m. $\frac{3}{3}$. Molars with four low cones and weak accessory conules. The cones of each pair separated by a longitudinal valley. Lower molars like the upper but longer; the hindermost one with a well developed heel. Upper incisors directed downwards.

The members of this genus inhabit, at the present day, the region extending from the Red River of Texas, through Central and South America, to Patagonia. Several species have been established and these have been divided into two genera or subgenera, *Tayassu* and *Olidosus*. Certain fossil remains of a peccary, found at several localities in the United States, have been assigned to the living species, under the names *Dicotyles torquatus* and *D. tajacu;* but (as Leidy finally concluded) it is probably an extinct species. Hence, Leidy's specific name *lenis* is here adopted for it.

TAYASSU LENIS (Leidy).

Nothing that is to be referred with certainty to this species has been discovered as yet in Indiana; but remains assigned to it have been reported from South Carolina, West Virginia and Maryland. Hence, it is likely to occur within our limits. Only a brief description will be given. This is the peccary recorded in the author's Bibliography and Catalogue of the Fossil Vertebrates of North America, page 159, under the name *Tayassu tajacu.* Of course, some of the literature there cited refers to the living peccary.

Tayassu lenis was based by Leidy (Jour. Phila. Acad. 1869, vol. VII, p. 384) principally on two teeth that had been found near Charleston, South Carolina, and which had been described and figured in 1860 (Holmes' Post-Pliocene Fossils of S. C., p. 108, plate XVII, Figs. 13, 14). One of these teeth is the second, the other the third lower molar. Inasmuch as it is not wholly certain that both teeth belonged even to the same species, it seems best to choose as the type of *T. lenis* the third true molar. Judging from the figure this has a length of 18 mm. and a width of 12 mm. The same tooth in a specimen of *T. angulatum* from Mexico (the same species as the Texas animal), measures in length 17 mm. and in width across the anterior cones hardly 11 mm. The tooth of the living species measures across the second pair of cones not quite 10 mm.; the fossil specimen, 11 mm. The heel of the fossil tooth is broader than in the tooth of the living species considered here, and seems to consist of a single tubercle, instead of three. If we consider the second molar, we find its length 15 mm., width 13 mm.; whereas in *T. angulatum* these dimensions are respectively 13 mm. and 11 mm.

Other remains of a true peccary resembling some of those now living have been found in the lead region of Wisconsin, Iowa, and Illinois, but the locality is not clearly indicated; also, in Charles County, Maryland, and in Wythe County, West Virginia.

To this species the writer refers provisionally some jaws (with scanty remains of teeth) and bones that have kindly been sent by Prof. J. W. Beede of the State University of Indiana. The materials consist of a part of a left lower jaw with roots of the three premolars and the first molar. This fragment of jaw is greatly like the same part in a specimen of *Tayassu labiatum* from Costa Rica, but of slightly less height, 37 mm. below the first true molar, instead of 40 mm. The space occupied by the first true molar and the two premolars in front of it is 37 mm. long; in *T. labiatum* these teeth occupy only 35 mm. A fragment of the limestone deposit of the cave contained a part of another left ramus of the lower jaw, with a good first true molar and impressions of the succeeding molars (Plate IV, Fig. 2). This molar has short-coned cusps, intermediate tubercles, all much like those of the living peccaries. The length of the crown is 14 mm., the width, 12 mm. In the same cave were obtained a last upper molar and a part of a second upper molar that are here described under *Platygonus vetus*.

Professor Beede states that this material, together with some bones of probably a peccary but not yet worked out of the matrix, and most of the carapace of a box-tortoise, *Terrapene carolina*, were found in the stalagmitic deposit of an old cave that had been exposed in quarrying operations at the Rock Cliff quarry just northwest of Williams, in Lawrence County, Indiana. This place is southeast of Bedford. The cave had all been quarried away except one corner. This was from 20 to 30 feet below the surface at that point. Professor Beede says that the top of the cave must have been nearly on a level with the high terrace of White River, about 100 feet above the present level of the river.

Genus PLATYGONUS Le Conte.

Peccaries with moderately elongated snout. No premolars with more than one pair of cusps. Molars with the four primary cusps more strongly developed and the accessory cusps less developed

PLATE IV.

1

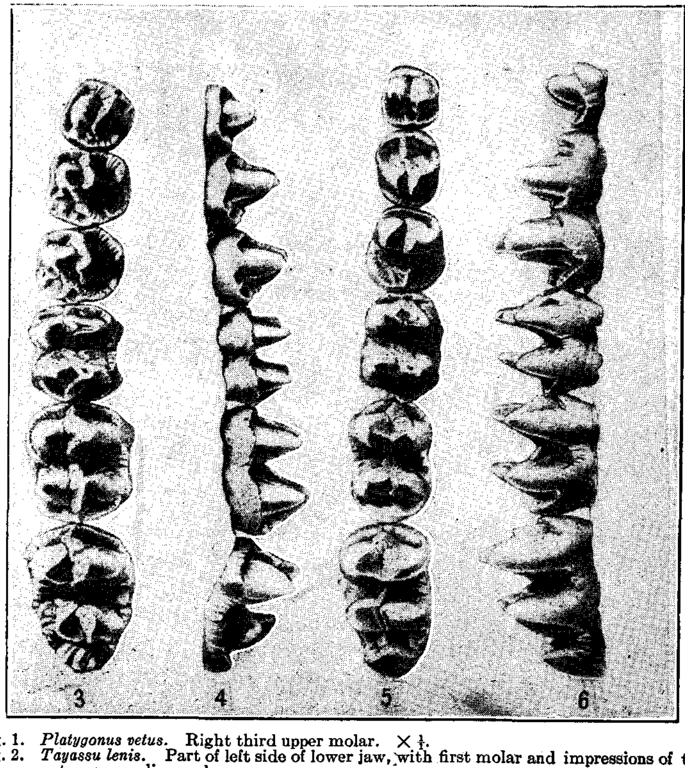


Fig. 1. *Platygonus vetus.* Right third upper molar. × ½.
Fig. 2. *Tayassu lenis.* Part of left side of lower jaw, with first molar and impressions of the two succeeding molars.
Figs. 3–6. *Platygonus compressus.*
Figs. 3, 4. Two views of the upper premolars and molars.
Figs. 5, 6. Two views of the lower premolars and molars.

than in *Mylohyus* and *Tayassu,* forming distinct cross-crests. Incisors two on each side of upper jaw; three on each side of the lower. All the feet with only two digits.

The type of the genus is *P. compressus,* the species described immediately below.

PLATYGONUS COMPRESSUS Le Conte.

This is, so far as yet known, the most widely distributed species of extinct peccary. Remains referred to it have been found in Illinois, Indiana, Ohio, Kentucky, New York, Missouri, Iowa, Kansas, and probably in Mexico. At Columbus, Ohio, a collection of 12 individuals were found, six smaller animals in one nest eight feet below the surface, and six larger ones about six feet away from the first lot and at a depth of 12 feet. The individuals of each nest were lying side by side and with their snouts pointing toward the southeast. These materials have never been adequately described.

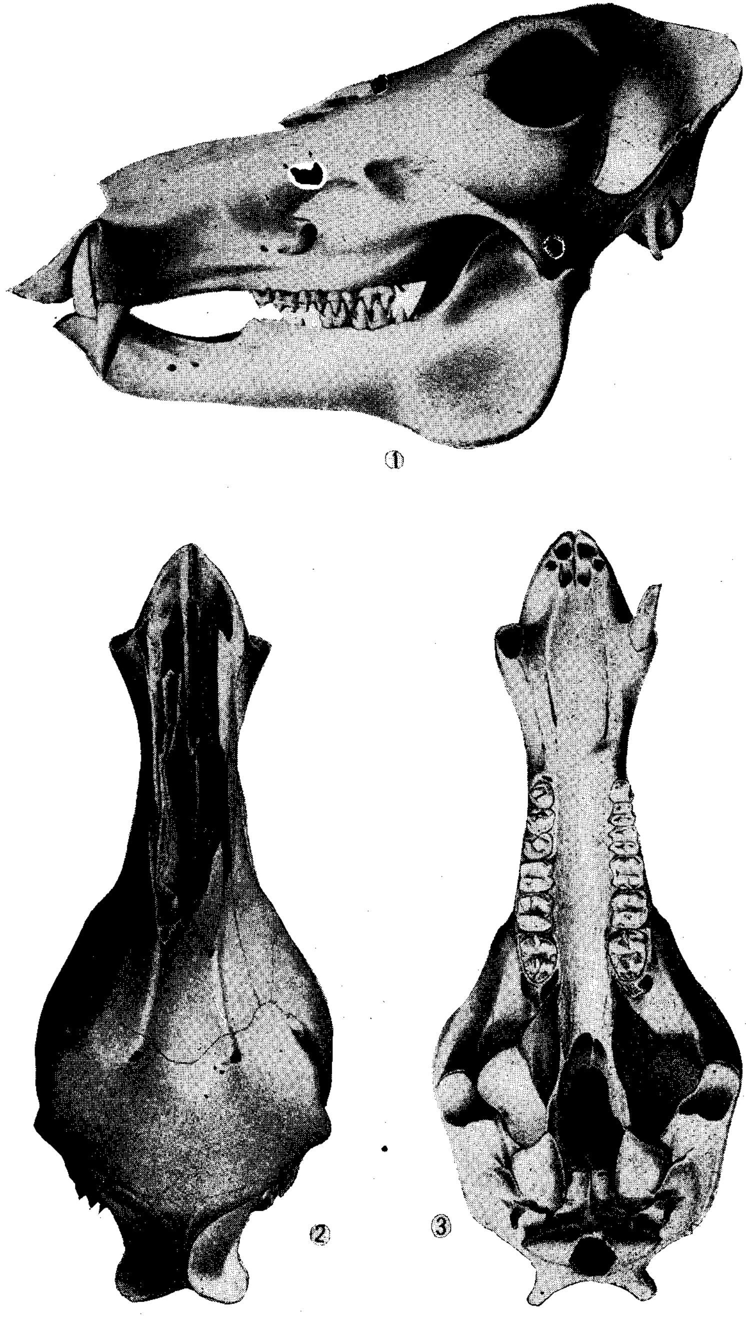
In the 14th Annual Report of the Geological Survey of Indiana, page 20, Cope and Wortman stated that there was in the Survey's collection the symphysial portion of the lower jaw and a large part of the left ramus supporting all the premolar teeth, except the last. This had been found at Laketon, in Wabash County. There were given no further details and the writer failed to find the specimen in the collection. In the collection of Earlham College, Richmond, are photographs of probably this specimen and of a part of the upper jaw. The latter bone shows three premolars and the first molar; the lower jaw, the symphysis, the right canine and the two anterior premolars. The photographs are labeled as having been identified by Cope as *Platygonus compressus* and as having been found in Wabash County.

This species was described in 1848 by Dr. John L. LeConte. His materials had been found in the lead region, near Galena, Illinois, at a depth of 50 feet. The materials consisted of parts of the skull and jaws, with teeth and some limb bones.

Other teeth and scanty bones he described under the names *Hyops depressifrons* and *Protochœrus prismaticus;* but these were afterwards shown by Leidy to be the same as *Platygonus compressus.*

In 1853 (Trans. Amer. Philos. Soc., vol. X, pp. 330-341, pls. XXXVI, XXXVII), Leidy described under the name of *Euchœrus macrops,* a nearly complete skull of a fossil peccary that many

PLATE III.



Platygonus compressus. Three views of the skull. After Leidy. × ⅓.

years before had been found in a saltpeter cave in central Kentucky. Leidy afterwards concluded that this specimen belonged to *Platygonus compressus.* The beautiful figures furnished by Leidy are here reproduced (Pl. III). These show better than any descriptions the form of the skull and of its various parts.

The following measurements of this skull are taken from Leidy's description, his inches and lines being reduced to millimeters. Some other measurements are introduced, taken from Leidy's illustrations:

Length of head from occipital condyle to alveoli for incisors	286 mm.
Length of head from occipital condyle to end of the snout	296 mm.
Length of frontal bone on midline	26 mm.
Greatest breadth of the forehead	108 mm.
Breadth at second upper molar	51 mm.
Breadth at sockets for canines	60 mm.
Height from between fronts of orbits to palate	87 mm.
Height of inion (rear of skull) from occipital foramen	89 mm.
Length of hard palate	190 mm.
Length of upper premolar-molar series	77 mm.
Length space from canines to premolar	46 mm.
Lower jaw from condyle to front	225 mm.
Height of lower jaw at first true molar	37 mm.
Length of symphysis of lower jaw	72 mm.
Length of lower premolar-molar series	80 mm.
Upper premolar 2, length	9 mm.
Upper premolar 2, breadth	9 mm.
Upper premolar 3, length	10 mm.
Upper premolar 3, breadth	10.3 mm.
Upper premolar 4, length	10 mm.
Upper premolar 4, breadth	11 mm.
Upper molar 1, length	13 mm.
Upper molar 1, breadth	12 mm.
Upper molar 2, length	16 mm.
Upper molar 2, breadth	14 mm.
Upper molar 3, length	19 mm.
Upper molar 3, breadth	14 mm.
Lower premolar 2, length	8 mm.
Lower premolar 2, breadth	7.6 mm.
Lower premolar 3, length	10 mm.
Lower premolar 3, breadth	8 mm.
Lower premolar 4, length	11 mm.
Lower premolar 4, breadth	10 mm.
Lower molar 1, length	14.5 mm.
Lower molar 1, breadth	10 mm.
Lower molar 2, length	16 mm.
Lower molar 2, breadth	11 mm.
Lower molar 3, length	20 mm.
Lower molar 3, breadth	12 mm.

The figures of the skull show that it resembles considerably that of a common hog. It differs, however, in many points. Seen in profile the region between the eyes is convex, instead of being concave as it is in the hog. It is also convex from side to side between the eyes; whereas, in the hog it is flat. The front of the orbit is half way between the rear of the skull and the foramen over the fourth premolar; in the hog the front of the orbit is much nearer the foramen. In the hog there is hardly any space between the canine teeth and the first premolar. In the peccary the first premolar is missing entirely and the second one is far away from the canine. In the hog there is a pair of very long processes in front of the occipital condyles; in the peccary these are of very moderate size. The molars of the hog are far more tuberculated than are those of the fossil peccary.

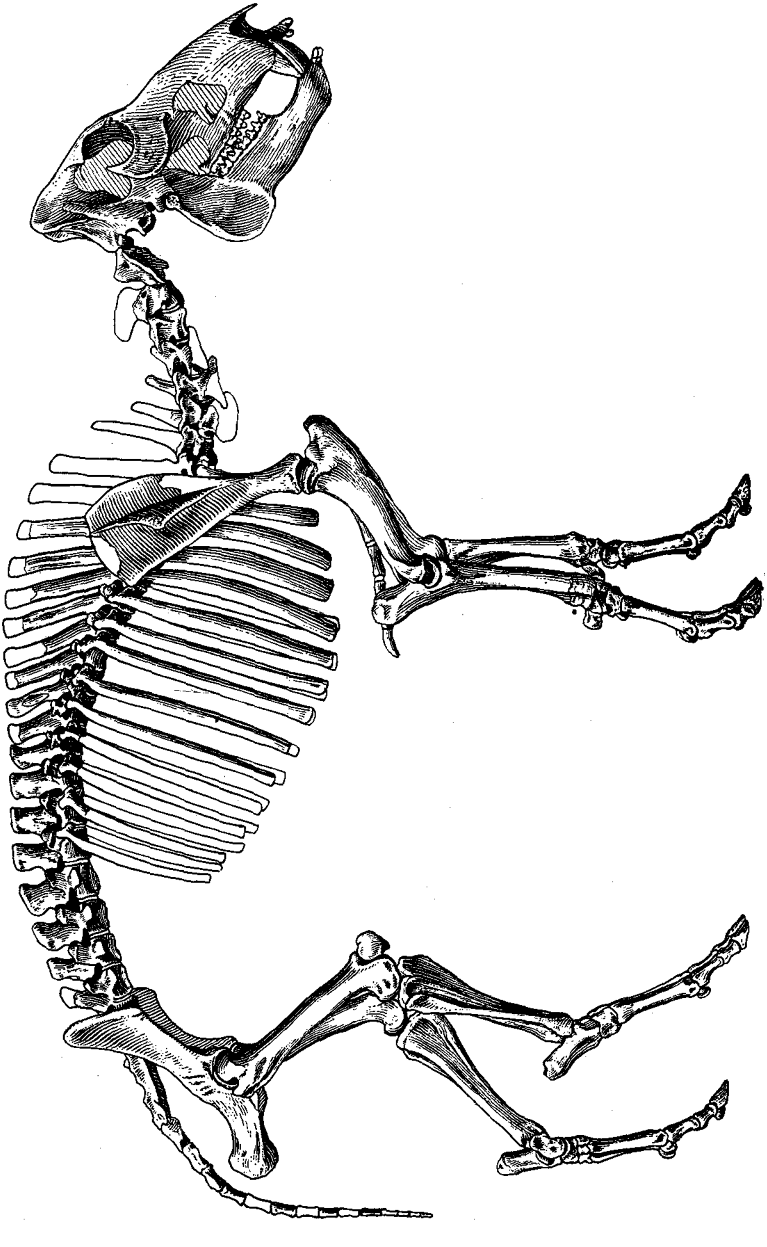
Leidy's figures of the teeth of this specimen are here reproduced (Pl. IV, Figs. 3-6). On the left are those of the right upper jaw presenting their grinding surfaces and a view of the outer faces. On the right are the lower teeth showing the grinding surfaces and a view of the outer faces. It will be observed that each of the true molars is crossed by two prominent ridges or crests, and that a longitudinal cleft divides each of these into two cones. These crests and cones are much more prominent than in the living peccaries. Likewise, the transverse valley separating the two crests of each tooth are less obstructed by tubercles than in either *Tayassu* or *Mylohyus.*

The hinder upper molar has a considerable projection, heel, or talon, at the rear; and this is composed of tubercles. From the inner cone of each crest, both in front and behind, there descends a buttress to the middle of the width of the tooth. At the base of the cones, especially on the outer border of the tooth and at its anterior end, there is a tuberculated shelf, or cingulum. The two other molars are without the talon, but they have a well developed cingulum and some tubercles in the valley between the two crests.

The premolars have only one cross-crest. They possess each a well defined cingulum and buttresses descending from the main cones.

The lower teeth resemble, in general, the upper ones, but they are narrower. The molars are crossed each by two crests, the premolars by only one each. The hinder molar has a considerable talon, and the hinder cingulum of the other molars and of the hinder premolar, resembles a talon. The lateral view of the upper and lower teeth illustrates the height of the cones before they have

PLATE V.



Platygonus leptorhinus. Restoration of skeleton.

suffered any wear. Later in life these teeth would present a different aspect. In 1903 George Wagner published (Jour. Geol., vol. XI, p. 777) a description of a skull belonging to this species which had been found near Belding, Kent County, Michigan. This had been found in a peat bog with a lot of bones which were supposed to belong to five individuals.

Some years ago two well preserved adult specimens of this species were found in a gravel bank, near Rochester, New York. Most of the remains are now in the Philadelphia Academy of Sciences. Leidy (Trans. Wagner Institute, vol. II, p. 41) described them and figured a complete skull.

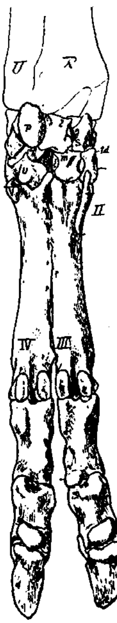
Undoubtedly this species belonged with the fauna which took possession of our northern States soon after the withdrawal of the last, or Wisconsin, ice-sheet. The remains found in Wabash County, Indiana, at Columbus, Ohio, and at Rochester, New York, are all within the region occupied by the Wisconsin drift, and there is little probability that any of these remains were in deposits laid down preceding the Wisconsin epoch. The remains found in the region about Galena, Illinois, may belong to an earlier time; but of this we cannot be certain. The species has been identified by Matthew among materials collected at Hay Springs, Nebraska, and these deposits were certainly laid down early in the Pleistocene. The species seems, therefore, to have lived during the whole of this epoch.

In order to illustrate the structure of the peccaries of this genus, the writer has had a drawing (Pl. V) prepared of a specimen of *Platygonus leptorhinus* Williston. The drawing was made by Mr. R. Weber, from a photograph kindly furnished by the American Museum of Natural History, New York, and shows a specimen mounted in that museum. This fine skeleton is one of a number of individuals that were found together near Goodland. Sherman County, Kansas, and which were afterwards described by Williston. It will be observed that the animal has longer legs than the hog has. It seems to have had a height, at the shoulders, of somewhat more than two feet six inches (750 mm.).

Leidy (Trans. Wagner Institute, Vol. II, p. 41), gave the dimensions of some of the bones that had been found at Rochester, New York. A part of his measurements is here given:

Extreme length of the humerus	190	mm.
Extreme length of the ulna	196	mm.
Extreme length of the radius	156	mm.
Length of femur head to inner condyle	193	mm.

Length of tibia internally	196	mm.
Length of metacarpals	93	mm.
Length of metatarsals	100	mm.



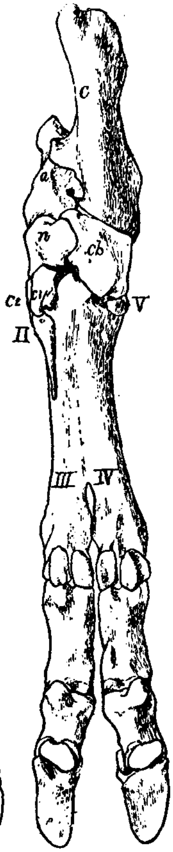


FIG. 40. FIG. 41.

Figs. 40, 41. *Platygonus leptorhinus.* Fore and hind feet seen from behind. × ⅓.

Fig. 40. Forefoot *R*, radius; *U*, ulna; *II*, second metacarpal; *III*, third metacarpal, a short stylet; *IV*, fourth metacarpal; *V*, fifth metacarpal, a nodule of bone; *l*, lunar; *m*, magnum; *p*, pisiform; *s*, scaphoid; *td*, trapezoid; *u*, unciform.

Fig. 41. Hind foot. *II*, second metatarsal, a short stylet; *III*, third metatarsal; *IV*, fourth metatarsal; *V*, fifth metatarsal, a nodule of bone; *a*, astragalus; c, calcaneum; c^1, internal cuneiform; c^2, middle cuneiform; *cb*, cuboid; *n*, navicular.

Figure 40 represents the structure of the fore leg, Fig. 41 that of the hind leg of *P. leptorhinus,* and those of *P. compressus* were probably almost exactly the same. These figures are taken from Williston's paper (Kan. Univ. Quart., Vol. III, pp. 38, 39). It will be observed that the second and fifth digits are greatly reduced in size.

PLATYGONUS VETUS Leidy.

From Prof. J. W. Beede, of the State University of Indiana, the writer has received remains of two extinct species of peccary. One of these has already been mentioned under *Tayassu lenis.* The remains here described appear to belong to *Platygonus vetus.* All that indicates this species is the hinder upper molar of the right side and a part of the next tooth in front of it (Pl. IV, Fig. 1). The hinder tooth had not yet come into use and its roots are not developed. The length of the tooth is 26 mm.; the width across the base of the anterior crest is 20 mm.; across the second crest, 17 mm. The crown of the tooth greatly resembles that of *Platygonus compressus,* as shown by Fig. 3, plate IV. It is, however, a much larger tooth. It is evident also that the main cusps were not so high as in that species, and there are other differences. The size of the tooth agrees with that of *Platygonus vetus,* as as shown in Leidy's figure (Ann. Rep. Penn. Geol. Survey, 1887, Pl. II, Figs. 1, 2). The tooth differs from that in having stronger anterior and external cingula, and in having a broader and more complicated talon. In the type of *P. vetus,* just referred to, the talon is eight mm. long and narrowed and rounded off behind. In the specimen from Bloomington the talon is only five mm. long and is broad and truncated behind. It consists of two large tubercles in the rear of the tooth measuring together, from side to side, 11 mm. Between these and the hinder of the two main crests, there is a strong tubercular ridge that enters from the outer side of the tooth. On the front of the anterior inner cone (protocone) there descends a strong buttress to the anterior cingulum; and on the hinder face of the same cone a feebler buttress descends to the middle of the transverse valley. Similarly, there are anterior and posterior buttresses on the hinder cone (hypocone).

The fragment of second true molar presents strong external and hinder cingula.

The specimen was found in Rock Cliff quarry, northwest of Williams, in Lawrence County. It was accompanied by some bones, probably of the skeleton, but these have not been worked out of the matrix. In the same quarry were found *Terrapena carolina* and *Tayassu lenis.*

It is thought better to refer this tooth provisionally to *Platygonus vetus* than to name and describe a new species on such inadequate materials. Leidy's type of this species was found in a crevice in a limestone quarry in Mifflin County, Penn. It consisted of a palate with molars and damaged premolars and a left ramus of the lower jaw with the last premolars.

This species has been reported from Hay Springs, Nebraska, and the molars and premolars have been figured by Gidley (Bull. Amer. Mus. Nat. Hist., Vol. XIX, p. 479); but it is not certain that the identification is correct. None of the finds of this species give us any certain indications of the time during the Pleistocene that it existed, unless it be the specimen from Hay Springs, Nebraska.

Genus MYLOHYUS Cope.

Peccaries with narrow and elongated snout; second, third, and fourth premolars present above and below, and molariform; that is, provided each with two pairs of primary cones. Two incisors on each side above and below. Forefeet with second and fifth digits present, with all their elements; the hinder apparently wholly lacking the second and fifth digits.

The type of this species is Leidy's *Dicotyles nasutus,* of which only the snout with an incisor, a canine, and two premolars are known. Cope referred to the genus other species, one of which showed two incisors only on each side of each jaw. Far more needs to be learned yet regarding the skeleton of some species of the genus.

The greater part of our knowledge of this genus is derived from remains found by Mr. Barnum Brown in the Conard fissure, in northwestern Arkansas (Mem. Amer. Mus. Nat. Hist, IX, p. 200).

MYLOHYUS NASUTUS Leidy.

The type specimen of this species comprises the snout extending backward so as to include two premolar teeth on the right side. The specimen was found many years ago in Gibson County, Indiana, the more exact locality not having been published. The specimen was sent to Leidy for examination by Dr. David Dale Owen. Where it is now is not known to the writer. It was discovered in digging a well, at a depth of between 30 and 40 feet below the surface.

Besides the two premolars contained in this piece of upper jaw there is present the right canine and the inner of the two upper left incisors. There are sockets for the three missing incisors and for the left canine.

Two of the figures which illustrated Leidy's description are here reproduced. (Figs. 42, 43.) Leidy has stated that this fragment of skull indicates an animal larger than any of the living peccaries and larger than *Platygonus compressus.* The snout is much longer and narrower than that of any of the living peccaries, and somewhat longer than in *Platygonus compressus.*

The following measurements are taken from Leidy's figures:

Distance from front of snout to line even with rear of second premolar	140 mm.
Distance from front of snout to line joining hinder border of canines	55 mm.
Distance from rear of canines to front of the first premolar	60 mm.
Width of jaw across sockets for canines	59 mm
Width of jaw where narrowest	32 mm.
Width of jaw at front of first premolar	35 mm.
Length of crown of first premolar	9 mm.
Width of crown of first premolar	8.5 mm.
Length of crown of second premolar	13 mm.
Width of crown of second premolar	11.5 mm.

The incisors were smaller than those of the living peccaries. The diameter of the anterior incisor is hardly 5 mm., while the socket for the second is barely 4 mm. in diameter. In *Tayassu angulatum*, a smaller animal, the incisors are somewhat larger. The canine has a height of 55 mm., the crown occupying 29 mm. of this. It is therefore somewhat shorter than in the living peccaries. The fore-and-aft diameter of the base of the crown is 14 mm. There appears to have been a wide and well-marked groove

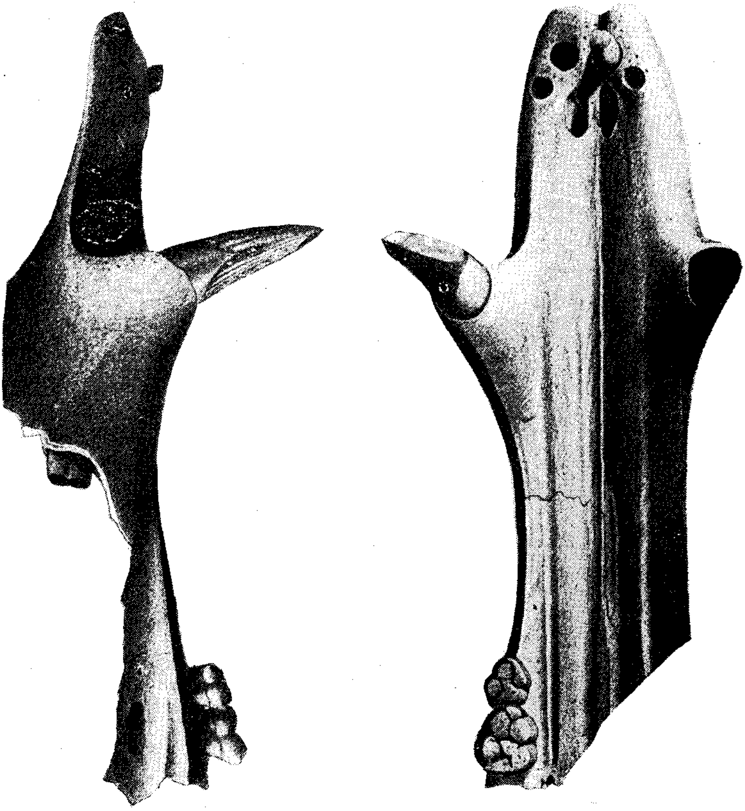


FIG. 43. FIG. 42.

Figs. 42, 43. *Mylohyus nasutus*. Palatal and side views of the type specimen. $\times \frac{3}{5}+$.

on the outer face and a number of narrower grooves on its both faces.

The hinder of the two premolars has the structure of a true molar of the living peccaries, having two pairs of cusps, with accessory cusps in front, the center and the rear (protoconule, metaconule, hypoconule). The anterior premolar is more simply constructed. The Conard fissure specimens show that the second premolar was molariform, although smaller than the others.

It would be of value to know exactly where in Gibson County this specimen was found. A part of this county, the eastern and southeastern, lies outside of the drift-covered region. A strip along the river is occupied by river deposits belonging to the Recent epoch. Outside of this again is another strip that Leverett regards as made up of sand and gravel plains and terraces of Wisconsin age. The remainder of this county is covered with Illinois drift forming a strip 10 miles or more in width, running across the middle of the county in a direction from southwest to northeast. In case the well in which the fossil was found was dug in the area of the Illinois drift, a depth of 30 feet or more would probably pass through this drift and thus make the age pre-Illinoian. Professor Cope identified, as belonging to this species, some teeth which had been found in Port Kennedy cave, in southeastern Pennsylvania. From the fact that a large percentage of the animals found in this cave are now extinct, one may conclude that they belonged to an early period in the Pleistocene. With our present knowledge of the locality where the Gibson County specimen was found, we cannot be certain of its geological age. Leidy referred (Jour. Acad. Nat. Sci., Phila., VII, 1869, p. 387) to this species a second molar tooth which had been found in Monmouth County, New Jersey. Cope identified as belonging to this species some molars and canine teeth which he had found in cave breccia in Wythe County, West Virginia. With these were found remains of *Tapirus haysii,* an extinct horse, and various other extinct species, as well as remains of yet existing species.

The writer believes that the animals found in the Conard fissure lived during the Illinoian stage.

SUPERFAMILY BOÖIDEA.

THE DEER, GIRAFFES, ANTELOPES, SHEEP, MUSK-OXEN, OXEN.

Artiodactyla with the third and fourth metapodials consolidated into one mass. The lateral digits reduced or wholly missing. Fibula appearing only as a small bone at the lower end of the tibia. Tooth formula, i. $\frac{0}{3}$, c. $\frac{0 \text{ or } 1}{1}$, pm. $\frac{3}{3}$, m. $\frac{3}{3}$. The lower canines close to and resembling an incisor. Cusps of the molars and often of the premolars wearing into crescents, whose extremities are directed outward in the upper jaw, inward in the lower. Habits herbivorous.

The earliest members recognized of this group are found in the Lower Miocene. From that time they appear in increasing numbers.

FAMILY CERVIDÆ.

THE DEER.

Second and fifth digits of all the feet usually present, but much reduced. Head sometimes without frontal appendages, but often, especially in the males, furnished with antlers which, with rare exceptions, are found only in the males and which are periodically shed and reproduced. Teeth usually short crowned and with large roots. Upper canines usually present.

At the present day species of deer are found in North and South America, Europe, Asia, and Africa north of the Sahara. In time they range from the Lower Miocene to the present. From the Pleistocene of North America seven or eight extinct species are known, besides remains of several of the species yet living. The genera represented are *Odocoïleus, Cervus, Cervalces, Alces,* and *Rangifer.* These all belong to the following subfamily:

SUBFAMILY CERVINÆ.

Antlers with short pedicel; periodically shed and in all genera except *Rangifer* found only in the males. Upper canines usually wanting or feebly developed. Cheek-teeth short crowned, the enamel more or less wrinkled.

Genus ODOCOILEUS Rafinesque.

Antlers in the males only; with a short pedicel, the bases rising nearly in the plane of the face, turning outward then strongly forward; furnished with a sub-basal snag; the tines arising from the hinder border of the main stem. No brow tine. Metacarpals 2 and 5 having only the distal end preserved. Lateral hoofs well developed on all the feet. Canines usually absent. Gland pit of face small. Hinder nares divided into 2 passages by the vomer.

The deer of this genus inhabit the New World. The type of the genus is the common Virginia, or white-tailed deer, which occurs also in the Pleistocene.

ODOCOILEUS VIRGINIANUS Zimmermann.

This is the Virginia, or white-tailed deer which, at the coming of white men to this continent, inhabited the country from the Atlantic Ocean to the Rocky Mountains and from southern Canada to the Gulf of Mexico.

It has been reported as occurring in Pleistocene deposits from Pennsylvania, New York, West Virginia, Michigan, Illinois, Indiana, Missouri, and elsewhere.

Since the skeleton of this species may be procured and employed for comparison of extinct species, some parts will be briefly described.

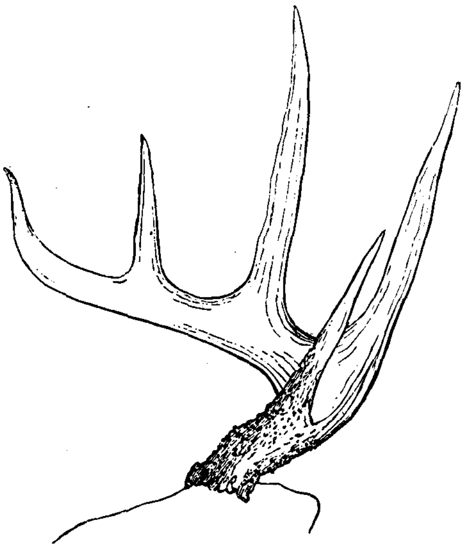


FIG. 44. *Odocoileus virginianus*, the white-tailed deer. View of the right antler from the left side; nose toward the left hand.

The face is rather low and narrow. The antlers (Fig. 44) show a main stem which at first proceeds from the skull upward, outward and backward. The stem then turns outward strongly, then forward and upward, ending in well-developed males far in front of the orbits. Besides, the backwardly directed sub-basal snag there may be three or four tines rising from the upper border of the stem. Of course, no antlers occur in the females and the skulls of males may be found without them, but these will present the pedicels. The antlers of young males are smaller and have fewer tines than those of adults. The length of the skull, from the occipital condyles to the front of premaxillæ, will measure about 285 mm.; the breadth across the rear at the mastoid process, is about 100 mm. The length of the upper premolar-molar series is 80 mm.; of the premolar series, 36 mm.; of the molar series, 48 mm. The length of the lower premolar-molar series is 85 mm.; of the premolars, 38 mm.; of the molars, 51 mm. These measurements and the following ones of the individual teeth are taken from a specimen in the U. S. National Museum, No. 17452. The width is taken at the base of the crown:

MEASUREMENTS OF THE TEETH.

UPPER TEETH.	Length of Crown.	Width of Crown.	LOWER TEETH.	Length of Crown.	Width of Crown.
Pm. ^{2}	11 mm.	11 mm.	Pm. $_2$	10 mm.	6 mm.
Pm. ^{3}	11 mm.	13 mm.	Pm. $_3$	12 mm.	7 mm.
Pm. ^{4}	11.5 mm.	14 mm.	Pm. $_4$	12 mm.	9 mm.
M. ^{1}	14 mm.	14 mm.	M. $_1$	14 mm.	10 mm.
M. ^{2}	16 mm.	15.5 mm.	M. $_2$	16 mm.	11 mm.
M. ^{3}	16.5 mm.	16 mm.	M. $_3$	22 mm.	11 mm.

In the upper molars there is often a small tubercle on the inner face between the two lobes, and a similar one on the outer face of the lower molars between the two lobes.

In the upper jaw the distance from the front premolar to the front of the premaxilla, is about 95 mm. In the lower jaw the distance from the front of the jaw to the anterior molar, is 85 mm. The height of the lower jaw at the first true molar, is 22 mm.

To aid in the recognition of remains of the Virginia deer, measurements are here presented of some of the principal bones of the skeleton. They are taken from a young but mature male, No. 35139, U. S. National Museum. The measurements are taken in a straight line:

Skull, length from condyles to front of premaxillæ	245	mm.
Atlas, width across hinder end	73	mm.
Axis, total length	65	mm.
Axis, width of anterior end across articulation	48	mm.
Scapula, length parallel with its spine	170	mm.
Scapula, width of upper end	115	mm.
Humerus, extreme length	187	mm.
Humerus, from head to surface for ulna	173	mm.
Radius, total length	200	mm.
Ulna, total length	240±	mm.
Anterior cannon bone	200	mm.
Pelvis, total length	230	mm.
Pelvis, width at acetabula	117	mm.
Pelvis, width at hinder end of ischia	148	mm.
Femur, total length	230	mm.

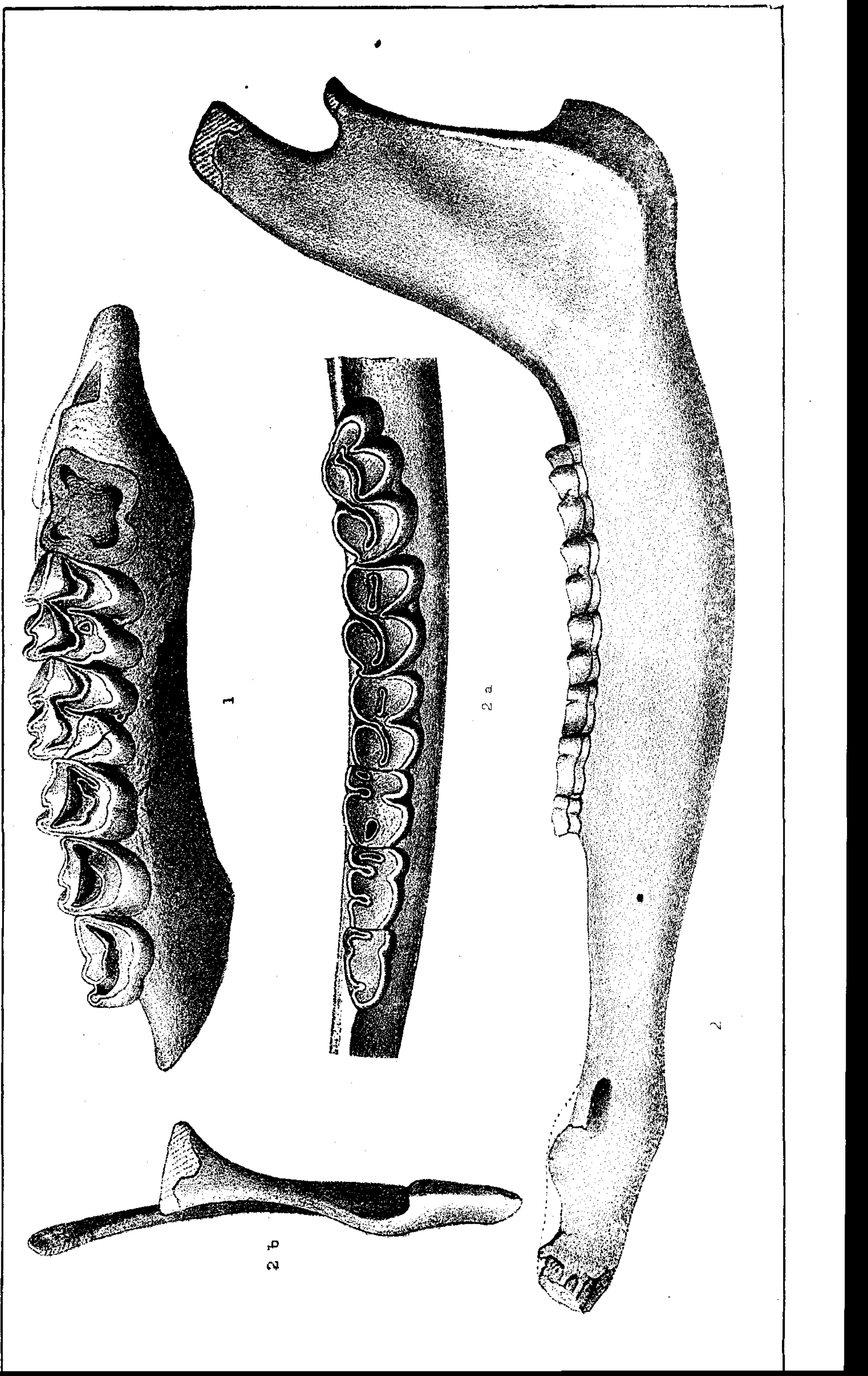
Femur, from head to outer condyles	215	mm.
Tibia, total length	270	mm.
Hinder cannon bone	235	mm.

Remains of this deer have been reported from many localities within the area occupied by it in historical times. We cannot always be sure that the identifications have been correct, nor sure that the remains belonged to Pleistocene times. Cope, in 1869, reported that remains of this species were abundant in the cave breccia of West Virginia. He also found in the collection made in Port Kennedy cave, in eastern Pennsylvania, teeth which he could not distinguish from that of the Virginia deer. It is the present author's opinion that the deposits made in that cave were made early in the Pleistocene. Hildreth (Amer. Jour. Sci., Vol. XXIX, 1835, p. 147) reported the finding of bones of the deer, probably this species, in cave stalagmite, in Wood County, W. Virginia. Leidy found, in Peace Creek beds, Florida, regarded as early Pleistocene or even Pliocene, antlers, bones, and teeth of a deer, that he could not distinguish from corresponding parts of the Virginia deer.

In Indiana reports of discovery of deer remains have come from a number of places. In 1854, Leidy (Proc. Phila. Acad., p. 200) published a list of bones that had been found near Evansville, at the mouth of Pigeon Creek, by Francis A. Lincke. There were parts of two tibiae, part of a metacarpal, parts of two metatarsals, parts of two scapulae, a piece of rib, a mutilated cranium of a doe, a part of the cranium of a buck which had shed his antlers, parts of three lower jaws of different ages and containing some of the molars. With these remains were found parts of a *Megalonyx,* a vertebra of a horse, scant remains of a bison, of a tapir, and the jaw of the wolf, *Canis dirus.* It is the opinion of the writer that these remains antedated the Wisconsin ice-sheet.

In the 17th Annual of the Indiana Geological Survey, page 241, Elrod and Benedict reported that in 1882, Mr. Rantz, while digging a ditch on the farm of William Ruckle, three and a half miles north of Roann, Wabash County, unearthed at a depth of nine feet the antlers and part of the skeleton of a deer, *O. virginianus.* I have a letter from Mr. B. E. Golthy, of Roann, who tells me that Mr. Ruckle stated to him that many bones were found at the time mentioned, shin-bones, ribs, and antlers. All those bones have disdisappeared. The deposit in all probability was laid down after the retirement of the Wisconsin ice.

PLATE VI.



ODOCOILEUS DOLICHOPSIS Cope.

This species was based on the left side of a lower jaw which, we are told, was discovered by John Collett of the Indiana Geological Survey, in a late lacustrine deposit in Harrison County, Indiana. It is to be regretted that those concerned in this matter did not think it necessary to give more exact information regarding the locality where the jaw and the ulno-radius of a bison that accompanied it were discovered. Had we this information it might be possible for some one to determine with some probability the time in the Pleistocene when these animals lived. To add to the confusion, Cope, in Volume IV of the Bulletin of the Hayden Geological Survey, page 379, states that the jaw was found in Vanderburgh County. The specimen was described first by Cope in the American Naturalist, Vol. IV, p. 189; then in the Bulletin of the U. S. Geological Survey, Vol. IV, p. 379. In the 14th Annual Report of the Geological Survey of Indiana, Cope and Wortman further described the jaw and gave figures illustrating it and the teeth. These figures are reproduced here (Pl. VI). From the description and the figures it seems quite certain that the species is distinct from *O. virginianus*. The length of the jaw from front to rear of the angle is given as 250 mm. In the specimen of *O. virginianus* whose measurements are given on page 612, this length is only 225 mm. Notwithstanding this, the length of the series of molars and premolars is the same in both, 85 mm. Using Cope's illustration, figure 2, of plate VI, which is a very little less than seven-tenths of the natural size, we find that the last molar was placed 70 mm. in front of the angle of the jaw; while in the specimen of *O. virginianus* it is only 56 mm. in front of the angle. In the fossil the space between the front of the jaw and the anterior molar measured 100 mm.; in *O. virginianus* it measures only 80 mm. We see therefore that this deer had, in proportion to the length of the series of cheek-teeth, a considerably longer lower jaw and doubtless a larger head; more especially a longer nose. The length of the premolar series is given as 34 mm. The length of the last premolar is stated to be 21 mm.; its width 11 mm. Cope's figure 2*a* seems to indicate that the dimensions were greater. In the figure the series of grinding teeth is made too large, 90 mm.; but this does not account for all the differences. Perhaps Cope measured only the worn surface of the teeth.

In the 14th Annual Report of this survey, Cope and Wortman described and figured a left maxilla with all of its teeth present.

The hinder one had, however, lost its crown. They say that the bone was in the collection and that it probably belonged to the same species; but seemed to offer no differences when compared to the same part in *O. virginianus*. In the absence of the materials it is impossible to add any remarks on this matter.

Genus CERVUS Linn.

Antlers in the male only; with a pedicel short, large and cylindrical; with a brow tine and two other tines on lower half of shaft. The tines springing from the front of the main shaft. Canine teeth present; upper molars with an accessory flattened column on the inner side. Antorbital gland pit of moderate size.

The members of this genus inhabit central Europe and central and northern Asia and central North America. Formerly the American species occupied the United States from the Atlantic to the Rocky Mountain region and to northern California and Yukon Territory, south to Tennessee and probably even western Florida in the Eastern region.

CERVUS CANADENSIS Erxleben.

The Wapiti; American Elk.

The American Elk, or Wapiti, is a stately and splendid species of deer which, on the coming of white men to this continent, occupied the more temperate parts of the country from the Atlantic to the Pacific, extending its range north to about 57° latitude and south to North Carolina, Tennessee, Arkansas, Texas, and New Mexico. It is now on the verge of extinction. It is a much larger animal than the Virginia deer, having a length of about eight feet from the nose to the root of the tail, a height of nearly five feet at the shoulders and somewhat more at the rump. The female is somewhat smaller. The antlers are large, (Fig. 45), reaching sometimes four feet 6 inches, measured along the curve, and sometimes probably they were still larger. They extend upward, outward and somewhat backward. The tines, five to seven in number, project from the front of the main shaft. Other details of the structure are given below.

Remains of the Wapiti in a fossilized or semi-fossilized condition have been reported from various parts of the eastern half of the United States, Vermont, New York, New Jersey, Maryland, North Carolina, South Carolina, Kentucky, Indiana, Michigan, Wisconsin and Illinois, and from Ontario, Canada. Certainly some of the remains reported belong to the recent epoch; others are certainly of Pleistocene times; about others there must remain great doubt. More finds of its remains have been made in Indiana than in any other State, and all these belong to the northern half, in deposits evidently overlying the Wisconsin drift. There seem to be no remains that prove the presence of this animal in our country during the earlier part of the Pleistocene, none that seem to be as ancient as some of the finds of the Virginia deer. I agree with Osborn that so far as we can now determine the Wapiti was a late

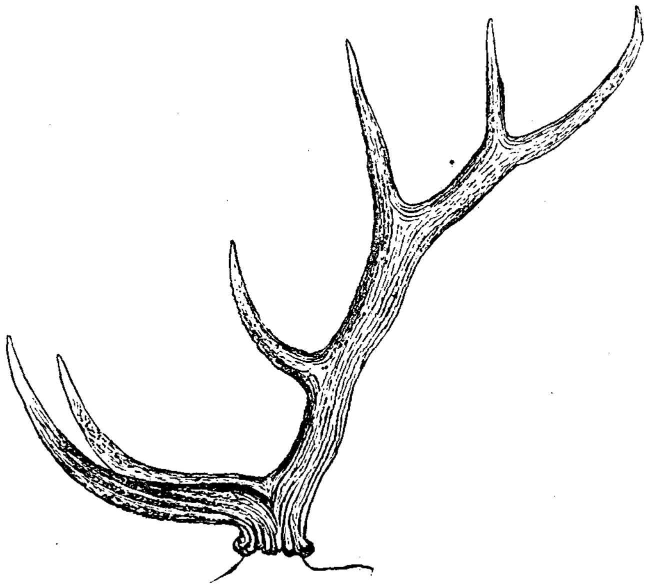


FIG. 45. *Cervus canadensis*, the Wapiti. View of right antler from left side; nose toward the left hand. After Baird.

comer to this region; but it was probably here before the extinction of the mastodon.

In the 22d Annual Report of this Survey, page 90, Professor Blatchley reported that antlers of a large elk had been found near Kouts, in Porter County, and that they were lying close to teeth of a mastodon. So far as it goes, this account indicates that the antlers were in Pleistocene deposits; but it is to be regretted that the finders did not furnish more detailed information.

In the same report Professor Blatchley stated that antlers of this species had been found in Lake County.

In the collection belonging to the Geological Survey at Indianapolis, there is a part of an elk antler which had been presented by Dr. Loughridge, of Rensselaer, Jasper County, and which had presumably been found near that place. The piece is 400 mm. long and forms the base of the antler. The greatest diameter of this base is 90 mm., and at 200 mm. above the base the diameter of the shaft is 55 mm.

In the collection at Indianapolis is a left antler which has a length of 1,200 mm. It presents five tines. The base has a diameter of 94 mm. It appears to have been found about 1884, near Foresman, Newton County, and it is credited to D. E. Dowe. We know nothing regarding the depth or the kind of deposit in which it was found.

Messrs. Elrod and Benedict (17th Ind. Rep., 1892, page 290), stated that, near the western border of Wabash County, the head and antlers of an elk had been unearthed by a Mr. Longnecer on a swamp which he was draining. The statement is made that the antlers measured eight feet from tip to tip. It seems probable that in making the measurement the antlers were laid out with their shafts in the same line; for no elk is known to have had antlers of this extent. Here again, we must lament the fact that the material was not preserved.

In the 12th Annual Report of the Indiana Geological Survey, page 169, Mr. McCaslin reported that in Jay County the bones of the mastodon and post-glacial deer or elk had been frequently met with. The gigantic antlers of the latter have been found in size indicating an animal eight or nine feet high and 10 or 11 feet in length. These antlers are said to have been picked up in a bog north of Camden, in Penn Township. Unless these antlers belonged to an animal yet unknown, they certainly were those of *Cervus canadensis.* The bearer of the bones was probably not so large an animal as imagined.

In the 12th Annual Report of the Survey, page 181, Dr. A. J. Phinney stated that in draining swamps in Randolph County, elks' fossil antlers had often been found, some very large and having a spread of six feet. No other details are given.

In the geological collection at Earlham College, Richmond, Indiana, there is a small lot of elk bones that were secured in May, 1893, by Messrs. Shoemaker, Grave and Moore in a ditch that was being put through a swamp in Randolph County, known as "The Dismal." Among these bones is a humerus, which has a total length of 300 mm. There is a scapula which appears to belong with it. Mr. Caswell Grave, now of Johns Hopkins University, informs me that these bones were found in a long ditch or canal that had been made in a swamp about one or two miles southeast of Winchester. They were found outcropping in the sides of the ditch for the space of half a mile. Only a few of the bones seen were brought back to Earlham College. It is to be hoped that somebody will soon make extensive collections here. The writer has reason to believe that "The Dismal" is located some miles east of Winchester.

This animal has been found likewise in Wayne County. In the Earlham College collection there is a skull of an elk, No. 5070 of the catalogue. It is labeled as having been presented by Lee Ault, superintendent of schools in Cambridge City. It is stated to have been found one mile northeast of Cambridge City, in Little Simonds Creek. It lay partly exposed in a bed of gravel four rods below the mill-dam and one-fourth of a mile above the place where the creek empties into the West Fork of White River. It is not at all improbable that the skull belongs to some part of the Recent epoch. The specimen is pretty thoroughly mineralized and stained with iron oxide.

In the same college there is the rear portion of the skull of an elk, with the bases of the antlers. It is recorded as having been found at Franklin City, Wayne County, on Nolan's Fork, and received from Mr. Isaac Thomas. The catalogue number is 5069. The animal appears to have been a large one and the skull furnishes the following measurements:

Height of the occipital crest above the bottom of the occipital foramen	100	mm.
Width of the skull behind	150	mm.
Width of the skull just in front of the pedicels	145	mm.
Antero-posterior diameter of the pedicels	50	mm.
Transverse diameter of the pedicels	52	mm.

The antlers are broken off at the point where the first, or brow, tine was given off. In order to identify fossil remains of this noble animal we must compare bones and teeth with those of prepared skeletons.

The following measurements are made from three skulls in the U. S. National Museum, No. 86417, a young adult male from Jackson Hole, Wyoming; a young adult female, No. 24217, from Yellowstone Park, and a second larger male, No. 171889, from Jackson Hole:

MEASUREMENTS.	Male, 86,417.	Female, 24,217.	Male, 171,889.
Length from condyles to front of premaxillae	408	380	455
Breadth at ear openings	123	110	160
Breadth across zygomatic arches	177	156	187
Breadth on rim of orbit at fronto-lachrymal suture	132	125	150
Breadth just above antorbital	88	88	98
Breadth at sockets of canines	86	68	90
Distance from front of premaxillae to palatines	192	192	215
Distance from front of premaxillae to hinder nares	255	245	283
Distance from front of premaxillae to anterior premolar	126	....	145
Width of palate at front premolars	50	55	57
Width of palate at front of hinder molars	70	70	78
Length of lower jaw from front to rear of angle	332	305	....
Length of symphysis	52	44	....
Height at first true molar	44	38	....
Length of upper premolar-molar series	133	133	138
Length of upper premolar series	59	58	62
Length of upper molar series	78	80	81
Length of lower premolar-molar series	144	140	....
Length of lower premolar series	57	55	....
Length of lower molar series	87	87	....
Distance from last incisor to anterior premolar	96	89	....
Pm. ^{2}, length	21	....	21
Pm. ^{2}, width	17	....	18
Pm. ^{3}, length	22	....	22
Pm. ^{3}, width	19.5	....	21
Pm. ^{4}, length	18	....	19
Pm. ^{4}, width	20	....	21.5
M. ^{1} length	23	24	23
M. ^{1}, width	24	25	26
M. ^{2}, length	29	30	29
M. ^{2}, width	25	28	28.5
M. ^{3}, length	27	....	28
M. ^{3}, width	23	....	25
Pm. $_2$, length	16	....	....
Pm. $_2$, width	10	....	....
Pm. $_3$, length	19	....	....
Pm. $_3$, width	13	....	....
Pm. $_4$, length	23	....	....
Pm. $_4$, width	15	....	....
M. $_1$, length	24	25	....
M. $_1$, width	16	17	....
M. $_2$, length	30	31	....
M. $_2$, width	18	19	....
M. $_3$, length	35	....	....
M. $_3$, width	17	....	....

In the case of the female skull measured above, the milk teeth, much worn, are yet in position. Although their individual measurements are not given, they are included in the lengths of the series. The lower hinder true molar is not sufficiently extended for accurate measurement. In considering the measurements of the teeth of this species, as in the other, it must be taken into the account that as they are worn down they become slightly shorter and the worn face broader. The latter fact does not affect the measurement given of the breadth, for this is taken at the base of the tooth.

The antlers of the elk rise from the pedicels, passing upward, and outward, and having between them an angle of less than 90 degrees. Toward the extremity the main stem turns forward and a little inward. The tines rise from the front of the main stem, not from the hinder border as they do in *Odocoileus*. There is a brow tine and two others in the lower half of the shaft, and two or three others in the upper half. In the specimen at hand, from Wyoming, the main shafts are about four feet long, and the tips of the two antlers are three feet apart.

To assist in identifying any bones that may be found, the following measurements are given. They are taken from a fully grown male individual in the U. S. National Museum. All measurements made in a straight line:

Axis, total length of the centrum	130 mm.
Axis, width of the anterior end across the articulation	88 mm.
Scapula, length parallel with its spine	350 mm.
Scapula, width of the upper end	205 mm.
Humerus, total length	340 mm.
Humerus, from head to surface for ulna	300 mm.
Radius, total length	345 mm.
Ulna, total length	430 mm.
Anterior cannon bone	313 mm.
Pelvis, total length	430 mm.
Pelvis, breadth at acetabula	205 mm.
Pelvis, breadth at hinder end of ischia	310 mm.
Femur, total length	400 mm.
Femur, from head to inner condyle	375 mm.
Tibia total length	445 mm.
Posterior cannon bone	345 mm.

In the female which furnished the measurements of the skull and teeth, the bones are considerably shorter. The femur, from the head of the surface for the ulna, is 260 mm. long; and the total length of the tibia is 385 mm. Allowance must therefore be made for individual variation, for sex and for age. In case that the antlers are not found with remains of the elk, it may be necessary to rely on the teeth for identification, or teeth only may be found.

The size of the teeth of the elk will distinguish them easily from those of the Virginia deer. They need to be carefully studied to distinguish them from those of the moose (*Alces americanus*), Scott's moose (*Cervalces scotti*), the musk-oxen and the various species of bison.

A comparison of the measurements of the teeth of *Cervus canadensis* with those of *Alces americanus* shows at once that those of the latter are larger, being especially broader. The greatest differences are found between the premolars of the two species, those of the moose being both much longer and much broader. There is not so great difference between the second upper molars of the two species, the lengths being nearly the same; but at the base that of the moose exceeds considerably the breadth of the same tooth as the elk. The upper true molars of the elk have, on the inner face, at the summit of the cleft between the two lobes, a little column. In the moose this is extremely small or absent. In the upper molar teeth of these species there are prominent folds of enamel on the outer face of each tooth. There is one at the front of the tooth. (parastyle of Osborn), one where the adjacent horns of the anterior and the posterior crescents meet (mesostyle), and one at the rear (metastyle). There is also a less prominent fold between the parastyle and the mesostyle, and another between the latter and the metastyle. In the moose the principal styles, especially the parastyle and the mesostyle, are broader and more prominent than in the elk; the fold between the parastyle and the mesostyle in the moose diverges perceptibly from the parastyle, while in the elk the two are parallel. In the premolars there are on the outer face three folds or styles. In the moose the median makes a greater angle with the front one than in the case of the elk.

Usually the greater length of the tooth and always the greater breadth will serve to distinguish the lower premolars and molars of the moose from those of the elk.

The greater size of the teeth of *Cervalces scotti* distinguish them readily from those of the elk.

The teeth of the bisons must be considered. If unworn or little worn upper molar teeth of the bison and of the elk are compared, the former may at once be distinguished by the far higher crowns, perhaps twice as high as those of the elk. If the teeth are worn down those of the elk will have the inner and the outer face sloping strongly toward each other, while in the bisons they will be nearly parallel. The worn faces of the molar teeth of the bisons are more nearly square than those of the elk. Those of the bisons have, on the inner face, instead of a little, freely projecting column, like a little stalactite, a large column that adheres to the tooth nearly the whole length and nearly fills the cleft between the two lobes. As to the premolars, the measurements must be applied, or those of the elk may be compared with the same teeth in the skull of the domestic ox. In regard to the lower teeth comparisons of the measurements of the elk teeth with those of the bisons will usually settle the matter. The lower true molars of the bison have, on the outer face, a strong fold of enamel, forming a style or column in the cleft between the two lobes.

Genus CERVALCES Scott.

Antlers dichotomous and palmated; the base of the shaft much longer than in *Alces*. Nasals and premaxillæ far less reduced than in the latter genus and the former bones in contact with the latter.

This genus appears to differ essentially from *Alces*, that containing the moose, in having the anterior nares, as shown in the skeleton, much smaller, an indication that the prehensile upper lip was not so greatly developed.

CERVALCES SCOTTI Lydekker.

SCOTT'S EXTINCT MOOSE.

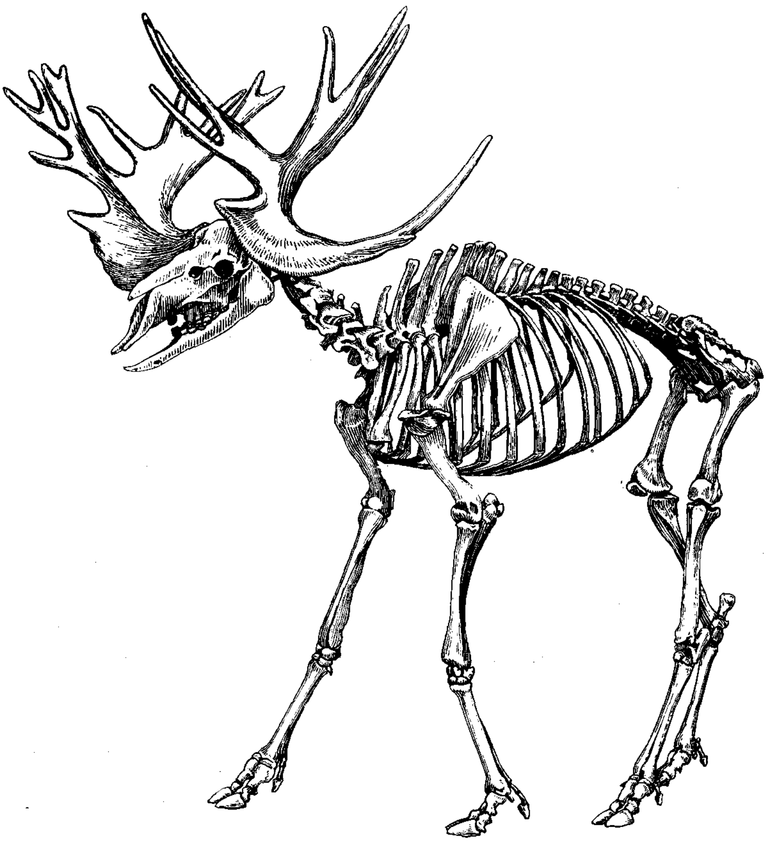
This is the species that Prof. W. B. Scott (Proc. Phila. Acad., 1885, p. 181, pl. 11), described under the name *Cervalces americanus*. Lydekker, in his Deer of All Lands, p. 60, pointed out that the specific name was preoccupied, and he therefore named the animal in honor of Professor Scott.

The first known remains of this species were found at Big Bone Lick, Kentucky, and were described and figured by Wistar in 1818, (Trans. Amer. Phil. Soc., Vol. I, p. 375, pl. X, Figs. 4, 5). He mentions it as a "*Cervus.*" Cooper, Smith, and Dekay, in 1831, referred it with doubt to the living species of moose. Harlan, in 1834, gave it the name *Cervus americanus*. The descriptions and figures were based on the hinder part of the skull which bore the bases of the antlers. Leidy (Jour. Phila. Acad., Vol. VII, 1869, p. 378), expresses some doubt regarding the place where the skull was found. With the skull in the Academy of Natural Sciences in Philadelphia Leidy found the bases of the antlers of another specimen and two metacarpals, all in the same friable and abraded condition.

About the year 1884 there was discovered in a shell-marl deposit, under a bog, at Mt. Hermon, New Jersey, a nearly complete skeleton of a moose which is referred to this species. The only bones missing are five tail bones, two ribs, the right scapula and humerus, and a few foot bones. Excepting the bones of the tail, every bone is represented on one side or the other of the animal. The bones are beautifully preserved and look as if they had been obtained from a recently killed animal. They belonged to an animal that was adult, but not old. They have been mounted, and the skeleton forms one of the attractions of the natural history collection at Princeton University. From Scott's plate, representing this skeleton as mounted, has been prepared the line drawing here presented (Pl. VII). The other figures also are from Scott's memoir.

The only certain identifications of this moose are those of the materials found at Big Bone Lick and at Mt. Hermon, New Jersey. It has been reported with doubt from Kansas and from the interglacial deposits at Toronto, Canada. It is impossible to determine

PLATE VII.



Cervalces scotti. View of the skeleton.

the age of the Big Bone Lick remains. Animals left their remains there probably from the time of the retirement of the Illinois ice-sheet up to the present. The Toronto formation may belong to the Sangamon interglacial stage. There is more certainty about the time when this fine specimen at Princeton University lived. The whole country about Mt. Hermon, N. J., is, according to Salisbury's map of the glacial deposits of New Jersey (Geol. Surv., N. J., Vol. V), covered with what is called late drift. This is regarded as equivalent to the Wisconsin. The specimen was found in a bog on this drift, and may be regarded therefore as post-Wisconsin in age.

A study of the measurements of this specimen, as presented by Scott, seems to the writer to show that the proportions of the extinct species were almost exactly those of the moose, the legs being little if any longer and the neck rather longer than shorter, all as compared with the length of the animal. This moose was thought by Scott to have stood higher on its legs than does the living species. He has given comparative measurements of this specimen and

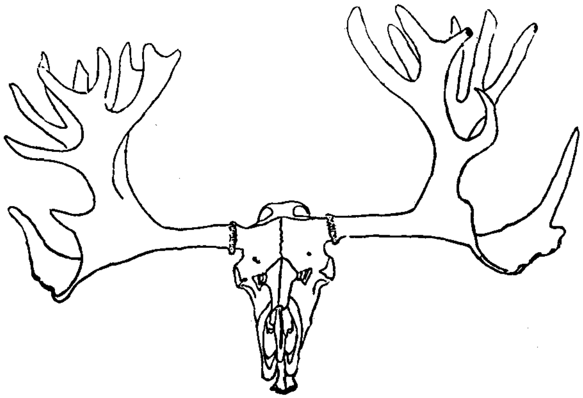


FIG. 46. *Cervalces scotti.* Skull and antlers seen from in front. Compare with Fig. 47.

of one of the moose. The latter is said to have had a height of 1,695 mm. at the withers and 1,565 mm. at the sacrum. The extinct species showed 1,810 mm. and 1,680 mm. as the corresponding measurements. That is, the extinct species had a height of about six feet at the shoulders. The living species of *Alces* furnish still larger specimens.

In order that it may be possible to recognize remains of this species if found, the following descriptions and measurements are presented:

The skull has a length of 550 mm. from the condyles to the front of the premaxillæ. The width across the paroccipital processes is 150 mm.; at the hinder borders of the orbits, 252 mm.; at the anterior premolar, 132 mm. From the front of the premaxilla to the front of the nasals is 185 mm., one-third the length of the skull; in the moose this is 285 mm., one-half the length of the skull.

Along the midline, between the back of the head and the antlers, there is a slight depression; between the antlers a convexity; in front of the antlers, a slope downward. In the male moose there is a high knob of bone between the antlers. The nasal bones of *Cervalces scotti* are 181 mm. long, and extend forward in advance of the hinder end of the premaxillæ. In the living moose the nasals are very short and lack much of reaching the premaxillæ.

The antlers start out laterally at nearly right angles with the plane of the midline of the skull (Fig. 46). At a distance of 100 mm. from the base the diameter of the shaft is 55 mm. At about 170 mm. the shaft begins to flatten and soon divides into two palmations. One of these may be said to continue the main axis outward, then somewhat upward ending in the outer snag. Its hinder border is thickened, and the width of the palmation amounts to as much as 300 mm. The other branch is directed upward and is soon divided into an anterior division and a posterior one. Each of these divides and subdivides into terminal snags. The length of the antler, measured on the outside of the curve, is 863 mm.; the distance between the outer extremities of the two antlers is 1,620 mm., over five feet.

All the teeth are present except the lower incisors and canines. The following measurements have been taken by the writer:

Length of the premolar-molar series, 168 mm.; of the premolar series, 74 mm.; of the molar series, 90 mm.

MEASUREMENTS OF THE TEETH.

UPPER TEETH.	Measurements.	LOWER TEETH.	Measurements.
Pm^2	Length, 23 mm.	$Pm._2$	Length, 21 mm.
$Pm.^2$	Width, 23 mm.	$Pm._2$	Width, 14 mm.
$Pm.^3$	Length, 26 mm.	$Pm._3$	Length, 23 mm.
$Pm.^3$	Width, 24 mm.	$Pm._3$	Width, 17 mm.
$Pm.^4$	Length, 26 mm.	$Pm._4$	Length, 27 mm.
$Pm.^4$	Width, 27 mm.	$Pm._4$	Width, 20 mm.
$M.^1$	Length, 29 mm.	$M._1$	Length, 28 mm.
$M.^1$	Width, 27 mm.	$M._1$	Width, 20 mm.
M^2	Length, 28 mm.	$M._2$	Length, 30 mm.
$M.^2$	Width, 29 mm.	$M._2$	Width, 22 mm.
$M.^3$	Length, 31 mm.	$M._3$	Length, 41 mm.
$M.^3$	Width, 27 mm.	M_3	Width, 21 mm.

The width of the molars, upper and lower, except $M._1$ is taken across the anterior lobe.

There may be in the upper molars minute accessory pillars or columns at the base of the valley between the two lobes, on the inner side of the tooth. On the outer face of the premolars there are two strong pillars, of which the anterior is the broadest. Both rise below the anterior root of the tooth, and the hinder swings backward to the middle of the face of the tooth. On the outer face of the molars there are three strong pillars. Two of these rise below the anterior root and diverge little. The third root rises between the two roots of the tooth. This swings somewhat backward. In front of it is a strong excavation; behind it a shallower one. In the hinder molar there is a fourth pillar into which the hinder crescent sends an extremity.

In the lower molars there is a rather thick pillar on the outer face in the interval between the two lobes. It is, however, short. On the inner face the molars are deeply and obliquely notched between the lobes, and the notch penetrates the anterior cement lake. The inner face of each lobe has a pillar which subsides toward the base of the crown. The hinder molar has a large heel or third lobe. Pm.$_{\overline{4}}$ resembles a molar, but it has a little external pillar. The inner face of the two anterior premolars is strongly folded and notched.

The following measurements are given of some of the principal bones:

Scapula, length along the spine	445 mm.
Scapula, width at upper end	255 mm.
Humerus, length from tuberosity	425 mm.
Humerus, least fore-and-aft diameter	55 mm.
Humerus, least transverse diameter	44 mm.
Radius, length	450 mm.
Metacarpal bone	355 mm.
Metacarpal, transverse diameter at middle	40 mm.
Femur, length from the head	440 mm.
Tibia, length	412 mm.
Metatarsus	421 mm.

Genus ALCES Gray.

The antlers broadly palmated. Base of the shaft relatively short. Nasals very short, far removed from the reduced premaxillæ and leaving the bony anterior nares open a distance equal to nearly one-half the length of the head. With a long prehensile upper lip.

ALCES AMERICANUS Clinton.

The Moose.

This magnificent animal, still in existence, ranges from Labrador to Nova Scotia and west to the Rocky Mountains and north to Great Slave Lake.

The only claim that Indiana can at present make on this animal is that some remains of it have been found at Big Bone Lick, Kentucky. Inasmuch as it was during probably either the Illinoian or the Wisconsin glacial stages, more probably during both, crowded down as far as Kentucky, its remains are very likely to be found in Indiana.

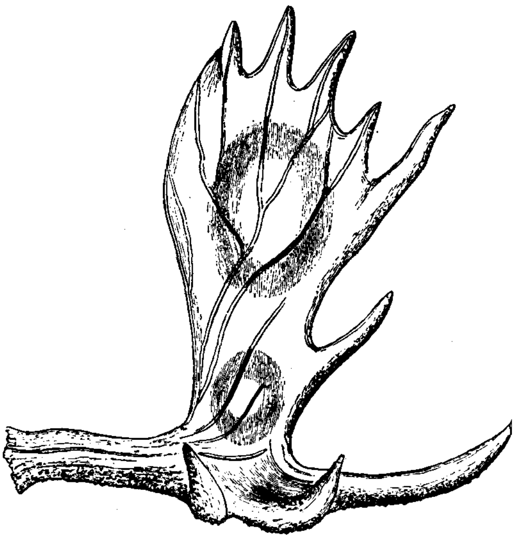


Fig. 47. *Alces americanus*, the Moose. Left antler seen from in front. Compare with Fig. 46. After Baird.

The endeavor will be made here to present enough of description and of measurements to enable students to determine with some certainty the teeth and some of the principal bones of the moose.

In bulk this deer is about equal to a horse. The height at the shoulders may be as much as 2,440 mm. (8 feet); its length, 2,190 mm. (7 feet). It is, however, usually smaller.

The skull is long and narrow, the part of the upper jaw in front of the front premolar being considerably longer than the series of molar and premolar teeth. In this respect it resembles *Cervalces*, but differs from the American elk, *Cervus americanus*. The nasals are extremely short, so that the anterior ends are behind the front premolars. The skull of a specimen in the U. S. National Museum, No. 111671, from Manitoba, is 560 mm. long, from the exoccipital condyles to the front of the premaxillæ; 165 mm. in width at the ear-opening; 218 mm. wide at the zygomatic arches; 232 mm. wide at the hinder border of the orbits; 100 mm. wide just above the antorbital foramina; from the front of the premaxillæ to the front of the nasals is 255 mm.

The antlers are, of course, absent in the female. In the grown males they form two enormous expansions which are furnished on their anterior borders with numerous tines or snags (Fig. 47). The bases are directed outward approximately at right angles with the median plane of the skull. The base is short. The antler divides into a smaller palmation directed forward and a much larger one directed outward, upward and backward. In size and form there is great variation. The extent from outside to outside of the antlers may be more than four feet.

The following measurements of the teeth are taken from the specimen mentioned above:

Length of the upper premolar-molar series, 147 mm.; of the premolar series, 67 mm.; of the molar series, 82 mm. Length of the lower premolar-molar series, 163 mm.; of the premolar series, 67 mm.; of the molar series, 93 mm.

MEASUREMENTS OF THE TEETH.

UPPER TEETH.	Measurements.	LOWER TEETH.	Measurements.
$Pm.^2$	Length, 24 mm.	$Pm._2$	Length, 19 mm.
$Pm.^2$	Width, 21 mm.	$Pm._2$	Width, 14 mm.
$Pm.^3$	Length, 23 mm.	$Pm._3$	Length, 23 mm.
$Pm.^3$	Width, 25 mm.	$Pm._3$	Width, 17 mm.
$Pm.^4$	Length, 23 mm.	$Pm._4$	Length, 27 mm.
$Pm.^4$	Width, 28 mm.	$Pm._4$	Width, 18 mm.
$M.^1$	Length, 26 mm.	$M._1$	Length, 25 mm.
$M.^1$	Width, 27 mm.	$M._1$	Width, 20 mm.
$M.^2$	Length, 28 mm.	$M._2$	Length, 27 mm.
$M.^2$	Width, 29 mm.	$M._2$	Width, 22 mm.
$M.^3$	Length, 28 mm.	$M._3$	Length, 39 mm.
$M.^3$	Width, 30 mm.	$M._3$	Width, 22 mm.

The following measurements of the bones are taken from Scott's paper on *Cervalces:*

Length of the scapula, 443 mm.; total length of humerus, 405 mm.; length of radius, 415 mm.; length of metacarpus, 318 mm.;

length of femur, 435 mm.; length of tibia, 485 mm.; length of metatarsus, 385 mm. It must be recognized that all measurements will vary somewhat in different individuals.

Genus RANGIFER Frisch.

Antlers present in both sexes, placed nearer the hinder outer angle of the skull than to the orbits, more or less palmated, furnished with brow tine. The brow tines of the two sides usually unlike, one large and directed in front of the face. A bez, or second, tine present. Axis at middle of length bent forward and ending in a snagged palmation. Lower tines on front of shaft; upper ones on its hinder border. Canine teeth present. Rather heavily built animals.

RANGIFER CARIBOU *Gmelin.*

THE CARIBOU.

Fossil remains of one or more species of caribou have been reported from many parts of North America, usually under the name *Rangifer tarandus,* which properly belongs only to an Old World species, or the name *R. caribou,* the Barren Ground Caribou of the colder parts of North America. Such remains have been found in Connecticut, New York, Ontario (Canada), New Jersey, Pennsylvania, Kentucky, Iowa, Nevada, Yukon, and Alaska. Inasmuch as the caribous of North America have been shown to belong to several species it is not at all improbable that the fossil remains do not all belong to *R. caribou.* Indeed, it is quite certain that the bones and teeth found long ago at Muscatine, Iowa, belong to what is now an extinct species.

As to the age of the caribou remains found in the United States we cannot always be certain. Some of them undoubtedly belonged to Wisconsin or post-Wisconsin times. The scanty remains found at Toronto probably lived at some time between the Illinois and the Wisconsin glacial stages. The same may be true of the Muscatine jaws and pieces of antlers.

The finding of remains of a caribou, possibly *R. caribou,* at Big Bone Lick, Kentucky, seems to justify a brief description of the caribou. It is, indeed, rather remarkable that remains of this animal have not been found in the northern half of Indiana. After the withdrawal of the Wisconsin ice-sheet there must have been a long period when the climate was favorable for the existence of these animals. Most frequently, perhaps, it is the antlers that will be found. As shown by Figure 48, the form of these is quite different from that of any other deer. This antler is that of *R. groendlandicus.* If the rear of the skull accompanies the antlers the identity of the animal is shown by the nearness of the bases of the antlers to the rear of the skull. As to the teeth there is a good deal of range in the size. There are given here measurements from a specimen of the subspecies *R. caribou sylvestris,* from Manitoba, No. 111700, U. S. National Museum. It is, however, larger than the caribou of Labrador.

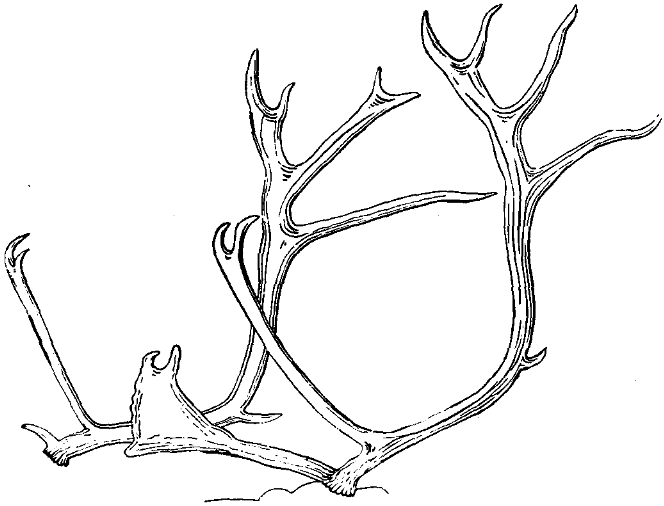


FIG. 48. *Rangifer groendlandicus,* the Barren Ground Caribou. View of two antlers of the right side, seen from the left side. The one in front belonged to a male and shows the palmated brow tine; the other, supposed to have belonged to a female, has a very short brow tine. The brow tines are directed forward. After Baird.

MEASUREMENTS OF THE TEETH.

UPPER TEETH.		LOWER TEETH.	
Premolar-molar series, length	106	Premolar-molar series, length	108
Premolar series	49	Premolar series	45
Molar series	59	Molar series	64
Pm.^{2}, length	18.5	Pm.$_2$, length	11
Pm.^{2}, width	15.5	Pm.$_2$, width	8
Pm.^{3}, length	17	Pm.$_3$, length	18
Pm.^{3}, width	16	Pm.$_3$, width	10
Pm.^{4}, length	17	Pm.$_4$, length	18
Pm.^{4}, width	16	Pm.$_4$, width	11.5
M.^{1}, length	19	M.$_1$, length	20
M.^{1}, width	16	M.$_1$, width	11
M.^{2}, length	20	M.$_2$, length	20
M.^{2}, width	16.5	M.$_2$, width	11.5
M.^{3}, length	20	M.$_3$, length	24
M.^{3}, width	16	M.$_3$, width	12

The bones of the limbs of the reindeer are relatively shorter and thicker than in other deer. The following measurements are taken from a skeleton of a caribou in the U. S. National Museum, No. 4176:

Length of scapula along the spine, 280 mm.; width across upper end, 175 mm.; humerus, total length, 256 mm.; length from head, 236 mm.; radius, length, 330 mm.; ulna, length, 280 mm.; metacarpal, length, 210 mm.; femur, total length, 300 mm.; from head to lower end, 285 mm.; tibia, length, 325 mm.

Family BOVIDÆ.

Sheep, Goats, Antelopes, Musk-oxen, Oxen.

The second and fifth metacarpals and metatarsals rarely present as separate elements; but the extremities of these digits usually present and furnished with small hoofs. The third and fourth consolidated into a single cannon bone. Males and often females provided with horns, which are outgrowths of the frontal bones and covered with a corneous sheath. Teeth, i. $\frac{0}{3}$, c. $\frac{0}{1}$, pm. $\frac{3}{3}$, m. $\frac{3}{3}$. The cheek teeth usually high-crowned and with moderate or small roots.

The earliest known relatives of this widely distributed and numerously represented family are found in the Lower Miocene. Antelopes, sheep, and oxen all existed in the Pliocene and abounded during the Pleistocene. So far as known, none of the family has ever reached Australia or South America, except through the agency of man.

Subfamily OVIBOVINÆ.

The Musk-oxen.

Bovidæ with the horn-cores rising close behind the orbits and directed outward and more or less downward and forward. Premaxillæ not reaching the nasals. Teeth high-crowned, but with the styles not as strongly developed as in the Bovinæ.

These animals appear always to have inhabited the colder parts of the Northern Hemisphere. Five genera are probably to be recognized: *Preptoceros, Euceratherium, Symbos, Boötherium,* and *Ovibos.* The first two are known only from the Pacific Coast.

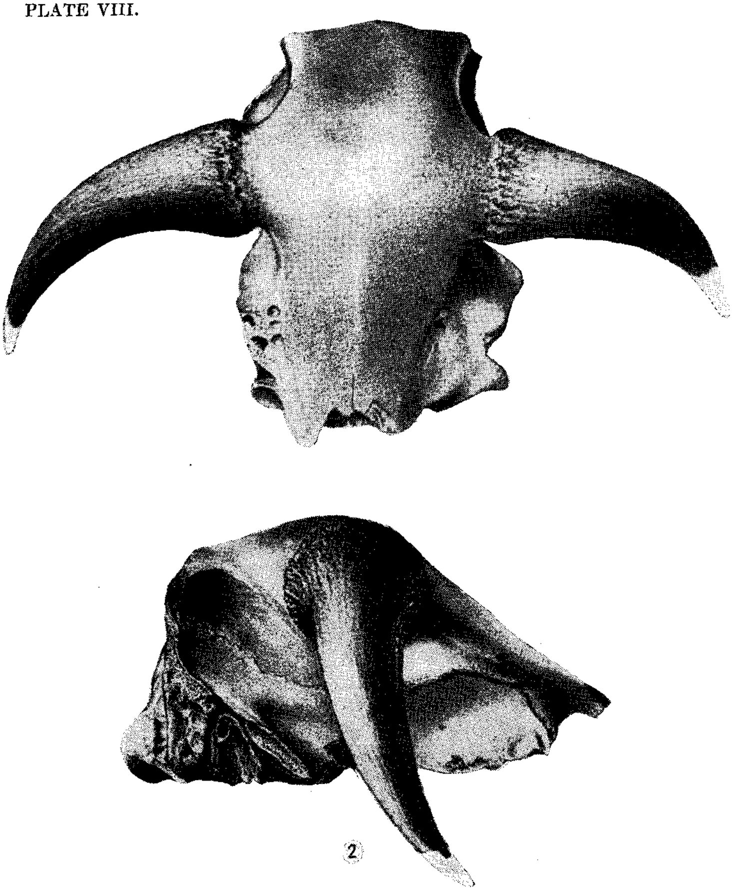
Genus BOOTHERIUM Leidy.

Horn-cores diverging outward and downward from the skull; the rough surfaces for the horn forming a circular burr at the bases of the cores and not encroaching on the forehead. Space between the bases of the horn-cores smooth and convex. Teeth formula as in other Bovidæ, but their special structure unknown.

BOÖTHERIUM BOMBIFRONS Harlan.

Little is known about the species except from the original specimen which was found nearly a hundred years ago near the Ohio River, at Big Bone Lick, Ky. This specimen is now preserved in the Academy of Natural Sciences in Philadelphia. It was described

PLATE VIII.



Bootherium bombifrons. Front and side views of the type skull. Slightly less than one-fourth the natural size. After Leidy.

in 1818 by Casper Wistar, without systematic name. In 1854 Dr. Leidy described and figured it under the name which it now bears. In 1905 Mr. W. H. Osgood made the species the type of the genus *Boötherium*, which had been made by Leidy to include likewise the species described below under the name of *Symbos cavifrons*.

Two of Leidy's figures are here presented somewhat reduced (Pl. VIII). These figures show well the direction taken by the horn-cores; the burr at the bases, resembling that in the oxen; the nearly equal diameters at the bases; the short but distinct pedicel between the forehead and the burr; and the wide, convex, and smooth surface between the two horn-cores.

The following measurements have been taken by the writer from the skull at Philadelphia:

Length of the skull from occipital condyles to notch for the nasals.	263 mm.
Length of the skull from occipital crest to notch for the nasals...	240 mm.
Height of the rear of the skull above lower border of the occipital condyles	137 mm.
Width of skull at the occipital crest	117 mm.
Width of the skull at the ear-opening	170 mm.
Width of face at front of the orbits	180 mm.
Diameter of the orbit, fore and aft	80 mm.
Circumference of base of horn-core	225 mm.
Diameter of base of horn-core on plane of face	70 mm.
Diameter of base of horn-core at right angles to preceding	67 mm.
Length of horn-core along upper curve	225 mm.
Distance between tips of horn-cores	440 mm.
Distance between bases of horn-cores	150 mm.

Remains of *Boötherium bombifrons* may be expected with confidence to occur within the limits of Indiana.

This species has by some authors been regarded as the female of *Symbos cavifrons,* but the writer does not share in this opinion.

Genus SYMBOS Osgood.

Horn-cores directed outward, downward and forward; the upper face flattened at the base. The exostoses of the two sides coalescing at the midline, extending backward to the occipital crest and forward to or beyond the orbits. Space between the horn-cores concave. Borders of orbits not so much produced as in *Ovibos.* Teeth not well-known, but as far as known essentially like those of *Ovibos,* but larger.

The type of this genus is Osgood's *Scaphoceros tyrrelli,* later called *Symbos tyrrelli,* found in Yukon Territory. This was based on a nearly complete skull, lacking, however, the lower jaw. In the same genus he included the species long known as *Boötherium cavifrons,* originally described by Leidy.

SYMBOS CAVIFRONS Leidy.

The type of this species was found many years ago near Fort Gibson, Indian Territory, near the junction of the Neosho River with the Arkansas. When discovered it was used as a seat in the hut of an Indian. It is now in the collection of the Academy of Natural Sciences of Philadelphia. It was described and figured by Leidy in 1853 (Smithson. Cont. Knowl., Vol. V, Art. 3). Figures of the same skull were published by W. H. Osgood in 1905 (Smithson. Misc. Coll., Vol. XLVIII, pls. XL-XLII). The skull was represented by only the hinder part, extending forward only to the notch for the hinder end of the nasal bones. However, the tips would have extended to the rear of the orbits. The base of the horn-core is flattened on the upper surface, so that the one diameter is much greater than the other. Between the horn-cores the forehead is rough and pretty deeply concave, with a slight median longitudinal ridge. In *Ovibos* there is, between the rough horn-supporting surfaces of the two sides, a narrow but distinct groove, and in life this groove is occupied by a streak of hair. It is probable that in the members of the genus *Symbos* the horns of the two sides coalesced across the forehead.

The following measurements were taken by the writer from this skull at Philadelphia:

Measurements.

Skull, length from the condyles to the fronto-nasal suture......	300 mm.
Skull, length from occipital crest to fronto-nasal suture, straight.	285 mm.
Height of the occipital crest from bottom of condyles............	220 mm.
Width of skull at occipital crest	140 mm.
Width of skull at ear-opening	210 mm.
Width of skull at front of orbits	210 mm
Diameter of orbit, fore and aft............................	95 mm.
Circumference of base of horn-core	300 mm.
Diameter of base of horn-core, on plane of face	110 mm.
Diameter of base of horn-core, at right angles to preceding.....	75 mm.
Length of horn-core along upper curve, estimated	300 mm.
Distance between tips of horn-cores	575 mm.

The finest known specimen of this species is a skull which was discovered about the year 1904 by some workmen while digging for the foundations of a railroad bridge across a slough, about six miles east of Hebron, Porter County, Indiana, about 60 miles south-southeast of Chicago. The more exact location given is the N. E. corner of Section 16, Township 33, north, Range 6 west of the Second Principal Meridian. This, according to the map, would be

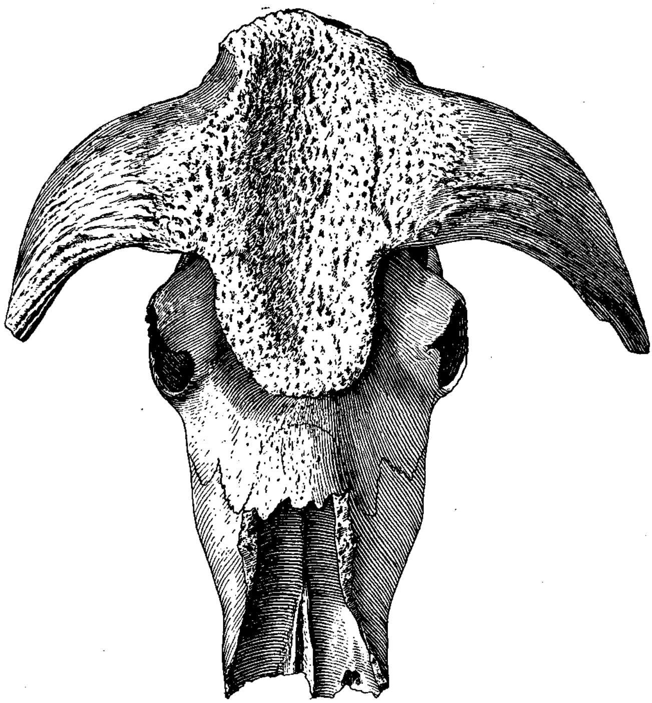


FIG. 49.

not far north of the Kankakee River. The depth was about seven feet and the soil is stated to have been a mixture of sand and clay.

This specimen lacks the lower jaw, a part of each of the nasals,

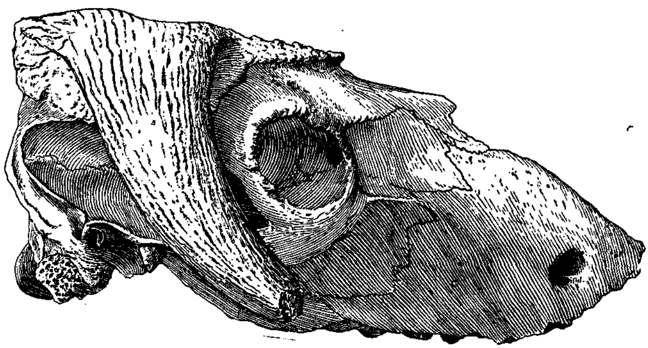


FIG. 50.

Figs. 49, 50. *Symbos cavifrons*. Front and side views of the skull from Hebron, Indiana; now in the American Museum of Natural History, New York. Drawing by R. Weber. About ⅙ the natural size.

the premaxillæ, the extremities of the maxillæ, all the teeth except one, and the tips of the horn-cores. For many years this specimen had been in the merchandise store of Mr. J. W. Dowd, in Hebron, by whom the writer was kindly permitted to take photographs and measurements. From the photographs figures 49 and 50 have been prepared. The extremity of the right maxilla was present when the specimen was found, as is shown by a photograph taken at that time, but has not been included in the drawings here presented. The specimen is now in the collection of the American Museum of Natural History, New York.

From occipital condyles to the maxillo-premaxillary articulation	478 mm.
Height of occipital crest above lower face of condyles	223 mm.
Width at opening of ear	191 mm.
Width at hinder end of temporal fossæ	134 mm.
Lateral extent of occipital condyles	118 mm.
Tip to tip of horn-cores, as preserved	525 mm.
Median length of rough surface of forehead	267 mm.
Width of the concavity, taken at middle of horn-cores	125 mm.
Depth of the concavity between horn-cores, greatest	36 mm.
Fore-and-aft width of bases of horn-cores	118 mm.
Length of horn-cores, as preserved	225 mm.
Length of horn-cores, originally, calculated	380 mm.
From rear of skull to hinder border of orbit	191 mm.
Diameter of orbit	63 mm.
From occipital crest to fronto-nasal suture	275 mm.
Height of skull above alveolar border at front of rough surface in forehead	228 mm.
Width of face at rear of articulation of maxilla and premaxilla	116 mm.
Width of face 50 mm. in front of orbits	203 mm.
Width of face between horn-cores and orbits	141 mm.
Width across zygomatic arches	223 mm.
Width of hinder end of basioccipital eminence	82 mm.
From rear of occipital condyles to front of hinder nares	263 mm
Greatest width of hinder nares	58 mm.
Width of palate between the molars	95 mm.
Width of palate between front premolars	70 mm.
Length of tooth series, as shown by alveoli	182 mm.

The exostosis which occupies the forehead is greatly developed. It extends backward to the occipital crest and forward to the line joining the fronts of the orbits. It is very rough. The space occupied by it is concave from side to side. There is no median ridge and no ridges bounding it in front and in the rear.

The horn-cores are flattened above, and wide fore and aft. Away from the base the upper surface becomes more and more convex. The lower surface is more convex than the upper. From the bases these cores are directed forward and downward. Their extremities fell below the orbits and reached fully to the front of the orbits.

In front of each orbit there is a considerable excavation for a gland. The orbits do not have their borders built out so extensively as in *Ovibos.*

The alveolar border of the maxilla appears to be unusually convex, as seen from the side. The antorbital foramen is above the second tooth from the front, pm.[3]. The palatine bones extend forward to the space between the first and the second true molars. One tooth, the left first upper molar, is present. It is considerably worn, but yet rises 25 mm. above the root. The crown has a fore and aft length of 38 mm. and a width of 28 mm. It is thus considerably larger than the same tooth in *Ovibos moschatus.* The structure of the tooth resembles that in the latter musk-ox; but the external pillars seem to be less strongly developed.

In the geological collection at Earlham College, Richmond, there is the rear of the skull of an individual of this species. This was found in Randolph County, but at what place is not known. The skull has been somewhat eroded and thereby injured.

The following measurements were taken:

Height of occipital crest above foramen magnum	170 mm.
Width at hinder ends of temporal fossæ	130 mm.
Width at ear-openings	190 mm.
Width of concavity between bases of horn-cores	120 mm.
Length of concavity between bases of horn-cores	170 mm.
Fore-and-aft width of bases of horn-cores	95 mm.
Length of left horn-cores, on upper curve (some gone)	200 mm.

In the American Museum of Natural History, in New York, is a part of the skull of a musk-ox that is to be referred with necessarily some doubt to this species. The specimen was reported to have fallen out of the bank of White River, near Walesboro, Bartholomew County, Indiana, in 1904. It was presented to the American Museum by Dr. J. J. Edwards of Columbus, Indiana, in 1908. A tooth of *Elephas* is reported to have been found previously in the same gravel.

The specimen is a much damaged one consisting of the rear of the skull, with only stumps of the horn-cores, and it has been somewhat waterworn. Between the bases of the horn-cores there is a great concavity nearly 100 mm. wide and rough. This narrows backward and forward.

The following measurements were taken:

Height of occipital crest above upper lip of foramen magnum	170 mm.
Width across the rear of skull at ear-openings	200± mm.
Width of occiput at constriction below horn-cores	114 mm.
Diameter of horn-cores on plane of face	120± mm.
Diameter of horn-cores at right angles to preceding	73± mm.

Frank H. Bradley (Geol. Surv. Ill., IV., 1870, p. 375), stated that remains of "*Boötherium*" had been found at Beaver Lake, Newton County, Indiana. He mentioned that a Dr. Keyser, of Momence, Illinois, had found the bones. It is more probable that the remains belonged to the species here described. Still another specimen is known from Indiana. This is now in Earlham College, Richmond, and was found at some point in Randolph County. The rear of the skull is present with the horn-cores, which have lost their distal ends. The rear of the skull is high and the horn-cores are broad at their bases. The width of the ear-openings is 190 mm.; that at the hinder ends of the temporal fossæ, 130 mm.; width of the concavity between the horn-cores, 120 mm.; length of the rough surface between the horn-cores, 170 mm.; length of portion remaining of left horn-core, 200 mm.

It is impossible to say exactly to what stages of the Pleistocene either the Big Bone Lick specimen or that from Bartholomew County belongs. The former place is located on the southern margin of the Illinois drift sheet; the latter on the margin of the Wisconsin drift. And with our present knowledge we cannot be certain in regard to the relations of the specimens to the drifts in, below or above, which they may have been buried.

We need be in no such doubt concerning the epoch of the Hebron specimen. All that region is covered with deposits of Wisconsin drift. According to Leverett's map (Monogr. XXXVIII, U. S. Geol. Surv., pl. VI), the specimen must have been in a deposit overlying what he calls Iroquois till, belonging to the late Wisconsin. It is possible that the animal was living near the foot of the glacier which left the Valparaiso moraine. The Randolph County specimen must likewise be looked on as belonging to post-Wisconsin time.

Attention ought to be directed to the recovery of the bones of the trunk and limbs of this and other species of extinct musk-ox.

Genus OVIBOS Blainville.

Musk-oxen with horn-cores directed forward and strongly downward, close to the sides of the skull; the bases broad and flat above and with the horn supporting surface extending nearly to the mid-

PLATE IX

FIG. 1.

FIG. 2.

Fig. 1. *Ovibos moschatus*, the Musk-ox. No. 14413, U. S. Nat. Mus.; from photograph furnished by Dep't Agriculture. $\times\frac{1}{5}\pm$.
Fig. 2. *Ovibos moschatus*. Front view of the imperfect skull at Earlham College, Indiana. $\times\frac{1}{3}$.

line of the forehead, leaving, however, a narrow space between them. Teeth, with rather high crowns. Lower incisors and canines small.

At the present day this genus contains two species, *O. moschatus,* of the shores of the Arctic Ocean east of the Mackenzie River, and *O. wardi,* of northern Greenland and Elsmere Land. The latter may, however, be only a subspecies of *O. moschatus.* In prehistoric time what has been regarded as *O. moschatus* extended from Great Britain across Europe to northern Asia and into Alaska and Yukon Territory.

OVIBOS MOSCHATUS Zimm.

Within historical times this species has been found in the Arctic regions of North America from the Mackenzie, on the lands and islands washed by the Arctic Ocean, south to Hudson Bay and north to Jones Sound. Its range has now become much more restricted. It, or a species not yet distinguished from it, was during late Pleistocene times forced southward by the Wisconsin ice-sheet and again followed this as it withdrew towards the Hudson Bay region. Plate IX, Fig. 1, presents a front view of a skull of a recent specimen of the musk-ox for comparison with figure 2 of the same plate.

The writer has knowledge of three specimens of a musk-ox belonging to the genus *Ovibos* and at present not distinguishable from *O. moschatus.* One of these is now in the geological collection at the University of Ohio, at Columbus. This was found in 1894, by W. A. McGinnis, at Youngstown, Ohio. The statement is made that it was discovered under 60 feet of gravel. The horn-cores had been eroded off to their very bases.

The writer has photographs of a part of a musk-ox skull that is in the possession of Dr. Frederick Becker, of Clermont, Iowa, and which was found in that region. His son, Mr. A. G. Becker, has kindly sent me photographs of it. It seems to belong to *Ovibos moschatus.*

A third specimen is in the collection at Earlham College, Richmond, Indiana. Photographs of this have very kindly been sent to the present writer by Prof. D. W. Dennis, who secured the specimen from the workmen who unearthed it near Richmond. From one of these Fig. 2 of plate IX has been made. The writer has also been permitted to examine and take measurements of the specimen.

Only the hinder end of the skull is preserved, and, when found, this was in a very fragile condition. The horn-cores are broken off close to their bases.

The following measurements were taken of this specimen:

Height of the upper surfaces of bases of horn-cores above the lower surfaces of the occipital condyles	165 mm.
Width across skull at hinder ends of temporal fossæ	140 mm.
Width across skull at ear-openings	160 mm.
Width across skull just behind the orbits	160 mm.
Length of exostoses of bases of horn-cores	180 mm.

The upper surfaces of the exostoses are concave in all directions. A rather prominent ridge bounds each of them next to the median groove. The suture between the squamosal and the frontal bones was yet open; that between the supraoccipital and the parietal was closed. The close resemblance of this skull to that of the living species of musk-ox will be noted on comparing figure 1, plate IX, with figure 2 of the same plate.

Inasmuch as other specimens of this musk-ox are likely to be found, some of them, it is to be hoped, furnishing skulls with both jaws and teeth and bones of the trunk and limbs, it is thought well to give measurements of the skull and teeth and of some of the principal bones of the skeleton of a specimen of a recent *Ovibos moschatus*. These measurements may serve in the identification of the fossil remains. The measurements of the skull and teeth are taken from a skull, No. 108722, belonging to the Biological Survey of the U. S. Department of Agriculture. The other measurements were obtained from a skeleton belonging to the U. S. National Museum.

Length of skull from condyles to front of premaxillæ	435 mm.
Length of skull from condyles to front of hinder nares	191 mm.
Height of occipital crest above the occipital condyles	116 mm.
Width of occipital at just behind ear-openings	160 mm.
Width of occipital at hinder end of temporal fossæ	120 mm.
Width of occipital across middle of zygomatic arches	165 mm.
Width of occipital across orbits, lower border	230 mm.
Width of occipital above second true molars, greatest	137 mm.
Width of occipital front of above anterior premolar, greatest	95 mm.
Distance from lower jaw to anterior premolar	106 mm.
Depth of lower jaw at first true molar	42 mm.
Length of upper premolar-molar series	130 mm.
Length of upper premolar series	45 mm.
Length of upper molar series	84 mm.
Length of lower premolar-molar series	136 mm.

Length of lower premolar series .... 46 mm.
Length of lower molar series .... 90 mm.
Scapula, length along the spine .... 335 mm.
Scapula, width of upper end .... 200 mm.
Humerus, total length .... 325 mm.
Humerus, from head to inner side of distal end................. 285 mm.
Humerus, transverse diameter at middle of shaft .... 36 mm.
Radius, total length .... 298 mm.
Radius, transverse diameter at middle of shaft .... 37 mm.
Ulna, total length .... 363 mm.
Anterior cannon-bone, length .... 172 mm.
Anterior cannon-bone, transverse diameter of middle of shaft.... 36 mm.
Pelvis, length .... 410 mm.
Pelvis, width at acetabula .... 195 mm.
Pelvis, width at hinder end of ischia .... 325 mm.
Femur, total length .... 338 mm.
Femur, length from head to inner side of distal end........... 338 mm.
Tibia, total length .... 340 mm.
Tibia, transverse diameter at middle of shaft .... 37 mm.
Tibia, width of distal end .... 58 mm.
Hinder cannon-bone, length .... 187 mm.
Hinder cannon-bone, transverse diameter at middle of shaft..... 27 mm.

MEASUREMENTS OF TEETH

UPPER TEETH.	Measurements.	LOWER TEETH.	Measurements.
Pm.^{2}	Length, 14 mm.	Pm.$_2$	Length, 11.5 mm.
Pm.^{2}	Width, 11 mm.	Pm.$_2$	Width, 7 mm.
Pm.^{3}	Length, 18 mm.	Pm.$_3$	Length, 16 mm.
Pm.^{3}	Width, 15 mm.	Pm.$_3$	Width, 9 mm.
Pm.^{4}	Length, 18 mm.	Pm.$_4$	Length, 19 mm.
Pm.^{4}	Width, 16 mm.	Pm.$_4$	Width, 13 mm.
M.^{1}	Length, 26 mm.	M.$_1$	Length, 24 mm.
M.^{1}	Width, 20 mm.	M.$_1$	Width, 16 mm.
M.^{2}	Length, 30 mm.	M.$_2$	Length, 28 mm.
M.^{2}	Width, 19 mm.	M.$_2$	Width 15 mm.
M.^{3}	Length, 32 mm.	M.$_3$	Length, 38 mm.
M.^{3}	Width, 19 mm.	M.$_3$	Width, 13 mm.

The shaft of the anterior cannon-bone is broad and flat; that of the hinder cannon-bone nearly square. In the male of the living animal the horn passes close to the skull, downward and forward below the eye, then upward and slightly outward in front of the eye, and finally upward, outward and backward. The orbit is thus nearly surrounded by the horn. When the horn is removed from the core, the latter is found to be about one-half the length of the horn. It is sometimes, however, much less than one-half the length of the horn.

The upper teeth of *Ovibos* differ in several respects from those of *Bison,* and of *Bos* (the common ox). The teeth of *Ovibos* have no cement. This may, of course, be missing in fossil teeth of the bisons, for it dissolves more easily than the other elements. The teeth of *Ovibos* are not nearly as broad as those of the bisons, but the crowns of the molars are fully as long, fore and aft. *Ovibos,* like *Bison* and *Bos,* has, on the outer face of each premolar, an anterior and posterior style; and, on the true molars, an anterior, a median, and a posterior style. However, in *Bison* and *Bos* there are in the premolars and in the molars two intermediate styles which exceed in breadth and prominence the main style; while in *Ovibos* these appear as mere swellings of the enamel. *Bison* and *Bos* have on the inner face of the true molars a large column between the two lobes. This is not present in *Ovibos.*

In *Ovibos* the lower premolars and molars are both shorter along the crown and narrower than those of the bisons. The true molars of the latter have on the outer face, between the lobes, a large column of enamel which is missing in the species of *Ovibos.* The styles on the inner faces are more strongly developed than in the bisons and the common ox.

The teeth of the elk, *Cervus canadensis,* are lower-crowned and broader than the corresponding ones of *Ovibos;* and they have the styles, especially the intermediate ones, better developed than in *Ovibos.*

These remarks are to be applied with still stronger force to the teeth of *Alces* when compared with those of *Ovibos.*

Subfamily BOVINÆ.

The Bisons, Buffaloes, and Oxen.

Bovidæ with the horn-cores placed well behind the orbits, sometimes at the hinder outer angles of the skull; directed upward and outward. Frontal bones developed posteriorly at the expense of the parietal. Premaxillæ not reaching the nasals. Teeth high-crowned, prismatic, with strongly developed styles and accessory columns, and covered with a coat of cement.

The earliest known members of this group appeared in the Pliocene of India. They are known also from the same age in Europe. They were well represented in Europe, Asia and America during the Pleistocene. All the species native to America belong to the genus *Bison.* The common domestic ox belongs to the genus *Bos.*

Genus BISON H. Smith.

Horn-cores cylindrical, directed outward and upward, usually somewhat backward, rising nearer the hinder outer angle of the skull than to the orbit. Forehead short and unusually broad, the muzzle narrowed.

The type species of this genus is *Bison bison,* the American Bison, or American Buffalo, that once occupied a large part of our continent, but which is now on the verge of extinction. Besides this species, there once existed in North America several other species of the same genus, as *Bison antiquus, B. occidentalis, B. crassicornis, B. alleni, B. ferox,* and *B. latifrons.*

BISON BISON Linnæus.

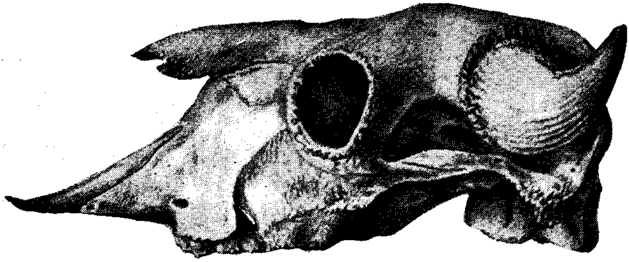
THE AMERICAN BISON; AMERICAN BUFFALO.

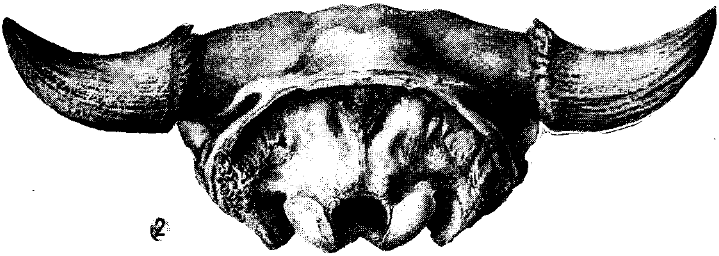
Inasmuch as this species has been reported from the State as a Pleistocene fossil, and as its structure is thoroughly known, and may therefore serve as standard for the comparison of remains of other fossil bisons, a rather detailed description of it and measurements will be given. These are taken from a mounted skeleton at the U. S. National Museum, No. 12456. Measurements of other specimens are to be found in Dr. J. A. Allen's monograph on American bisons. Figures are here presented, taken from Allen's monograph (Pl. X, Figs. 1-4). Figures 1 and 2 give views of the skull of an old male from Kansas. Figure 3 represents, of two-thirds the natural size, the teeth of the right lower molars of a middle-aged specimen; while Fig. 4 represents the upper cheek-teeth of the same specimen.

MEASUREMENTS OF THE SKELETON.

Length from front of head along the face and straight to hinder end of pelvis	2,808 mm.
Height at the shoulders	1,660 mm.
Skull, length from premaxillæ	528 mm.
Distance from occipital crest to front of nasals	445 mm.
Distance from front of premaxillæ to front of hinder nares	315 mm.
Distance from front of premaxillæ to first premolar	154 mm.
Width at hinder ends of temporal fossæ	177 mm.
Width between bones of horn-cores	260 mm.
Width above first true molar, greatest	212 mm.
Width above anterior premolar, greatest	128 mm.
Width of palate between last molars	115 mm.
Width of palate between anterior premolars	93 mm.

PLATE X.





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3

4

Bison bison. Fig. 1. Skull of old male, side view. ×⅛. Fig. 2. Same skull seen from behind. Fig. 3. Upper premolars and molars of left side of a middle-aged specimen, showing the grinding surfaces. ×⅔. Fig. 4. Right lower molars of same specimen. ×⅔. After Dr J. A. Allen.

Length of horn-core along upper curve	222 mm.
Length of horn-core along lower curve	275 mm.
Circumference of base of horn-core	275 mm.
Diameter of base of horn-core on plane of face	93 mm.
Distance between tips of horn-cores	610 mm.
Diameter of base of horn-core at right angles to latter	83 mm.
Length lower jaw from front to angle	415 mm.
Length lower jaw from front to condyle, straight line	436 mm.
Breadth of atlas	220 mm.
Breadth of axis, in front	127 mm.
Height of spine of first dorsal vertebra	495 mm.
Length of scapula along the spine	490 mm.
Width of upper end of scapula	300 mm.
Humerus, total length	375 mm.
Humerus, length from head to inner side of distal end	315 mm.
Humerus, diameter at middle of shaft, side to side	60 mm.
Humerus, diameter at distal end, side to side	110 mm.
Radius, total length	335 mm.
Radius, diameter at middle of shaft, side to side	57 mm.
Radius, diameter at middle of shaft, fore and aft	36 mm.
Ulna, total length	435 mm.
Anterior cannon-bone, total length	206 mm.
Anterior cannon-bone, diameter at middle of shaft, side to side.	52 mm.
Anterior cannon-bone, diameter at middle of shaft, fore and aft	33 mm.
Pelvis, total length	555 mm.
Pelvis, width at acetabula	280 mm.
Pelvis, width at hinder end of ischia	295 mm.
Femur, total length	450 mm.
Femur, length from head to inner side of distal end	400 mm.
Femur, diameter at middle of shaft, side to side	53 mm.
Tibia, total length	412 mm.
Tibia, diameter at middle of shaft, side to side	60 mm.
Tibia, diameter at middle of shaft, fore and aft	46 mm.
Calcaneum, total length	162 mm.
Hinder cannon-bone	255 mm.
Hinder cannon-bone diameter at middle of shaft, side to side	40 mm.
Hinder cannon-bone diameter at middle of shaft, fore and aft	38 mm.

Inasmuch as the teeth of the specimen measured above were too much worn to give satisfactory measurements, use is made of a skull of a male bison from northern Alberta, British America, No. 172689, U. S. Nat. Mus. The length of this skull is 566 mm., and therefore somewhat larger than that of the mounted skeleton.

Length, upper premolar-molar series	143 mm
Length, upper premolar series	60 mm.
Length, molar series	87 mm.
Length, lower premolar-molar series	154 mm.
Length, lower premolar series	53 mm
Length, lower molar series	102 mm.

MEASUREMENTS OF THE VARIOUS TEETH.

UPPER TEETH.	Measurements.	LOWER TEETH.	Measurements.
$Pm.^2$	Length, 21 mm.	$Pm._2$	Length, 14 mm.
$Pm.^2$	Width, 14 mm.	$Pm._2$	Width, 10 mm.
$Pm.^3$	Length, 22 mm.	$Pm._3$	Length, 19 mm.
$Pm.^3$	Width, 20 mm.	$Pm._3$	Width, 11 mm.
$Pm.^4$	Length, 18 mm.	$Pm._4$	Length, 20 mm.
$Pm.^4$	Width, 25 mm.	$Pm._4$	Width, 13 mm.
$M.^1$	Length, 24 mm.	$M._1$	Length, 25 mm.
$M.^1$	Width, 26 mm.	$M._1$	Width, 19 mm.
$M.^2$	Length, 30 mm.	$M._2$	Length, 31 mm.
$M.^2$	Width, 28 mm.	$M._2$	Width, 22 mm.
$M.^3$	Length, 33 mm.	$M._3$	Length, 47 mm.
$M.^3$	Width, 27 mm.	$M._3$	Width, 20 mm.

The premolars of the specimen, especially the lower ones, are much worn and the measurements are not reliable.

The intermediate styles on the outer faces of the upper teeth, those between the horns of the crescents, are strongly developed, being broader than, and fully as prominent as, the primary ones. These intermediate styles project beyond the rest of the crown. On the inner side of the upper molars, between the two lobes, is a strong column, which, as the tooth becomes worn, appears on the worn surface as a strong fold of enamel filling up the valley between the lobes. When the tooth becomes worn down to near the roots, this fold disappears.

In the lower molars the intermediate styles are on the inner side of the teeth and project strongly upward. On the outer face, filling up the valley between the two lobes, is a column, like that of the upper teeth, which, on wearing down, produces a similar fold of enamel.

In his monograph on the American bisons, Dr. J. A. Allen has given measurements and figures which show that the cannon-bones, both of the front and of the hinder limbs, are extremely variable, especially in the side to side diameter. The horns of this species are short and stout, the circumference at the base being considerably greater than the length along the upper curve. They are sometimes only slightly curved, usually rather strongly so. They are directed outward, more or less downward and backward, then somewhat upward. Usually a line drawn from the tips of one horn-core to the other will fall behind and about on a level with the occipital crest. Often the forehead is more or less inflated, and then the horn-cores are directed more strongly downward. The species may be distinguished in general by the short, stubby horn-cores directed outward and backward. The horn-cores of the female are smaller and slenderer than those of the male.

Remains of the American buffalo, as it is called, *Bison bison*, were reported from Jasper County by the State Geologist, John Collett, in the 12th Annual Report of the Geological Survey, 1883, p. 73. He stated that in that county the bones of the buffalo, beaver, and bear, are common. It is to be regretted that no details were presented as to exact localities and the nature of the materials found. We are wholly unable to determine whether these remains might belong to Pleistocene deposits or to those of rather recent times.

At the mouth of Pigeon Creek, Vanderburgh County, Mr. Francis A. Lincke, some time previous to 1854, found what were supposed by Leidy to be probably remains of this bison, in company with remains of the megalonyx, an extinct horse, a tapir, the Virginia deer, and the wolf, *Canis dirus*. It is not at all unlikely, however, that the bison remains belonged to some one of the extinct species. While teeth and some other parts of a bison which can not yet be distinguished from those of the American bison occur in deposits belonging to the very beginning of the Pleistocene, we can not rely on the identifications. We are not yet able to distinguish the teeth of this bison from those of various other species. At least one good reason for this is that we have not good teeth of all the species in skulls that can be identified. The trend of the evidence is toward the conclusion that the existing bison was a late migrant into the region east of the Mississippi River.

If we cannot be certain regarding the discovery of fossil remains of *Bison bison* in Indiana, there is no such doubt about its occurrence at Big Bone Lick, Kentucky. Numerous bones and teeth, including some skulls, have been exhumed there. Unfortunately it is not certain that these remains were contained in actual Pleistocene deposits. Some of these skulls and various teeth and bones from this place are described and figured in Dr. J. A. Allen's monograph already referred to.

BISON ANTIQUUS Leidy.

This species was founded in 1852, by Dr. Joseph Leidy, on a right horn-core and the attached part of the cranium extending to the midline. It lacked the distal end and was somewhat damaged otherwise. It had been found at Big Bone Lick, Kentucky, and was a part of the collection presented to the American Philosophical Society by President Jefferson. It was described and figured by Leidy and again by Lucas in the 21st volume of the Proceedings of the U. S. National Museum, p. 759, pls. LXVII and LXVIII. Though thousands of bones of the living bison have been found at Big Bone Lick, no other parts of *B. antiquus* have ever been discovered there. Dr. Leidy afterwards referred to the same species

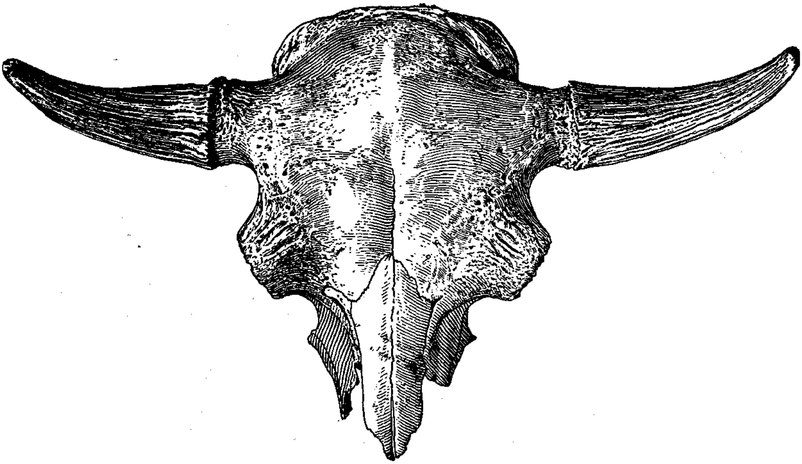


FIG. 50. *Bison antiquus*. View of face of specimen at Earlham College. × .115.

a fossil skull that had been found in California, associated with bones of elephant, a mastodon, a horse, and a camel. This specimen, as well as the Big Bone Lick specimen, is in the collection of the Philadelphia Academy of Sciences. On account of injuries to the horn-core it is difficult to determine the dimensions in life.

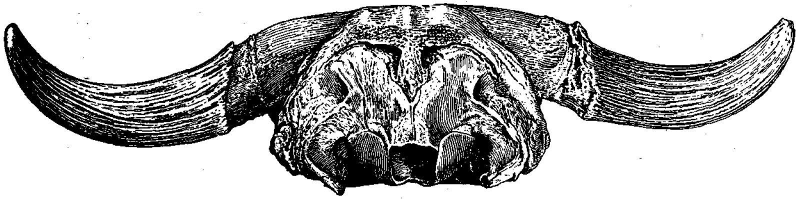


FIG. 51. *Bison antiquus*. View of rear of skull of same specimen as Fig. 50.

Professor Lucas estimated the circumference at the base as having been 364 mm.; the diameter on the plane of the face, 128 mm.; the one at right angles with this, 120 mm.; the length along the upper curve, 213 mm.; that along the lower curve, 252 mm. The writer made the same measurements respectively, 385 mm., 127 mm., 100 mm., 290 mm., and 326 mm. Dr. J. A. Allen gives the circumference of the base as 370 mm. At any rate, the specimen shows that the horn-cores were rather short and stout, with the circumference of the base greater than the length of the upper curve; also, that they were directed outward at right angles with the median plane of the skull, that the tips did not get behind the plane of the occiput and that, seen from behind, they sagged somewhat; but that nowhere did the lower face fall below the occipital condyles, while the tips rose somewhat above the plane of the forehead.

In the geological collection of Earlham College, Richmond, is the larger part of the skull of a bison which seems referable to this species. This was found in 1896 by a Mr. Brower, a few miles from Vincennes, Indiana, in a ditch at a depth of six feet. The writer has not been able to ascertain the exact locality.

It was described and figured by Mr. W. G. Middleton and Prof. Joseph Moore in the Proceedings of the Indiana Academy of Science for 1899, pp. 178-181, with a plate. Through the kindness of Prof. A. D. Hole, of the department of geology in that college, the writer was permitted to study and photograph this valuable specimen. From the photographs taken, Mr. R. Weber has made line drawings (Figs. 50, 51).

In this specimen the whole face is present except the premaxillæ and the extremities of the maxillæ. The lower jaw also is missing, as well as all the teeth of the upper jaw except M^1 and M^2; but these are worn down to their roots and are of no value. The tip of the right horn-core is gone.

The following measurements have been taken:

From the occipital crest to the front of the nasals	530 mm.
From the occipital crest to lower border of occipital condyles	160± mm.
Width across the occipital condyles	137 mm.
Width across the skull at hinder ends of the temporal fossæ	205 mm.
Width across the skull at ear-openings	310 mm.
Width across the skull between the orbits and bases of horn-cores	310 mm.
Width of skull across rear of orbits	360 mm.
Width of face immediately in front of orbits	182 mm.
Length of nasal bones	255 mm.
Width of both nasals near upper end	80 mm.
Space between bases of horn-cores	400 mm.
Space between tips of horn-cores	880± mm.
Circumference of base of horn-cores	290 mm.
Diameter of horn-cores on plane of face	103 mm.
Diameter of horn-cores at right angles to the latter	90 mm.
Length of horn-core along upper curve	290 mm.
Length of horn-core along lower curve	355 mm.

From the alveoli it is seen that the length of the series of true molars was 110 mm. Comparison of this and other measurements with corresponding ones taken from the skull of the Athabascan specimen of *Bison bison,* the measurements of which are given on page 645, indicates that the fossil skull was still larger than that of the large subspecies of the living species. It will be observed that in this specimen referred to *B. antiquus,* the horn-cores are slenderer than they appear to have been in the type, the circumference at the base being equal only to the upper curve. It is possible that this specimen was a female; or there may have been in this species, as in the living bison, a good deal of variation in the form of the horns. The horn-cores resemble those of *B. occidentalis,* but in the latter species they project at the base, not directly outward, but outward, backward, and upward.

As regards the geological age of this species, only this can be said: No extinct bison appears yet to have been found in deposits overlying the Wisconsin drift; and we may therefore draw the provisional conclusion that they had become extinct before the close, possibly before the beginning, of this Pleistocene stage.

BISON LATIFRONS Harlan.

This is a species of bison which inhabited the Mississippi Valley during a part of the Pleistocene epoch and which was characterized by the possession of rather straight horns of immense size. The first known remains of the animal were discovered more than a hundred years ago in the bed of a creek which empties into the Ohio River 12 or 14 miles above Big Bone Lick, Kentucky, and were described and figured by Rembrandt Peale in 1803. The name *Bos latifrons* was given to the species by Harlan in 1825, but now it is regarded as belonging to the genus *Bison* instead of the genus *Bos.*

The part known to the early investigators consisted of the rear of the skull bearing the basal portion, 14 inches in length, of the left horn-core. This specimen is now in the collection of the Academy of Natural Sciences, in Philadelphia. Dr. Leidy stated that the breadth of the forehead between the horn-cores was 15 inches (375 mm.); the circumference of the horn-core at its base, 20½ inches (508 mm.); circumference at 10 inches from the base, 17½ inches (432 mm.). Lucas gives as the diameters of the base of the horn-core 175 mm. for that in the plane of the face, 150 mm. for that at right angles to this. It will be observed that the diameter decreases slowly away from the base. A far more satisfactory

PLATE XI.

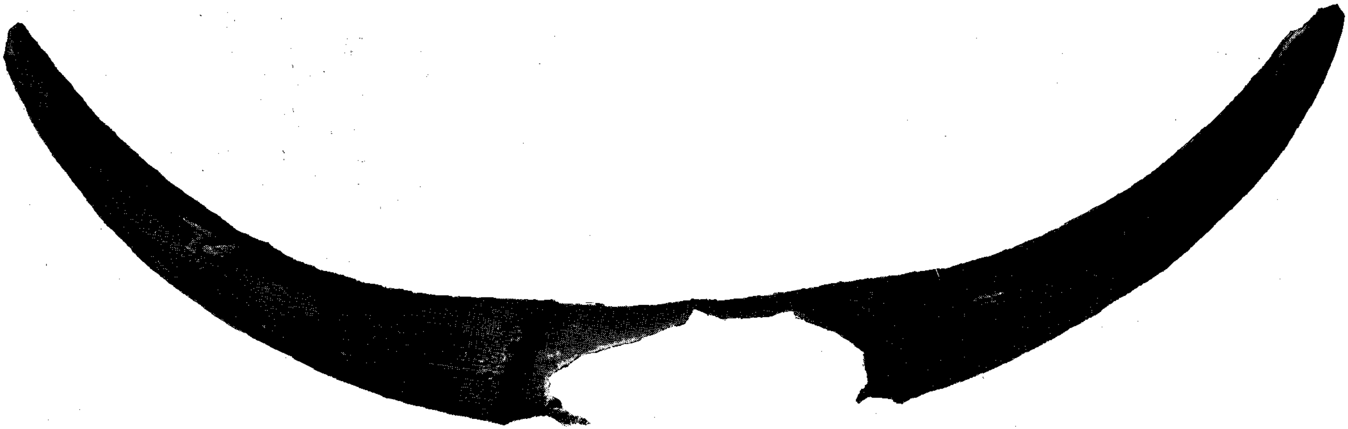


Fig. 1.

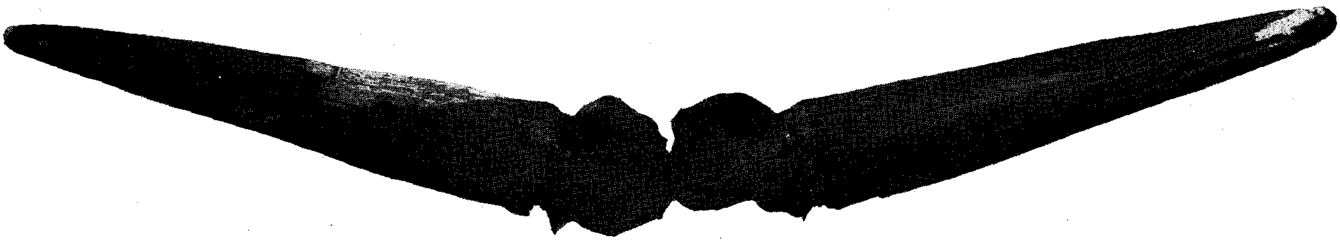


Fig. 2.

Bison latifrons. $\times \frac{1}{10}$. Fig. 1. View of horn-cores from rear of skull. Fig. 2. View of horn-cores with the plane of the face toward observer.

specimen of this species was discovered about the year 1869 on Brush Creek, Adams County, Ohio, while some workmen were digging a foundation for the abutments of a bridge. The specimen was found at a depth of 18 feet below the surface, in gravel. The remains consisted of both horn-cores in nearly perfect condition, together with the portions of the frontal bones belonging to each. These horn-cores are now in the collection of the Cincinnati Society of Natural History. Figure 1 of plate XI presents a front view, as seen at right angles to the face, while Fig. 2 of the same plate presents a view from behind.

Dr. J. A. Allen and Dr. F. A. Lucas have both described the specimen, and they give slightly different measurements. Dr. Allen estimates the width of the skull between the bases of the horn-cores at 16 inches, or 407 mm.; the length measured along the upper curve as 813 mm. (Lucas, 784 mm.); along the lower curve, 853 mm. (Lucas, 840 mm.); circumference at the base, 510 mm. (Lucas, 520 mm.). Lucas gives as the diameter at the base in the plane of the face, 166 mm.; at right angles to this, 146 mm.; as the distance between the tips of the horn-cores when in their natural position, 1,775 mm. This would be 6½ feet. If we allow for the projection of the horn beyond the horn-cores, we must conclude that in life the animal had a spread of the horns equal to probably 9 or 10 feet.

In size of horns this species resembled *Bison alleni*, but the horns of the latter were far more curved; so much so that the distal ends were directed upward and even somewhat inward. In *B. latifrons* the horns were curved little and were directed strongly outward and a little backward.

Specimens referred to *B. latifrons* have been reported with considerable certainty from widely separated localities, Florida, Mississippi, Texas, and Arizona. Other reports have been based on finds of teeth and are not to be relied upon too confidently. Nor must it be forgotten that some authors, following Leidy, have referred to *B. latifrons* the species now known as *B. antiquus*.

There is no certainty that *Bison latifrons* has ever been found in Indiana. In a footnote to Cope and Wortman's paper in the 14th Indiana Survey Report, Prof. John Collett stated that remains of the species had been found in Vanderburgh County. We are unable either to confirm or refute this statement. Inasmuch, however, as the animal lived in Ohio and in Kentucky along the Ohio River, it is to be inferred with certainty that it occurred also in Indiana.

THE PROBOSCIDEA.

The Elephants and Their Kindred.

Mammals mostly of large size; the feet all with five digits, and with these bound together into one mass; the terminal phalanges encased in hoofs. Not more than one pair of incisors in each jaw, sometimes in one jaw only. Sometimes both pairs and sometimes only one pair developed into great tusks. Premolars and molars with two or more pairs of cones or, in more advanced forms, composed of from 4 to 27 thin plates. Snout usually developed to form a proboscis.

The animals that are included in this order are the elephants, the stegodons, the tetrabelodons, the mastodons, the dinotheres, the palæomastodons, and the mœritheres. All these forms are extinct except the elephants, living species of which are found now in southern Asia and in Africa south of the Sahara Desert. Fossil Proboscidea are known from all the great divisions of the globe, except Australia. The earliest true elephant known is found in the Upper Miocene of India.

We have reason therefore to believe that the original home of the order was the continent of Africa. From here they made their way into Europe and southern Asia, meanwhile undergoing continual transformations. From southern Europe their descendants migrated over Europe as far west as Ireland, and as far north as Scotland, Denmark, and Russia. From India certain species extended probably northeastward into Siberia and crossed over a land bridge that was located probably in the region of Bering Strait. Thence they spread over the whole of North America, through Central America, and over South America.

Family ELEPHANTIDÆ.

The Mastodons and Elephants.

Proboscidea in which the outer nares are placed somewhat behind the orbits; symphysis of the lower jaw, short, usually without tusks; if present, they are small; the upper tusks curved more or less strongly upward and with or without a band of enamel; cheek-teeth six in each side of each jaw, the later ones succeeding the earlier from behind.

This family is represented in North America by several species. The best known of these are the common mastodon, *Mammut amer-*

icanum, and the mammoths *Elephas primigenius, E. columbi* and *E. imperator.*

The characters which distinguish this family are numerous and many of them very striking. The members of the family have almost always been animals of great size. However, certain elephants found in caves of the island of Malta are small, some not exceeding three feet in height. All are large of body, thick-skinned, straight-limbed, and heavy-footed. The skull is large, not from the magnitude of the brain, but because of the enormous development of air-cells between the outer and inner plates of all the bones of the brain-case and of most of those of the face. All these air-cells open finally into the nasal cavity. The external nares of the bony skull are large and are placed high up, somewhat above the eyes. The nose and the upper lip have coalesced and been extended into the long and extremely flexible proboscis. This is traversed by two canals which open above into the external nares of the bony skull. The eyes are small, the ears are large.

The teeth are remarkable for their form, structure, and manner of appearance in the jaws. In the upper jaw there is always present (at least in the males) a pair of incisors, which project from the mouth as tusks and sometimes reach an enormous size. There may be another pair in the lower jaw, but if so, they are unusually small. There are never any canine teeth. During life, if sufficiently prolonged, there appears on each side of each jaw six cheek-teeth; but not more than four of these are in place at once, sometimes only one. The earliest formed teeth are small, and of simple structure. One after another younger, larger, and more complex teeth come up behind the first formed teeth and displace them, the sixth appears last of all, being retained until advanced age. The anterior three in each side of each jaw are really milk teeth.

In the vertebral column there are seven neck vertebræ; twenty-three presacrals, nineteen or twenty of which bear ribs; four sacrals, and as many as thirty-one caudals. The shoulder-blade is broad, and it has a much expanded spine. The humerus is long; the radius is slender and crosses the front of the large ulna. The carpal, or wrist bones are broad and flat, and they and the short metacarpals for the most part form vertical series, not interlocking as they do in most hoofed animals. There are five digits, all with short phalanges and terminating in small hoofs. The bones of each of the four feet are bound together into one mass. Beneath and behind the digits is a great pad of elastic tissue.

The pelvis is large and the nearly flat hip bones stand out vertically and at right angles with the vertebral column. The socket for the femur looks nearly downward. The femur is long and is without the third trochanter, the process so conspicuous on the inner side of the thigh bone of the horse. The straight and slender fibula runs down on the outer side of the large tibia, and it articulates with the massive but short calcaneum, or heel-bone. The hind foot resembles in form the fore foot, but in life the toes do not stand so nearly perpendicular.

Genus MAMMUT Blumenbach.

The Mastodons.

Elephant-like animals which differ from the true elephants in the character of their teeth, the grinding surface of the tooth being crossed by from two to five roof-like ridges separated by wide, open valleys; each ridge, in the little-worn tooth, divided by a sharp, longitudinal furrow into an inner and an outer cone. In some species the ridges consist of more numerous and more distinctly separated cones, while the valleys may be more or less choked up by smaller cones. Crown not so high as it is in the elephants. Upper jaw with well-developed tusks; the lower jaw sometimes with one or two short tusks.

The genus is represented in the Pleistocene of North America by at least two species, *M. americanum* and *M. mirificum*.

MAMMUT AMERICANUM Kerr.

The American Mastodon.

Teeth of simple pattern, the grinding surface being crossed by from two to five ridges which are separated by open transverse valleys. Lower jaw sometimes furnished with one or two short tusks.

Habitat, the whole of the United States; most if not the whole of British America and Alaska. Range in time probably from beginning to end of Pleistocene.

This species is by far the best known of any of those belonging to the genus. Hundreds of specimens have come to light in the course of the development of the resources of the country. The first published mention of its bones was made by the celebrated divine, Cotton Mather. Every year new finds are reported in the newspapers or in the scientific journals, as a result of excavations and draining operations. Plate XVIII shows the location of all the specimens found in Indiana, reports of which the writer has been able to collect.

. The mastodon was an animal resembling in general form the living elephants; but it was at the same time more heavily built and had thicker, shorter legs, a deeper chest and much broader hips. A comparison of the mounted skeleton of mastodon in the United States National Museum with that of the mounted Indian elephant, a male twenty years old, shows that the average length of the bodies of the dorsal vertebræ of the mastodon is somewhat greater (about 8 mm., or ⅓ of an inch), than that of the dorsals of the elephant. As to the bones of the fore limbs, the depth of chest and breadth of the hips, we find the following comparative measurements:

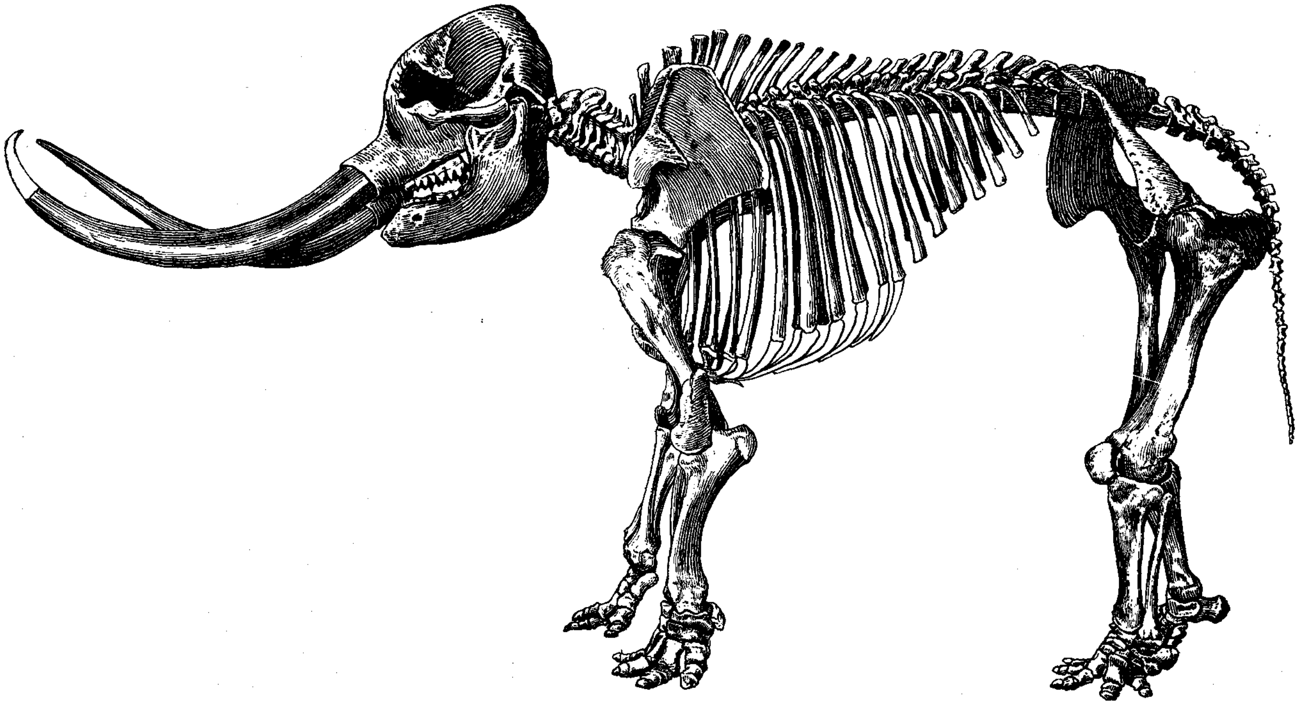
	Mastodon.	Elephant.
Humerus, length	727	962
Humerus, least circumference	355	310
Ulna, length	640	730
Ulna, least circumference	258	248
Femur,[1] length	930	995
Femur, least circumference	327	298
Tibia,[1] length	535	622
Tibia, least circumference	255	215
Depth of chest at 6th rib	850	730
Width across ilia	1,500	1,030

[1] It must be kept in mind that the femur and the tibia of the mastodon measured above belong to another individual supposed to have been of about the same size as the one furnishing the other bones. Furthermore, this mastodon is a very small specimen; but the proportion of the various parts of the framework are probably about the same as in larger specimens.

Dr. Warren, in his monograph on the mastodon (pp. 97-109), gave comparative measurements of the Cambridge mastodon and the skeleton of an elephant, probably the Asiatic species. The elephant had a height of about ten feet, the mastodon a height of eight feet six inches. His measurements confirm, in general, those given above. They indicate, also, apparently that the circumferences of the extremities of the long bones of the elephant are relatively somewhat greater than in the mastodon. This seems to be true in many cases, especially in that of the lower end of the humerus.

It is the wish of the writer to present here such a description of the anatomy of the common mastodon as will enable students, collectors, and accidental finders of remains, to identify the species.

PLATE XII.



Mammut americanum, the American Mastodon. From a specimen found in Miami County, Indiana, and now mounted in the Public Museum at Milwaukee. From a photograph furnished by Director H. L. Ward, of the Public Museum of Milwaukee. Drawing by Mr. R. Weber.

Of course, if some of the teeth have been found, either alone or with other parts of the skeleton, these at once reveal the nature of the remains. However, bones without teeth come to light sometimes, and even single bones, and these should, if possible, be made distinguishable from bones of any of the species of elephants occurring in our region.

To illustrate the structure and the appearance of the mastodon the writer has had prepared a drawing (Pl. XII) of a skeleton which was found near Denver, Miami County, Indiana. This is now mounted in the Public Museum, Milwaukee, Wisconsin.

Skull.—The skull of the common mastodon resembles in a general way that of the true elephants, but on close comparison presents important differences. For the most part these differences reveal a lower stage of modification than is seen in the elephants. Comparisons will be made with the skulls of *Elephas primigenius* and *E. columbi.*

The cranium is less elevated than in the species of *Elephas* just named (Pl. XII). This is due to the fact that the diploic layer of the bones of this region is less developed than in the elephants in general. If in a profile view of the skull of a mastodon a line be drawn from the occipital condyles to the lower border of the orbit, it will be found that the height of the vertex of the skull above this line equals only about two-thirds the distance to the front of the orbit; whereas, in the elephants mentioned, the height of the vertex equals, or nearly so, the distance to the hinder border of the orbit.

The alveolar border of the upper jaw lies below the line mentioned a distance of only about one-third the space between the condyles and the front of the orbit; in the elephants, a distance equal to nearly one-half the interval between the condyles and the front of the orbit. This great depth of the upper jaw of the elephants is due to the necessity of making room for the great molars.

In the mastodon the external nares are thrown back on the face to a position between the orbits. In the elephants they are placed above the orbits. In the mastodon the hinder face of the cranium is flat, its surface somewhat undulating, with a rough depression in the midline for the great ligament that supported the head, and this occiput stands at nearly right angles with the palate and with the upper surface of the cranium. This upper surface descends at a moderate slope to the external nares and then more rapidly to the front ends of the premaxillaries. The greatest width of the

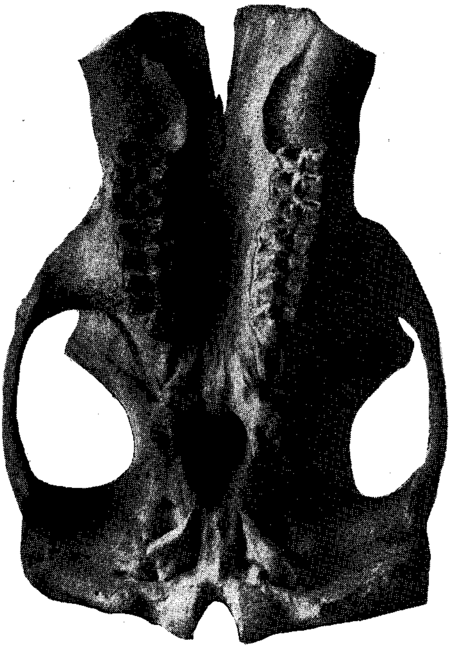


FIG. 52. *Mammut americanum.* Palatal view of skull of a mounted skeleton in the U. S. National Museum. $\times\frac{1}{10}$.

skull is close to two-thirds its length. The premaxillaries contain the bases of the great upper tusks, while the maxillæ support the grinding teeth (Fig. 52). These will be described below.

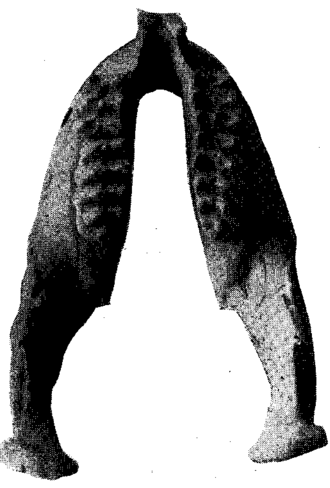


FIG. 53. *Mammut americanum.* View of lower jaw of specimen shown by Fig. 52. $\times\frac{1}{11}$.

The lower jaw is relatively more elongated than in the elephants, diminishes slightly in depth toward the front end, and the angle is rather sharply rounded. The horizontal part of the jaw is deepest behind. The mandible supports the lower molar teeth and sometimes one or two small lower tusks. In many cases these tusks were probably never present; in others, had fallen out so early in life that no traces are left of their sockets. In still other cases both sockets are present, but they present evidences that the teeth had been shed before death. In some adult specimens, probably males, one or the other or both of the tusks remains (Fig. 54). If the tusks had disappeared early, the jaw may end in a sharp,

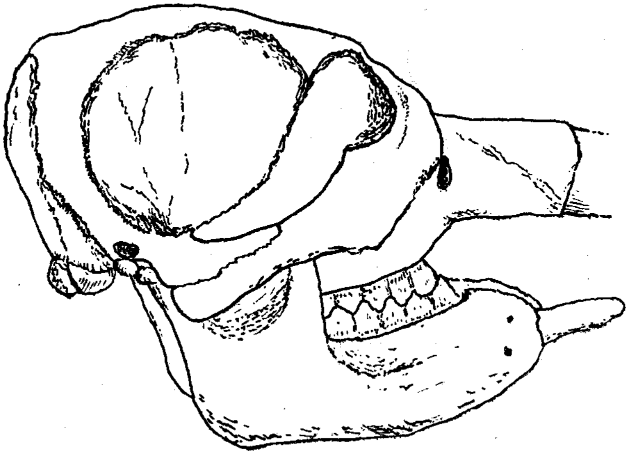


FIG. 54. *Mammut americanum.* Side view of skull, to show especially the tusk in the lower jaw. After a sketch by Falconer and Cautley.

spout-like beak; otherwise its termination is more or less truncated. The lower jaw of the mastodon differed in many respects from that of the mammoth. The coronoid process rises as high as the condyle of the jaw; whereas, in the elephants, the coronoid does not rise so high.

The teeth are more frequently found than any other part of the skeleton and are its most useful parts for identifying the animal. For that reason, they will be described and carefully figured. Among the teeth are included the upper and the lower tusks, inasmuch as they are greatly modified and enlarged incisors.

Tusks.—The upper tusks are the most striking part of the skeleton of the mastodon, as well as of the elephant, and the discovery of these tusks often occasions much excitement in the neighborhood where found. While they are often complete when found, they are seldom secured in good condition, and perfect ones are rare objects in museums. Usually too much haste is exercised in getting them out of the ground, so that they are broken into pieces. Then, on exposure to the air, they dry out, the ivory is likely to shrink and to break into fragments. The tusks ought to be left in the ground until the finders are prepared to treat them properly. If the tusks are uncovered or partly so, they should be kept wet. It is not the air that causes the ivory to break, but the drying. If they must be taken up, they should be strengthened by rods or strips of wood bound to the tusks with wrappings, so as to support the weight and prevent breaking. Then a good supply of shellac varnish, such as is used by painters, should be provided, and perhaps somewhat thinned by strong alcohol. Then as the tusks begin to dry out, and especially if cracks begin to appear in the ivory, the shellac should be applied and allowed to soak into the ivory. If liberally applied this material will prevent shrinkage and cracking of the ivory and will enormously strengthen the tusks. A solution of common glue or of gum arabic may be used, but in this case there is still some danger of shrinkage and cracking. If these substances last mentioned are employed, the tusks ought to be tightly wrapped with cloths and cords, and these should not be removed until the whole mass is thoroughly dry.

The tusks vary greatly in size, according to the age and probably sex of the animal; for it is probable that, as in the elephants, the females carried smaller tusks than the males. Warren, in his monograph on the mastodon, states that the tusk of his specimen had a length of ten feet and eleven inches; but, as is usual, these were soon broken. At the base these tusks were slightly oval, having one diameter of seven and one-half inches and the other of seven inches. In form these tusks had a double curve. As found, they curved outward then turned inward, so that the points approached each other, but they had probably turned somewhat after burial. The skeleton figured by Dr. Warren as the "Baltimore skeleton," has large tusks that are curved into almost a half circle. Usually the tusks are rather gently curved. Dr. Joseph Moore (Proc. Indiana Acad. Sci., 1876, p. 277 [?]) gave as the length of a tusk found near Richmond, Indiana, but in Ohio, nearly eleven feet, with a diameter of ten inches at the base.

The tusks are composed of ivory, and there is no enamel present. There was originally in the ivory a large per cent. of animal matter. As shown by many fossil tusks, the ivory is deposited in layers which form hollow cones, one within the other, whose bases are directed toward the skull. Figure 54a represents a part of a tusk of a mammoth that was found in Alaska. It has been split along the middle and somewhat weathered, so as to show well the layers of ivory. In broken sections of tusks many faint lines may be seen passing from the center of the tusk obliquely toward the circumference. As some of these are directed obliquely in one direction, and others in the opposite, they cross and produce an appearance like the "engine-turning" often seen on watch-cases. At the base of the tusk there is usually a large conical cavity which was during the life of the animal occupied by the massive pulp. In extreme old age, however, this cavity might have become filled with ivory.

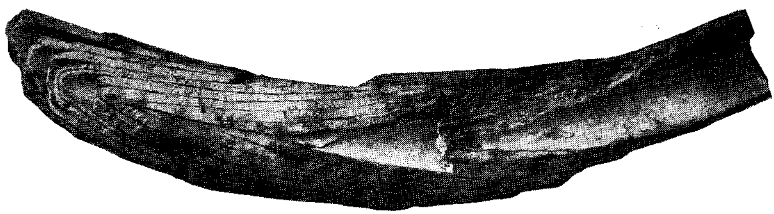


FIG. 54*a*. *Elephas primigenius.* Fragment of tusk, split and weathered so as to show the structure. The pulp cavity is seen on the right.

The great tusks of mature age were preceded in early life by a pair of small "milk tusks." Warren states that these were found on cutting into the tusk-socket of a calf elephant's head. They are occasionally found fossilized.

At present the writer knows of no means of distinguishing with certainty the upper tusks of the common mastodon from those of the mammoth or of the other elephants. The tusks of the latter, when large, are, however, likely to be more bent in a spiral form than those of the mastodon. The latter also may be spirally twisted. See description of the Randolph County tusk now at Earlham College. Eighty years ago, E. Grant and A. Nasmyth investigated the microscopic structure of the tusks and published figures illustrating their results, but they concluded that there were specific and even generic differences in specimens that are now regarded as belonging to a single species.

The tusks are sometimes furnished with narrow longitudinal ridges and grooves, as in the tusk just mentioned as being in Earlham College. It is possible that this feature may sometimes serve to distinguish them from those of the mammoths.

The tusks that not infrequently are found in the lower jaw of the mastodon are short and usually straight or slightly bent. The one in the left jaw of the mastodon described by Dr. Warren had a diameter of two inches at the base and a length of eleven inches. The point was worn considerably, but it may never have been any longer, for growth at the base may have just kept pace with the wear. It is evident that the animal found use for the organ. Warren stated that the tusk was directed downward and forward at an angle of 45° with a horizontal line, but his figure shows it directed horizontally. The lower tusks are usually smaller than the one just mentioned, but they are sometimes larger. Occasionally they are twisted spirally. Often one or the other is missing, but both were sometimes present. It is certain that some very young mastodons had no tusks; it is equally certain that some very old ones had at least one tusk; sometimes the right one, sometimes the left. Much importance has been attached to these lower tusks and much has been written about them. Long ago the specimens possessing such tusks were put in a separate genus called *Tetracaulodon* and a considerable number of species described. All these are now regarded as belonging to the species *Mammut americanum*. Dr. Albert Koch, who was a great collector of mastodon remains, and apparently also a good deal of a romancer, described some of these species of *Tetracaulodon*. One specimen found by him had the lower tusks distinctly flattened, with the edges directed up and down; another had the lower tusk directed perpendicularly. Koch stated that tusks found by him were covered by a layer of enamel, and this by a layer of cement; but it is quite certain that he was in error, the layer being only a denser ivory.

It is certain that the ancestors of the mastodons and elephants possessed well-developed tusks in the lower jaws. In the tetrabelodons these were very large. In the mastodons they were disappearing organs; in the elephants they have wholly disappeared. It is to be expected that such organs as these would be somewhat capricious in their appearance, sometimes not being developed in the young, often falling out early in life, but sometimes retained, especially by males, until old age.

The Cheek-teeth.—The cheek-teeth of the mastodon, those employed in the mastication of the food, may rise in number, during the life of the animal, to twenty-four, six on each side of each jaw.

Of these six, not more than four of the ones appearing first are in use at the same time; often not more than two of the later ones and probably in old age only one remained. The first tooth to appear is very small, the succeeding ones are successively larger, and the last and hindermost is very large. The three front teeth of the six are known as milk, or deciduous, molars; the hinder three, as permanent molars. In great numbers of mammals the milk molars are displaced by a second set, known as premolars. In the tetrabelodons some or all of the milk molars were thus displaced and succeeded by premolars; but no premolars have ever been observed in our mastodon.

Each new tooth that appears, both of the milk series and of the so-called permanent series, coming up behind its predecessor, pushes it forward; and by the time the older tooth is well worn down, it is pushed out of the jaw by the newer one. There is usually to be found on the front and hinder ends respectively of the tooth a polished area produced by contact with the predecessor and the successor.

Each tooth consists of the crown and the roots. The crown is in proportion to its size rather low. In its unworn state, it is crossed by from two to five prominent ridges, whose apices are at first sharp. However, soon after appearing through the gums, the ridges begin to be worn down by attrition against the teeth of the other jaw and against the food. This usually continued until the crown was worn down to the roots. Inasmuch as the front end of each tooth first appeared outside of the gums and began to wear, this is always worn down more than the hinder end. As the wear continued, the valley between the ridges gradually became shallower and finally disappeared, or nearly so. An examination of a new or little worn tooth shows that there is a very shallow longitudinal valley which crosses all the ridges and divides each of them into an outer and an inner portion. These two portions may be known as the outer and the inner cones. Each cone may, when unworn, show two or three conules at its summit.

In nearly all cases one end of each transverse ridge is nearly perpendicular to the grinding face of the tooth, while the other end slopes away less steeply from the apex to the base. The side of the tooth on which the sloping ends of the ridges are found is, in the lower jaw, the one next the cheeks, while in the upper jaw it is the one next to the tongue.

Both in the lower teeth and in the upper ones the cones which have the sloping sides are buttressed by two strong ridges, one which descends on the front face from the apex to the base and another which descends on the hinder face of the cone. At the bottom of each transverse valley, the ridge descending from the cone in front and that from the cone behind meet. There might be said to be a ridge running from the front of the tooth to the rear over the peaks and across the valleys. In unworn teeth these descending ridges are sometimes sharp-edged or tuberculated, or they may be nearly smooth. From the disposition of the cones it comes about that when the upper tooth was brought against the lower, the strongly-buttressed cones of each tooth fell between the cones having feeble or no buttresses. In the lower jaw the weakly-buttressed cones, that is, those with steep sides, are the highest; in the upper jaw the strongly-buttressed cones are the highest. As the teeth became worn down in mastication, it was the strongly buttressed cones that suffered most; that is, the outer side of the lower teeth and the inner side of the upper teeth became worn down most.

In the common mastodon the transverse ridges of the upper teeth are directed straight across the tooth, that is at right angles with its longitudinal axis; in the lower teeth the ridges are directed more or less obliquely to the longitudinal axis, the inner end being somewhat in advance of the outer. This arrangement appears to be due to the fact that the right and left rows of upper teeth converge backward, while those of the lower jaw are parallel.

In the common mastodon of our country there are two cross-ridges on the first and second milk molars; three on the third; three on the first and second true molars; and four or five on the third. This arrangement is indicated by the formula $\frac{2}{2}, \frac{2}{2}, \frac{3}{3}, \frac{3}{3}, \frac{3}{3}, \frac{4-5}{4-5}$.

The Roots of the Tooth.—Each tooth of the mastodon, even the relatively small first milk molars, has at least two roots. The larger ones may have three or four roots, and some of these are partially divided by deep lateral grooves. There is a tendency toward the formation of two distinct roots for each transverse ridge, but this tendency is only partially achieved. The roots of the lower teeth differ in some respects from the upper ones, inasmuch as they spread laterally to a less extent. The roots of each of the teeth will be described below.

Development of the Teeth.—A complete tooth consists of three kinds of material. The greatest part consists of dentine, or ivory. Over this on the crown is a layer, five millimeters more or less

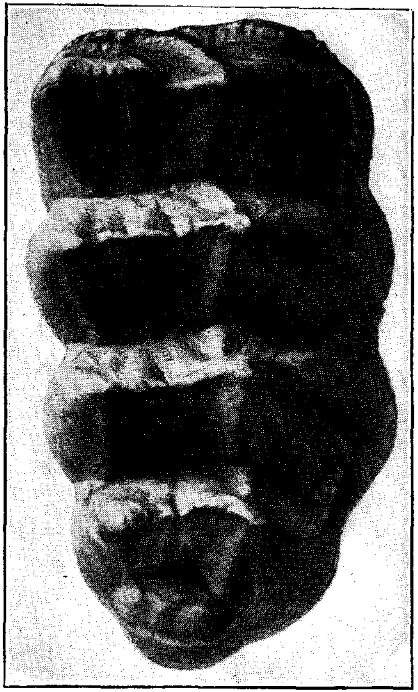
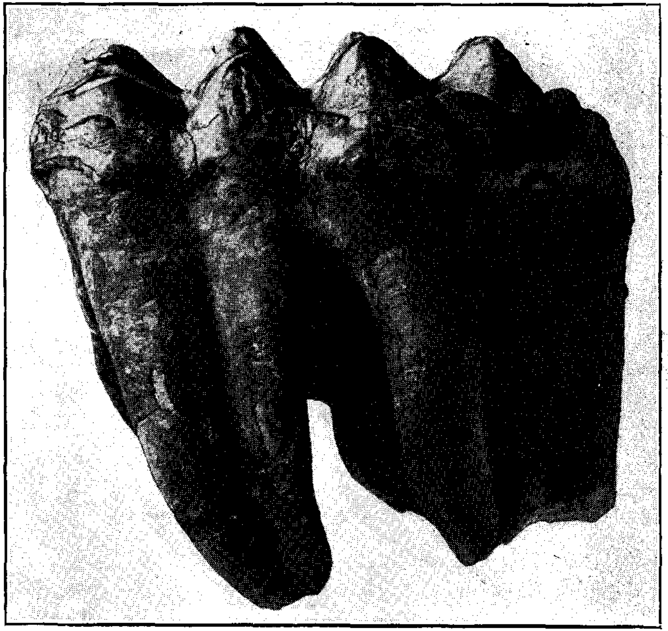


FIG. 1.



FIG

Mammut americanum. Fig. 1. Third upper molar of right side, showing the unworn grinding surface. × ½. Fig. 2. Third upper molar of left side, seen from left side. × ½.

thick, of a harder substance, the enamel. Over the latter, or a part of it, there may be a thin layer of cement.

Each tooth took its origin from a mass of soft tissue, the pulp, which had the size and the form of the completed tooth. This pulp was enclosed within the jaw bone. On the pulp was deposited first the dentine of the apices of the cones and this spread gradually to form the crown. On the outside of the dentine of the crown was deposited the enamel. Constant additions were made to the inner surface of the dentine by calcification of the pulp. From the crown the dentine spread to the roots, but even when the crown began to appear through the gums the dentine formed only a thin layer on the surfaces of the roots. The tooth was considerably worn down before the pulp was mostly converted into dentine. Figure 6, Pl. XV, shows the crown of a tooth that was not yet cut when the animal died. Figure 2, Pl. XVI, is the same tooth seen from the opposite side. No roots had yet become developed and the crown contained a great cavity that was filled with pulp.

In the emergence of the tooth from the gums the front end first appeared and consequently it is this end that is always the most deeply worn.

Description of the Series of Teeth.

Last True Upper Molar.—The teeth of the upper jaw will be first described; and, inasmuch as the last or hindermost molars are the ones most often found, the description will begin with these. In the upper teeth the ridges of the crown run directly across the tooth, and there are two roots at the front of the tooth, except in the case of the first and second milk teeth.

Figure 2, Plate XIII (No. 2220, U. S. N. M.), presents a side view of a tooth, so that both crown and roots are seen. The extremity of the large hinder root is broken off and is replaced in outline. In this tooth there are three roots, viz., outer anterior, which belongs to the outer end of the first crest; an inner anterior, which belongs to the inner ends of the first and second cross-ridges; and a posterior, which supports the inner ends of the third and fourth crests and the outer ends of the second, third and fourth crests.

Figure 1, Plate XIII (No. 2218, U. S. N. M.), from Afton, Oklahoma, shows the crown of a large third upper molar of the right side. This tooth had not yet been cut and is therefore wholly unworn. The buttresses on the front and rear faces of the inner cones are well shown; also the subdivision of the outer cones into a

FIG. 1.

FIG. 2.

Mammut americanum. Fig. 1. Last right lower molar; crown view. × ½. Fig. 2. Same tooth, showing pulp cavity. × ½.

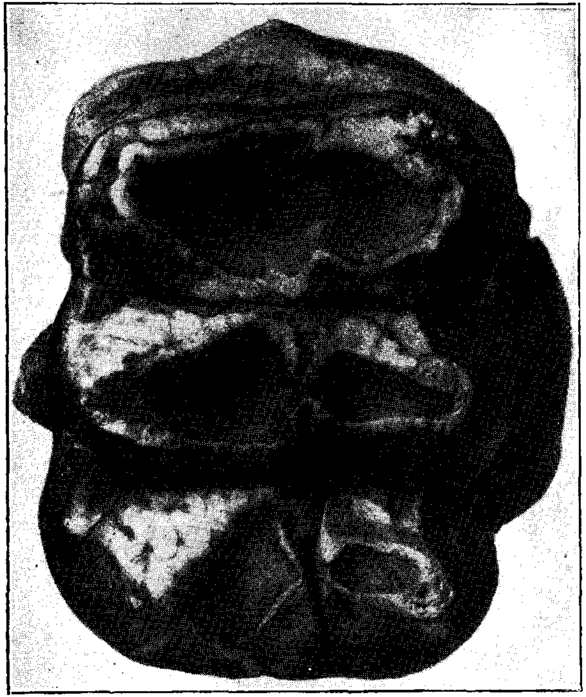


Fig. 1.

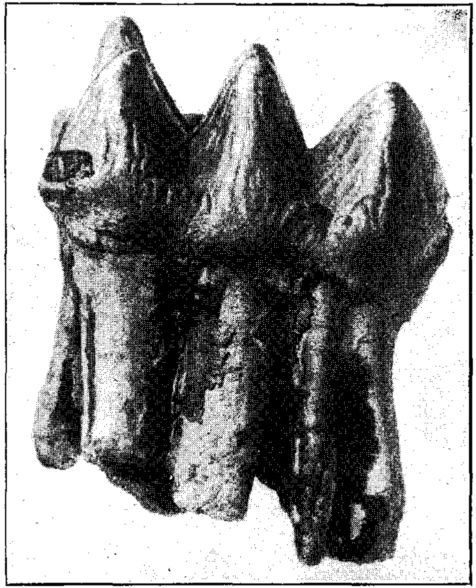


Fig 2.

Mammut americanum. Fig. 1. Upper left second molar. $\times \frac{3}{4}$. Front of tooth toward the left. Fig. 2. Upper left second molar showing inner face. $\times \frac{1}{2}$. Front of tooth above larger outer and a smaller inner conule. The talon is rather large. There are many minor ridges running down the faces of all the cones, and the inner ends of the transverse valleys are blocked by tubercles. The cingulum is not conspicuous but is seen on the right-hand side of the figure. A small amount of cement appears on the crown, but it has been mostly dissolved away during burial. The roots of this tooth were wholly undeveloped, and the pulp cavity presents an appearance resembling that of Figure 2 of Plate XVI.

The second upper molar is represented by Figures 1-2 of Plate XIV. Figure 2 (No. 2261 U. S. N. M.) shows the internal surface of a left molar from Afton, Oklahoma. This tooth had only recently been cut and is worn just through the enamel on the cones of the first transverse crest, and very slightly worn on the second crest. The third crest is untouched. The length of the tooth is 118 mm.; its width, 96 mm. The corrugated character of the enamel is well shown. The inner ends of the transverse valley are obstructed slightly by the cingulum. Figure 2 represents a view of the inner side of the tooth, showing both crown and roots. The extremities of all the roots are damaged somewhat, but they had not yet been completed.

It will be seen that the roots were originally covered with a thin layer of cement. During burial this became black in color and much of it was dissolved off.

Figure 1, Plate XIV (No. 2258 U. S. N. M.), shows the grinding face of a second true molar of the right side. This tooth is worn on all the cross-ridges, so that islands of dentine appear on all the cones. On the first two ridges the bottom of the longitudinal valley had been passed, so that the islands of inner and outer cones had coalesced. Had the wear proceeded a little further, the islands of the inner cones of the first and second ridges would have joined.

Figure 2, Plate XV (No. 2243 U. S. N. M.), representing the first upper molar, is taken from a considerably worn tooth found at Afton, Oklahoma. It is 87 mm. long and 68 mm. wide at the second ridge; 71 mm. at the third. It is considerably worn by mastication. The position of the first crest forms one great island of dentine surrounded by an ellipse of enamel. The two islands of dentine of the second ridge are joined by an isthmus. Four small islands are seen on the hinder crest, one of them belonging to the hinder buttress of the inner cone.

PLATE XV

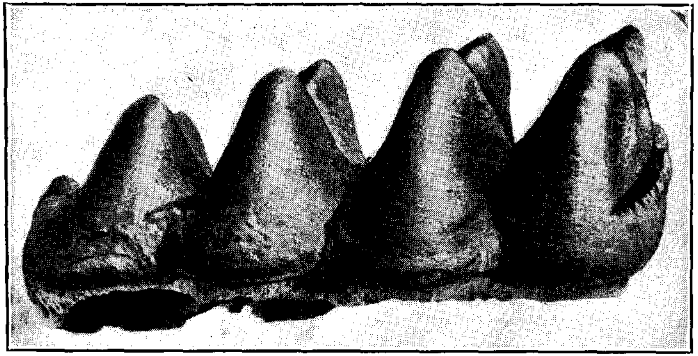


Fig. 6.

Fig. 3

Fig. 1.

Fig. 4.

Fig. 2.

Fig. 5.

Mammut americanum. Fig. 1. Last left lower molar. × ½. Fig. 2. First right upper molar. × ½. Fig. 3. Third right upper milk molar. × ½. Fig. 4. Second right upper milk molar. × ½. Fig. 5 Same as fig. 4; outside face. × ¾. Fig. 6. Third right lower molar; outer face. × ½. Same as that of Plate XVI.

The upper third deciduous molar is usually smaller than the first true molar, but sometimes there is little difference; and occasionally it is difficult to distinguish this tooth from the last mentioned tooth. The third deciduous upper molar is illustrated by Figure 3 of Plate XV, of a tooth almost unworn (No. 2230 U. S. N. M.), from Afton, Oklahoma. It has a length of 70 mm., an extreme width of 61 mm. There are here three transverse crests; the longitudinal valley is very distinct; the buttresses not conspicuous, except the one on the hinder face of the last crest. The enamel is corrugated and the cingulum well developed. There was yet a large pulp cavity.

Upper Second Milk Molar.—This tooth is represented by a specimen in the U. S. National Museum (No. 6689), belonging to the right maxillary. It is only slightly worn, but the islands of dentine belonging to the anterior of the two cross-ridges have coalesced. The tooth is shown half the natural size by Figures 4 and 5 of Plate XV. The enamel is broken away from the inner border and in two places in front. The length is 40 mm., the width at hinder end is 44 mm. The cingulum is moderately developed at the sides, strongly so at the hinder end.

Figure 5 is a view of the tooth from the outer side. The roots of this tooth are nearly complete, the hinder one having a length of 50 mm., measured from the base of the crown.

There is at hand no upper first milk molar that can be used for illustration. Such a tooth would belong only to a very young animal.

Lower Jaw.

Lower Third True Molar.—In the case of the lower teeth the ridges of the crown cross the tooth somewhat obliquely, and there is a single root crossing the anterior end of the tooth. All the other roots are united in a single mass.

An unworn last true molar of the right side is represented by Figure 6 of Plate XV and Figs. 1 and 2 of Plate XVI. Figure 1, Plate XVI, shows the grinding face of No. 2221 U. S. N. M., a tooth from Afton, Oklahoma. There are four distinct ridges that cross the axis of the tooth obliquely from the inside outward and somewhat backward. Behind the fourth crest there is a distinct heel of two tubercles. The cingulum is little developed. Here and there on the surface of the enamel is seen a thin layer of cement. This may originally have covered the whole tooth. Figure 6 of Plate XV gives a view from the right side, while Figure 2, Plate XVI, shows the under surface of the tooth. No roots, or only thin shells of them, had been developed at the death of the animal. The pulp cavity is very large.

The length of the tooth is 185 mm., the breadth at the second crest 107 mm.; the height of the third inner cone, 76 mm. This tooth is unusually broad for a lower molar.

The Third Lower Molar.—Figure 1, Plate XV (No. 2384 U. S. N. M.), from Afton, Oklahoma, presents a considerably worn tooth of the left side that possesses five cross-ridges and a talon, instead of the usual number of four ridges. It will be observed that the first crest was worn down so that there is a single ellipse of dentine surrounded by enamel; also, that at the place where the buttresses of the first and second outer cones meet, the dentines of these two cones are about to coalesce. The hinder half of the second inner cone has been broken away, as a result of which this island of dentine does not have its normal shape. A section of the roots would show four lobes in the hinder tooth, instead of three. This tooth has a length of 182 mm., and a width of 95 mm. at the second crest.

Second True Lower Molar.—Figure 1, Plate XVI A (No. 342 U. S. N. M.), is taken from a wholly unworn second lower molar of the right side. It is said to have been found in South Dakota. It shows finely the three crests and the intervening valleys, the buttresses of the outer cones, the corrugations of the enamel, and the cingulum well developed in front and behind, and at the outer ends of the valleys. The summits of all the crests are provided with denticles. While the tooth had evidently been pressing strongly on its predecessors, there is no indication that its successor was exerting pressure on it. There are thin patches of cement on the enamel. There was yet a great pulp cavity. The roots, which probably had already pretty thick walls, have been broken off. The tooth is 121 mm. long, 92 mm. wide at the hinder crest, and 64 mm. high from apex of the hinder inner cone to the base of the enamel.

The lower first true molar is represented by Figure 2, Plate XVI A (No. 2233 U. S. N. M.), taken from a wholly unworn left tooth found at Afton, Oklahoma. The specimen is complete, except that the apex of the anterior inner cone and that of the interior hinder cone have been broken off. There is a large pulp cavity and it is doubtful whether the roots had begun to form. The buttresses of the outer cones are not strongly developed, and some of the ridges on the other cones are nearly as prominent. The

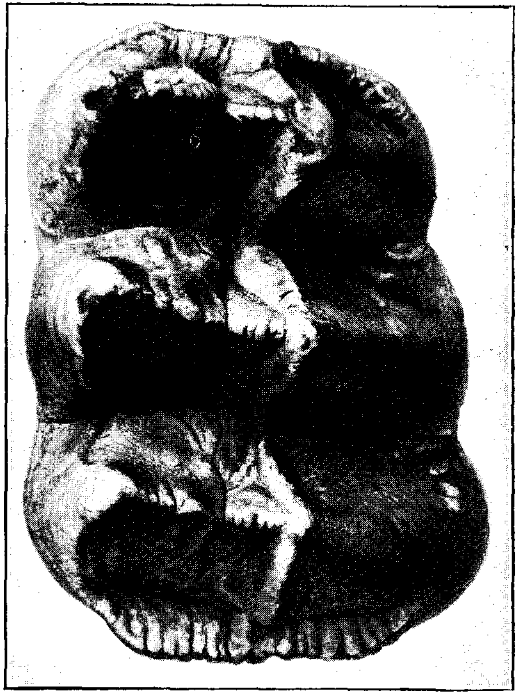


Fig. 1.

Fig. 2.

Mammut americanum. Fig. 1. Second right lower molar. × $\frac{3}{4}$. Fig. 2. First left lower molar. × $\frac{3}{4}$.

cingulum shows in front and behind. The tooth is 92 mm. long, 56.5 mm. wide at front crest, 62.5 mm. wide at second crest and 62 mm. at third crest.

Warren (Monograph, p. 67) stated that this tooth has two fangs, one which supported the first ridge, and a large posterior supporting the two remaining ridges.

The lower third milk molar, like the first and second true molars, has three cross-ridges and, in general, resembles the first true molar. It is to be distinguished from the latter principally by its smaller size; but, as there is variation in size in both these teeth, there may sometimes be some difficulty in the matter. Warren gave as the length of the first true molar figured by him three and a quarter inches, 83 mm.; the milk molar which is represented by Figure 1, Plate XVII, is 80 mm. long. Usually, however, there is more difference in the lengths of the two teeth and the true molar is always broader. The tooth figured by Warren was two and a half inches wide, 63 mm.; the widest milk molar at hand, Figures 2 and 3, Plate XVII, from Virginia, is 57 mm. wide. The ridges of the third milk molar seem to be somewhat more compressed, or thinner from front to back, than in the first true molar; the enamel is somewhat thinner than in the true molar; the outer end of the anterior valley is often, but not always, blocked by a heavy ridge of the cingulum. Notwithstanding these observed differences, specimens may possibly be found which cannot be certainly identified.

Figures 2 and 3, Plate XVII, are from an unworn tooth found somewhere in Virginia. The enamel is broken off all around the base of the crown and from the inner side of the first and third inner cones. The roots are perfectly preserved. The tooth is 78 mm. long, 48 mm. wide at the front ridge (making allowance for the missing enamel), and 59 mm. at the third ridge. The enamel is considerably wrinkled. There was no dam across the outer end of the first transverse valley; the buttresses of the outer cones are not conspicuous. There is a large pulp cavity, and the roots are widely open below. The dentine of these roots is thin. Figure 2 shows the outer face of the tooth.

Figure 1, Plate XVII (No. 2231 U. S. N. M.), represents a considerably worn last right milk molar. It was found at Afton, Oklahoma. Its length is 80 mm.; the width at the third crest, 56 mm. The cingulum had been considerably worn away in front, but it is strongly developed behind and there is a strong ridge across the outer end of the anterior valley. As will be seen in the figure, the

PLATE XVII.

FIG. 1.

FIG. 2.

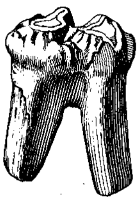


FIG. 6.

FIG. 3.

FIG. 7.

FIG. 4.

FIG. 5.

Mammut americanum. Fig. 1. Third right lower milk molar. $\times \frac{1}{3}$. Fig. 2. Third right lower milk molar; outer face. $\times \frac{1}{2}$. Fig. 3. Same as fig. 2; crown view. $\times \frac{1}{2}$. Fig. 4. Second right lower milk molar $\times \frac{1}{2}$. Fig. 5. Second left lower milk molar; much worn. $\times \frac{1}{2}$. Fig. 6. First right lower milk molar; seen from right side. Fig. 7. Crown view of same tooth as Fig. 6.

attrition of the anterior cones has reached through the hard dentine into the softer; also, the island of dentine corresponding to the first outer cone had just united with that of the inner cone and with that of the second outer cone. The latter has in like manner joined by a narrow isthmus that of the third outer cone. The outer islands are united through wear of the buttresses. There is even in this tooth a considerable pulp cavity within the hinder root. The walls of this root vary in thickness from 7 mm. to 14 mm.

The smallest third milk molar at hand is 71 mm. long, and 48 mm. wide behind.

Second Milk Lower Molar.—The first and second milk molars are distinguished from all the others by having two instead of three cross-ridges. These teeth, especially the first, are rare and would be known only from individuals that had died early in life. On account of their small size also, they are not so likely to be collected.

Figure 4, Plate XVII, (No. 6690 U. S. N. M.), represents the second deciduous molar of the right side of the lower jaw. It came from Afton, Oklahoma. Most of the anterior root has been lost and the whole of the hinder one, and with the last, a part of the hinder cingulum is gone. On the front of the tooth is a polished area, which shows that the tooth had been urging on its predecessor. The length of this tooth is 41 mm.; but it must originally have been slightly longer. The width in front is 32 mm.; at the second crest, 38 m. The fissure that separated the inner from the outer cone of each crest is scarcely indicated. There seems to have been a pretty strong anterior cingulum, and the outer end of the cross-valley has a ridge across it. How broad and high the hinder cingulum was cannot now be determined. Warren figures one of these teeth and represents the hinder cingulum as standing up like an incipient crest.

Figure 5, Plate XVII (No. 6701 U. S. N. M.), represents the second milk molar in a much worn condition—so deeply worn that the dentine areas of the front and hinder crests, and of the front and hinder cingula have coalesced into one area. The length is 42 mm.; the width in front, 32 mm.; at second crest, 39mm.

Lower First Milk Molar.—Specimens of this tooth are very rare. Figures 6 and 7, Plate XVII (No. 4986 U. S. N. M.), represent, as is supposed, the first lower milk molar of the right side. It was found at Kimmswick, Missouri. It is pretty well worn, so that the two islands of dentine of the anterior cones are united.

and those of the hinder crest on the point of uniting. The tooth is 33 mm. long front to rear, and 29 mm. wide at the hinder crest.[1] The width in front was greater than appears, for the enamel at each end of the front crest is broken off. The inner cones appear to have been much smaller than the outer ones. The transverse valley is wider at its outer end than at the inner, and seems to have been blocked by a ridge of the cingulum. The front and rear portions of the cingulum are present and moderately broad. There is a pressure area on the rear of the crown. There are two roots on this tooth, the hinder one being the larger. The roots were at one time doubtless longer. The apices may have been broken off after burial, or possibly absorbed preparatory to being shed.

Having described the teeth of the common mastodon, it may be a convenience to give some short rules for distinguishing these teeth from those of other animals, and for locating the position of any tooth in the jaw that may be found.

1. *To distinguish the teeth of the common mastodon from those of other animals.*

The great size of the teeth will at once distinguish most mastodon teeth from those of all other animals, except the elephants and perhaps some other mastodons. From the teeth of all elephants they may be distinguished by the fact that the teeth of the latter are composed of thin plates. For illustrations, see Plates XIX, XX. Other mastodons and tetrabelodons have the valleys between the ridges more or less obstructed by great buttresses and supplementary cones.

The rarely found first and second milk molars of the mastodon might be mistaken possibly for the teeth of tapirs or other smaller animals. The teeth of the tapirs have sharp cross ridges, but these are not divided by a longitudinal valley or fissure into inner and outer cones; besides, the cross-ridges of the tapir's upper teeth are united at their outer ends by a longitudinal ridge, wholly closing the valley. The same remark applies to the teeth of the rhinoceroses.

2. *To distinguish the upper teeth from the lower.*

The upper teeth of the common mastodon have the crests of the grinding surface running across the face at right angles with the long axis of the tooth, while the ridges of the lower teeth are ob-

[1] Warren states (p. 65) that the first lower milk molar figured by him had a width of only ⅞ of an inch.

lique to this axis. Excepting the small first and second upper milk molars, the upper teeth have two roots to support one cross-ridge of the crown, whereas all the lower teeth and the first two upper milk molars have a single root running across both ends of the tooth, one of them, the hinder, being much larger than the other.

3. *To distinguish which end of the tooth is the front end.*

a. If the tooth has been cut and subjected to wear this wear occurs first on the front of the tooth, and this end is, with very rare exceptions, worn down most deeply.

b. In the case of the three milk molars of each jaw, the front end is the narrower. In the case of the last true molar, the narrower and rounded end is the hinder one.

c. Leaving out of consideration the first two milk molars of each jaw, aid may be found in the disposition of the roots. In the upper teeth that end which has the crest supported by two roots, the inner of which supports also the inner end of the next crest, is the front end. In the lower teeth, that end which has a root supporting the terminal crest and unconnected with the root of the next crest is the front end. All the other crests are supported by one other root.

4. *To distinguish to which side of the jaw any tooth belongs.*

Hold the tooth with the grinding face upwards, and with the hinder end directed towards you. Then the sloping side of the crown, that on which are the cones with the buttresses, will look toward the side to which the tooth belongs. This rule applies to the upper and to the lower teeth alike.

5. *To distinguish the place of any tooth in the series.*

a. If the tooth has two transverse crests on the crown, it is either the first or the second milk molar. If it has three crests it may be either the third milk molar, the first true molar or the second. If it has four or five crests, it is the third true molar.

b. The first milk molar is smaller than the second, being about 33 mm. long, whereas the second is about 45 m. long. The anterior crest of the first is likely to be less complete than that of the second. Of course, the first tooth is narrower than the second.

c. The three intermediate molars, that is, the third milk molar and the first and second molars may be distinguished most easily by their relative sizes; the third milk molar varying from 70 to 83 mm.; the first true molar from 80 mm. to 95 mm.; the second true molar, from perhaps 105 mm. to 132 mm. The width of the third milk molar varies from about 49 mm. to 63 mm.; that of the first true molar from about 60 mm. to 71 m.; that of the second true molar from about 70 mm. to 97 mm. It will be seen from the above measurements that the greatest difficulty comes in distinguishing the last milk molar from the first true molar.

d. There should be no difficulty in identifying the last true molar, with its four or five transverse ridges and its great hinder root.

Vertebral Column.

The vertebral column of the mastodon consisted of seven cervicals, twenty dorsals, three lumbars, and of about 25 or 30 caudals; but no specimen has probably been found with all the caudals preserved, or at least with all rescued. It is probable likewise that the number of caudals varied somewhat in different individuals.

The neck of the mastodon, when compared with that of most other mammals, is extremely short. It was, of course, as in the elephants, impossible for the animal to bring his mouth to the ground when he was standing up.

The cervicals, except the last one, may be distinguished from all the other vertebræ by the fact that there is on each side, in the transverse process, a foramen for the passage of an artery. The seventh has no such foramina, but it differs from the dorsals in having a short, slender spinous process, and in having, just behind the base of the transverse process, a smooth concave surface for the head of a rib, and no such surface in front of the process.

With the exception of the second, the vertebræ of the neck were shorter than those of the dorsal region. They were, however, broader than the dorsals.

The first one behind the head, the atlas, is the broader of all the cervicals, and its lateral portions form the largest part of the bone. Figure 55 represents this bone, seen from the front, drawn from the mounted specimen in the U. S. National Museum. At the anterior end are seen the great, smooth, concave articular surfaces for the condyles of the skull. At the hinder end are somewhat similar surfaces for articulation with the next vertebra, the axis. As will be seen, there is a great opening in the atlas, and this is divided into an upper portion and a lower. The spinal cord traversed the upper division, the odontoid process of the axis occupied the lower. In the specimen figured, the width of the bone is 335 mm.; the height, 215 mm.; the fore and aft extent on the lower face of the bone, 73 mm. The opening is 111 mm. high, that part for the spinal cord is 80 mm. wide.

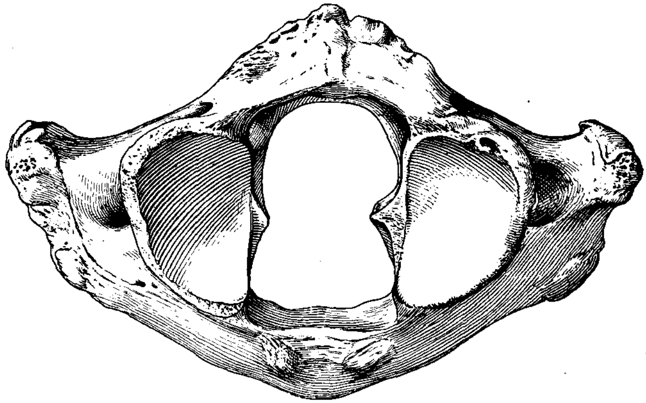


FIG. 55. *Mammut americanum.* Front view of atlas. × ¼.

This bone differs from that of the mammoth in having a much larger opening for the spinal cord and the odontoid process, and in having a different section at the midline of the neural arch.

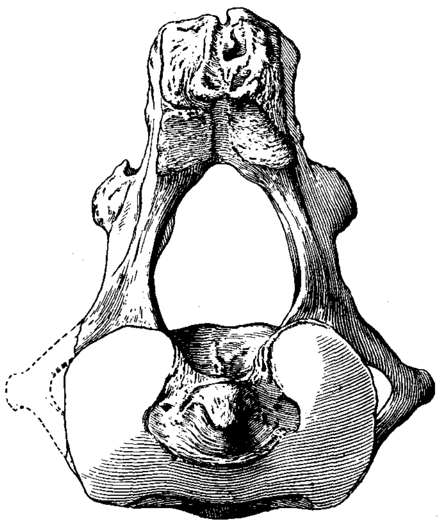


FIG. 56.

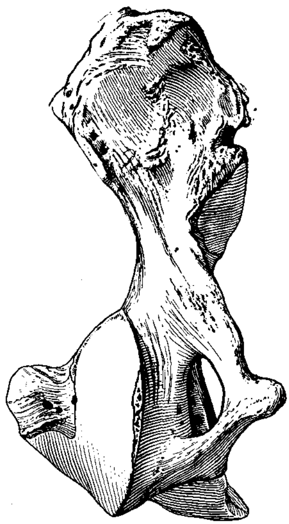


FIG. 57.

Figs. 56, 57. *Mammut americanum.* Front and side views of the axis. × ¼.

The axis differs from all other vertebræ of the spinal column in having a large nipple-shaped process on the front of the centrum, and a large, almost cubical neural spine. (Figures 56 and 57.) On the front of the centrum there is on each side a large smooth articular surface for the atlas, and these meet below the odontoid process. Each surface is 95 mm. high. The front end of the centrum is 166 mm. from side to side. The hinder end of the centrum is somewhat concave and somewhat broader than long.

The spinal canal is large, 72 mm. wide and fully as high. The neural spine is about 85 mm. long and wide.

The bone figured by Warren in his monograph on the mastodon as the axis of this animal certainly belonged to a very different species.

The axis of the mastodon differs much from that of the mammoth. In the latter the spinal canal is broader than high, the neural arches are shorter and thicker, and the neural spine is considerably longer than thick. Compare Figures 56 and 57 with the two views furnished by Figure 67.

The remaining cervicals are short, and they have short, slender spines. The third, fourth, fifth and sixth cervicals of the U. S. National Museum mounted specimen are each 47 mm. long, and the seventh, 54 mm.

The dorsal vertebræ are those to which were attached the ribs. They are twenty in number; but it may occasionally have happened that the hindermost rib was not developed, thus throwing the corresponding vertebra into the lumbar series. The dorsals may be known from their having short, thick, transverse processes which are not pierced by a foramen, and which arise from the arches; long, medium or short neural spines, which are mostly rather broad from front to back; and from having on each side one or two concavities for the heads of ribs. In the case of the anterior fourteen or fifteen of these vertebræ there are on each side two concavities for ribs, one in front for the rib which belonged to that vertebra, and one behind for the rib which belonged to the next vertebra behind. In such vertebræ the hinder cavity of one centrum fitted against the anterior cavity of the succeeding centrum, so as to make one hemispherical concavity for the reception of the head of a rib. In this way each rib articulated with two vertebræ at their junction. In the case of the hinder six or seven dorsal vertebræ, the articular cups for the rib-heads moved back from the front end of their respective centra, so that the hindermost rib articulated about the middle of the length of its centrum.

All the dorsals of the mounted specimen in the U. S. National Museum have a width of close to 125 mm. They vary in length from 56 to 70 mm. Those of the anterior half of the dorsal series average 59 mm. in length; those of the hinder half average a length of 68 mm. These measurements do not include anything for the intervening cartilages that were present in life.

The centra of the dorsals of the mounted Indian elephant in the U. S. National Museum, a male animal twenty years old, with a height of a little more than eight feet, vary in length from 52 mm. to 63 mm. The animal therefore had a shorter back and longer legs than the mastodon.

About six or eight of the anterior dorsals of the mastodon have very long neural spines, and these are directed upward and backward. In the U. S. National Museum specimen the third dorsal has the spine 381 mm. long (15 inches). The succeeding spines gradually became shorter, so that the hinder ones are very short.

The lumbar vertebræ are three in number. They resemble greatly the hindermost dorsals, but have no excavations on the sides of the centra for rib-heads. Their transverse processes are longer than those of the hinder dorsals and stand more directly outward. While the first lumbar centrum has about the same breadth as the last dorsal, the third lumbar is considerably wider, about 150 mm. in the U. S. National Museum specimen. Each lumbar in the specimen mentioned is 70 mm. long on the lower face.

In the Warren mastodon (Warren, Pl. XXIII, Fig. 3), the first lumbar had the transverse processes much longer than those of the last dorsal and longer than those of the other two lumbars.

The sacrum is that part of the vertebral column that is articulated between the two ilia, or hip-bones. It consists of five vertebræ, but three, in old age at least, are so thoroughly consolidated as to form a single mass. It appears that the first and the last of the vertebræ may remain, even to adult age, unconsolidated with the others, and one or the other may be missing from the specimen found. In old age the sacrum becomes wholly consolidated with the hip-bones, and then the bones of the pelvis form a single mass.

The lower surface of the sacrum is smooth and nearly flat. It is pierced by four pairs of holes, which are on the boundary lines between the originally distinct vertebræ. The upper surface is rough, with various processes. The anterior end joined the last lumbar vertebra; the hinder end, the first caudal. The sacrum of the mounted specimen in the U. S. National Museum is 400 mm. long. Its width in front is 275 mm.; behind, 220 mm.

Tail.

The number of caudals is somewhat doubtful, no specimen having been found with all present. The number varied probably somewhat in different individuals. There were probably about 25 or 30 in number.

They are naturally smaller than those of the trunk. The first are largest and have all the elements of a vertebra; those toward the tip of the tail are much reduced in size, and lack all parts except the centrum. Those of the upper half of the tail have long, flat, outstanding transverse processes and short neural spines. The second caudal of the U. S. National Museum specimen has the centrum 70 mm. long, 86 mm. wide in front, while from the extremity of one transverse process to that of the other is 230 mm. The base of the processes occupy nearly the whole length of the centrum.

Ribs.

As already stated there were in the mastodon twenty pairs of ribs. Of these, about the anterior six were connected directly with the sternum by cartilages. Of the others, all but the hinder six or seven sent forwards from their lower ends strips of cartilage to join the cartilage of the next rib in front.

Below the upper fourth, the first rib is nearly straight, flat, and paddle-like in form. Its length, in the U. S. National Museum specimen, is 540 mm. At one-third of its length from the upper end the width is 47 mm.; the thickness, 23 mm. At two-thirds the length the width is 87 mm. and the thickness 20 mm.; and at the distal end the width is 120 mm. The third, fourth, and fifth ribs are unusually broad in the upper third of the length. The fifth of the U. S. National Museum specimen is 78 mm. wide. The sixth is much narrower, as are all behind it.

In the U. S. National Museum mounted specimen the longest rib is the seventh, and is 1,063 mm. long. In the Warren mastodon the longest rib is stated to be the ninth and the length 54¾ inches, 1,390 mm.; but the ribs from the seventh to the tenth, inclusive, differ in length not more than an inch.

The longest rib of the Indian elephant in the U. S. National Museum equals 915 mm. The greatest width of the abdomen is 1,000 mm. In the mastodon described here, the width of the abdomen is 1,113 mm. wide, as mounted.

The ribs of the mastodon are slenderer than those of the Indian elephant. All, except a few in front, are less flattened on the inner surface than those of this elephant. There are indications that the same difference exists between the mastodon and the mammoth. The ribs of the elephants maintain their width, or even become broader toward the distal end.

STERNUM.

The *sternum*, or breast bone, of the mastodon, as that of the elephant, was composed of three segments of bone. The largest of these was in front and to it was attached by an interval of cartilage the broad lower ends of the front pair of ribs. The ribs of the second pair were attached at the interval between the front piece and the second; while the ribs of the third pair were attached at the junction between the middle and the hinder pieces of the sternum. In the U. S. National Museum specimen the anterior piece is missing, while the second and third pieces are consolidated into one bone. This is 190 mm. long, 90 mm. high in front, and 50 mm. behind. It is 42 mm. thick in front and 60 mm. behind. The upper surface is flat, while the bone is reduced below to a sort of keel.

Having described the axial structures and their appendages, the limbs and their supporting bones will next be considered.

The scapula of the mastodon, like that of the elephants, is very large and of an approximately triangular form, the sides of the triangle being nearly equal. The lower angle is greatly thickened, and the bone behind the angle excavated to form the glenoid fossa, for the head of the humerus. Another angle was directed upward and was placed opposite the basal portions of the neural spines of three or four anterior dorsal vertebræ. The third angle was directed backward. On the outer surface of the scapula and just above the glenoid fossa there arises a great spine whose greatest height above its origin on the bone is, in the U. S. National Museum, as much as 160 mm. This spine continues on to the upper angle of the scapula, its height becoming gradually reduced. The free border of the spine is expanded and at its lower end it gives off two great processes, one extending downward and forward, the other downward and backward. On the side of the bone that was applied against the ribs a strong ridge ascended from the glenoid fossa to the upper angle of the bone.

In the case of the scapula of the U. S. National Museum specimen, the anterior border measures 730 mm.; the border directed downward and backward, 660 mm.; the one directed backward and upward, including the glenoid fossa, 570 mm., of which 175 mm. belongs to the glenoid fossa. This fossa has a width, from side to side, of 100 mm. The anterior border and the glenoid border are smooth and thin, while the upper border is thick and rough from an edge of epiphysial bone.

A comparison of the scapula of the mastodon with that of the Indian elephant shows that in the mastodon the spine arose much farther behind the anterior border of the bone than in the elephants.

When the scapula is stood with the glenoid fossa downward and the border nearest to the spine forward, the spine will be directed toward the side to which the bone belongs.

The general form of the humerus may be seen in Plate XII. It is one of the great bones of the body and one of those the most likely to be preserved. It may be easily recognized from its greatly enlarged ends, the slender middle part, the rounded head for articulation with the scapula, the semi-cylindrical articulation for the ulna, the massive deltoid ridge, and the broad supinator ridge. The length of the humerus of the specimen in the U. S. National Museum measured in a straight line from the summit of the head to bottom of the trochlea, is 727 mm.; the trochlea measures from side to side 200 mm. The supinator ridge rises above the lower end of the humerus 270 mm. Where the shaft is most constricted the diameters are 95 mm. and 120 mm. The humerus of the Miami County, Indiana, specimen mounted in the Milwaukee Public Museum, is 900 mm. long.

The length of the humerus of this specimen equals that of the centra of eleven and one-half dorsal vertebræ; whereas, in the Indian elephant the humerus nearly equals the length of 15 vertebræ.

To determine to which side the bone belongs, stand it with the head upward, the bicipital groove directed forward and the deep cavity at the lower end into which the olecranon of the ulna fits looking backward; then the supinator ridge and the great deltoid ridge will be directed toward the side to which the bone belongs.

The ulna is the principal bone of the forearm. It may be recognized by the great sigmoid cavity for articulation with the lower end of the humerus, the enormous rough process standing backward from this articulation, the triangular shaft, and the rounded articulation at the lower end for some of the bones of the wrist. Plate XII shows the general form of the bone. In the case of the mounted specimen in the U. S. National Museum, the ulna is 640 mm. long, in a straight line. The line adjoining the hinder with the front end of the greater sigmoid cavity, that which receives the humerus, is 130 mm. long. At the lower end of the cavity is a notch that receives the upper end of the radius. The shaft is triangular, the outer face, at the middle of the length of the bone, having a width of 85 mm., the front face 87 mm., the inner or hinder face 95 mm. The lower end articulated with the lunar, the cuneiform, and the pisiform bones of the wrist. The bone is crossed in front by the radius.

To determine the side to which the bone belongs, stand it with the upper end upward, the rough olecranon and the concavity of the length of the bone backward, the great sigmoid cavity looking forward; the olecranon process will incline more toward the side to which the bone belongs; on that side too will be the sharp ridge which descends from the olecranon to form the hinder outer border of the bone; the smaller of the two processes that enclose the upper end of the radius will be on the same side; at the lower end of the bone the rough face with two eminences separated by a groove will look toward the same side; while the flat surface for the lower end of the radius will be directed toward the opposite side.

The ulna of the mammoth *E. primigenius* differs in being slenderer, in having the outer face divided by a ridge which, starting at the outer of the two processes which embrace the upper end of the radius, runs downward and backward to the outer eminence at the lower end of the bone. The upper half of the front face is more excavated than in the mastodon.

The radius is a relatively slender bone and is much twisted and bent. It occupied a position in front of the ulna, bending around below to the inner side of the latter. The head of the radius lay, in life, in a notch on the great sigmoid cavity of the humerus, and its upper extremity forms a smooth concave surface which articulated with the lower end of the humerus. The lower and larger end of the bone is flattened on the outer face for union with the lower end of the ulna. The lower extremity has a large, smooth articular surface, the greater part of which is applied to the lunar bone, but a small part thereof to the scaphoid. In the U. S. National Museum mounted specimen this bone is 600 mm. long; the upper end is 103 mm. wide, its lower end 133 mm. The diameters at the middle of the shaft are 43 mm. and 52 mm. respectively. The radius of the specimen mounted in the Milwaukee Public Museum is 725 mm. long.

Place the larger end of the bone downward, with the sharper edge of this lower end forward and the lowest process of the bone toward the rear, the smooth articular face for the upper end of the ulna backward; then the flattened face of the lower end will look toward the side to which the bone belongs.

The forefoot of the mastodon was greatly like that of the elephants. See Figures 58 and 59. It was a foot that in most respects was very primitive, in that it retained all of the elements typical of the wrist and all five of the digits. Besides this, none of the metatarsals is lengthened, as we find them in most of the hoofed animals. The foot was very short and was certainly furnished with a pad of connective tissue behind the digits, with the result that these, in

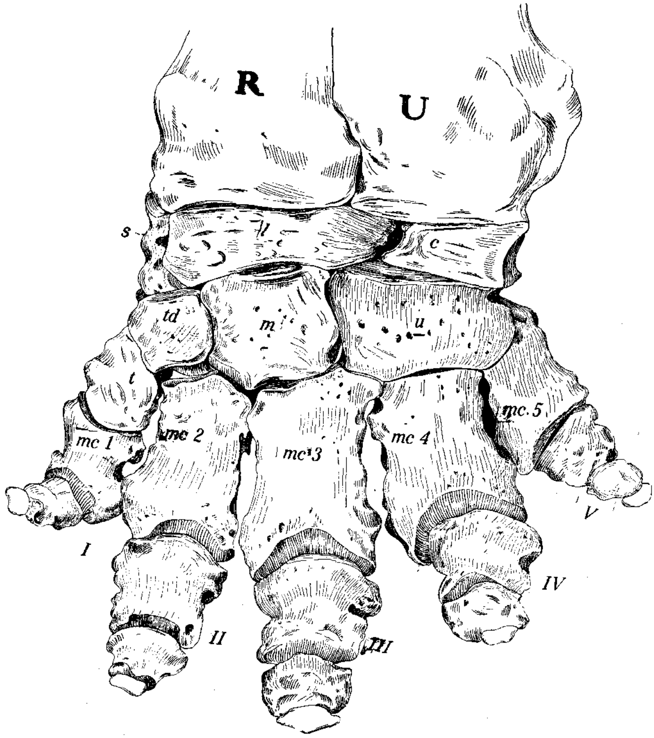


FIG. 58. *Mammut americanum.* Forefoot. After Warren. R, radius; U, ulna; *I*, first digit; *V*, fifth digit; *s*, scaphoid; *l*, lunar; *c*, cuneiform; *p*, pisiform; *td*, trapezoid; *m*, magnum; *u*, unciform; *mc 1–mc 5*, the metacarpals.

walking, were directed strongly downward, as well as forward; that is, the animal was digitigrade. There were certainly small hoofs at the end of each digit, as in the elephants.

The bones of the wrist, with the exception of the pisiform, are short and flat, with broad upper and lower smooth articulatory surfaces for movable union with one another, with the bones of the forearm, and with the metacarpals. The bones of the first, or upper, row of carpals are, commencing on the inner border of the foot, the scaphoid, the lunar, the cuneiform, and the pisiform. The connections of these may be seen from the figures, reproduced from Dr. Warren's monograph. The terminal phalanges of the digits are represented only in outline, inasmuch as they have probably never yet been found. They were certainly much reduced in size and may not have been present. It would require too much space to describe all these bones in detail. As to distinguishing them from the corresponding bones of the various fossil elephants the means for doing this hardly exist as yet; at least, the work has not yet been done. Where mastodon remains are found, care should be

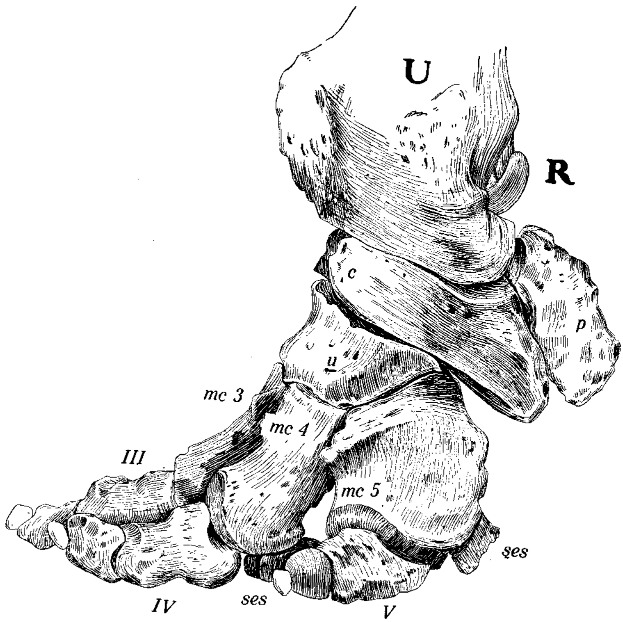


FIG. 59. *Mammut americanum.* Forefoot. After Warren. Explanatory letters same as Fig. 58.

taken to collect the smaller, as well as the larger bones. If the feet are present the bones of each foot, if not mixed with the bones of the other feet, should be kept separate, and, if possible, the bones of each digit separate from those of the others.

The pelvis, Figure 60, consists of the sacrum, which has been already described as a part of the vertebral column, and the two innominate bones. Each of the latter was composed, in early life, of three bones, the ilium, or hip-bone, the ischium, and the pubis, which joined one another at the acetabulum. These three became consolidated into one bone, and in old age, at farthest, all the pelvic bones became ankylosed into one mass.

The pelvis of the mastodon was enormously wide—much wider than that of the mammoth and that of the living elephants. Like those of the elephant, the ilia are nearly flat on the front face, that face that corresponds to the inner face of most animals, and they stand out at nearly right angles with the spinal column. In the case of the mounted specimen in the U. S. National Museum, the distance from the outer extremity of one ilium to that of the other is 1,425 mm. (56 inches). The width of the pelvis in the

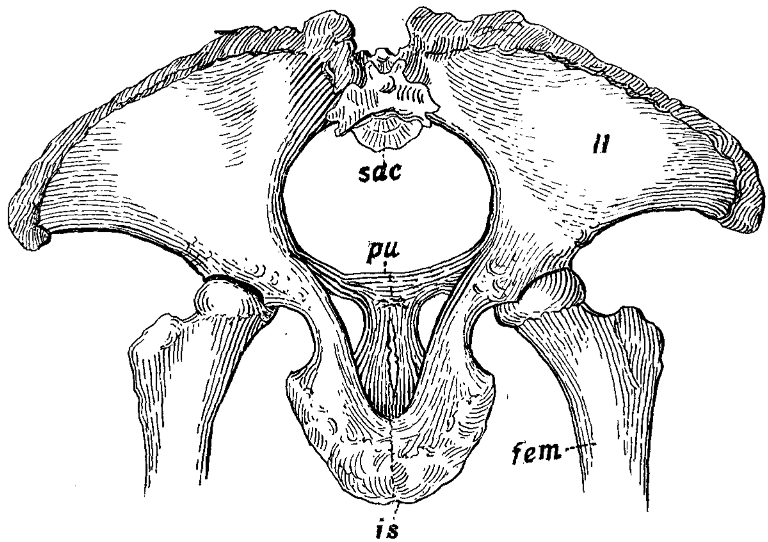


FIG. 60. *Mammut americanum*. Pelvis seen from behind $\times \frac{1}{19}$. After Warren. *fem*, femur; *is*, ischium; *pu*, pubis; *sac*, sacrum.

specimen in the Milwaukee Public Museum is 1,625 millimeters. The Randolph County specimen at Earlham College has the pelvis 1,900 mm. wide. In the Warren mastodon the width is given as 6 feet 2 inches. Figure 60, redrawn after Warren, represents the pelvis as seen from behind. In this specimen all the bones are thoroughly consolidated.

It will be seen that the ilia form the great wings of the pelvis and extend on each side from the sacrum to the acetabulum. The pubic bone extends in front from the acetabulum to the mid-line; while behind, an ischium runs downward and backward to meet its fellow of the other side at the mid-line. Each pubic bone sends backward, close to the mid-line, a branch which meets and becomes ankylosed to a forwardly directed branch from the ischium of its side. This results in producing on each side of the pelvis an opening, the obturator foramen, which is enclosed by the ischial and pubic bones.

The right and left sides of the pelvis enclose a large, nearly circular, opening, the pelvic strait. The roof of this is formed by the sacrum, the sides by the ilia, and the floor by the pubes and the ischia. In the U. S. National Museum specimen the depth of the anterior end of this opening is 564 mm; its diameter from side to side, 517 mm. The width is therefore about 92 per cent. of the height. In the mounted specimen at the Milwaukee Public Museum the depth of the opening is 470 mm., the width is 425 mm. The mounted specimen at Earlham College has the pelvic opening 520 mm. deep and 500 mm. wide. In the Warren mastodon the height is 21 inches, the width 22, the latter, 105 per cent. of the height. The latter animal has been regarded as a male, the one in the U. S. National Museum as a female, and it is possible that the difference in the form of the pelvic strait is due to difference in sex; but this is not yet certain. In the U. S. National Museum specimen the width of the pelvic strait is 36 per cent. of the width of the pelvis; in the Warren, it is 30 per cent., the opening being thus much smaller in the latter. It is to be observed that the opening in the U. S. National Museum specimen is almost as great as it is in the Warren mastodon, which was a much larger animal.

The longitudinal and transverse diameters of the obturator foramina in the U. S. National Museum specimen, are 185 mm. and 116 mm. respectively. The upper edges of the ilia are usually very rough from the presence of a border of epiphysial bone. In the younger animals this was not yet consolidated with the body of the bone and it may therefore in some specimens be missing. The hinder ends of the ischia are much thickened and usually very rough.

The acetabulum, which received the head of the femur, is a cup-shaped cavity, looks nearly directly downward. In the U. S. National Museum specimen its diameter is 150 mm. (6 inches).

The pelvis of the mastodon differs greatly from that of the mammoth and other elephants. Especially is it distinguished by the greater breadth, as compared with the centra of the dorsal vertebra. In the case of the U. S. National Museum specimen the width is equal to 22.4 vertebræ of average length, while in the

Indian elephant the width is equal to 19.4 dorsals of average length.

If, however, the width of the pelvis be compared with the length of the femur a great difference is observed. In the Indian elephant (probably, too, in the other elephants) the femur has the length almost exactly equal to the width of the pelvis; while in the mastodon, the femur is only 60%, or 65% of the width of the pelvis.

In the elephants the supra-iliac border descends from its articulation with the sacrum to its outer angle in a uniform curve, a part of a circle; while in the mastodon the border is nearly straight in most of its course to near the outer angle.

The femur is a long and relatively slender bone, with a flattened shaft and expanded ends. At the upper end, on a neck that projects inward and upward, is the head of the bone, with a hemispherical smooth surface that fitted into the acetabulum of the pelvis. Outside of the neck is the great trochanter, to which were attached powerful muscles. The shaft is flattened on the hinder face, passing into a concavity behind the great trochanter and into another at the lower end of the bone. At the lower end of the bone are found the inner and outer condyles, with smooth surfaces for articulation with the tibia. The inner condyle is the more prominent. Posteriorly these condyles are separated by a deep notch. Just above each condyle, on the outer and inner faces, is a rough prominence for attachment of ligaments. Above the condyles in front is a smooth surface for the patella.

The general form of the femur may be seen from Plate XII. In the U. S. National Museum specimen the femur is supplied from an animal found at Kimmswick, Missouri. This has a length of 970 mm. The head has a diameter of 140 mm.; at the middle of the shaft, the greater diameter is 130 mm.; the least, 70 mm. The greatest thickness of the bone at the lower end is 230 mm. A femur described by Blainville appears to have been a stouter bone than the one described, inasmuch as the greater diameter at the middle of the shaft was contained in the length of the bone only 6 1-3 times, instead of nearly 7 1-2 times. In the mounted specimen in the Public Museum, at Milwaukee, the femur is 1,070 mm. long.

The femur appears to be but little, if at all, stouter than that of the mammoth. In the latter the greater diameter, 146 mm., at the slenderest part of the bone, is contained in the length, 1,110 mm., 7.6 times; while in the femur of mastodon above described the diameter given is contained in the length 7.46 times.

To determine to which side the femur belongs, stand the bone with the head upward, with the hollow behind the great trochanter backward and with the surface for the patella forward. Then the great trochanter will point to the side to which the bone belongs. At the lower end the straighter border, ascending from the condyles, will be on that side.

The patella, or knee-pan, is a solid bone of considerable size that is very likely to be preserved. Its length, in the leg from Kimmswick, Missouri, is 120 mm.; the width, 116 mm.; the thickness, 80 mm. The surface which was applied to the lower end of the femur is smooth, concave up and down, convex from side to side. The other surfaces of the bone are convex and rough.

The tibia is one of the larger bones of the skeleton. It is straight and has the ends considerably enlarged. The upper end, cut off nearly at right angles with the length of the bone, presents two smooth concave surfaces for articulation with the condyles of the femur. These surfaces are separated by a prominent ridge. In front, below the surfaces mentioned, is first a concavity followed by a strong and rough tuberosity, continued downward nearly one-third the length of the bone. The remainder of the shaft is mostly smooth, convex from side to side in front, concave from side to side in the upper half of the hinder face, flat on the lower half. The hinder face is bounded on the outer and inner sides by two sharp ridges which descend from the inner and outer condyles. The upper end of the outer face of the bone is concave. On the rear of the outer condyle is a smooth surface for the head of the fibula. The lower end of the tibia has a smooth articular surface which fitted against the astragalus. It is concave from front to rear. On the inner side of the lower end an eminence, the internal malleolus, extended down against the inside of the astragalus. Outside of this surface is another, looking downward and outward, for union with the fibula. The U. S. National Museum specimen, the tibia of which is from Kimmswick, Missouri, presents the following measurements:

Length in a straight line	550 mm.
Transverse diameter of upper end	200 mm.
Greatest diameter of shaft where smallest	90 mm.
Shorter diameter of shaft where smallest	65 mm.
Diameter from side to side at lower end	160 mm.

In the mounted mastodon at the Milwaukee Public Museum, the tibia is 635 mm. long.

To determine the side to which a tibia belongs, place the bone with the large end upward, the tuberosity for the extensor muscles forward and the great concavity in the upper half of the bone directed backward; then, at the upper end, the concave surface that is at the lower level will be on the side to which the bone belongs, as will also the smooth surface for the fibula. At the lower end the sloping surface for the lower end of the fibula will also be on that side.

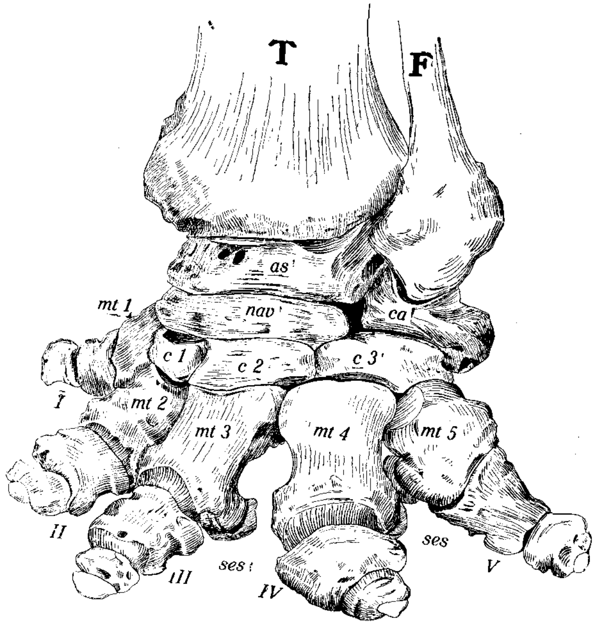


FIG. 61. *Mammut americanum.* Left hind foot seen from front. After Warren. *as*, astragalus; *c 1*, *c 2*, *c 3*, internal, middle, external cuneiform bones; *ca*, calcaneum; F, fibula; *I*, first or inner digit; *mt 1–mt 5*, metatarsals; *nav*, navicular; *ses*, sesamoid bones; T, tibia; *V*, fifth or outer digit.

The fibula is a long slender bone, with flattened faces and sharp ridges, and with one end moderately enlarged, the other considerably so. At the smaller, upper, end is a smooth surface which looked forward and was applied against a smooth surface on the back of the outer condyle of the tibia. The lower end of the bone has articular surfaces for three bones, the tibia, the astragalus, and the calcaneum. That for the tibia is on the inner face of the fibula and looks inward and upward. That for the astragalus is just below that for the tibia, is long and narrow and looks inward.

That for the calcaneum is larger and looks inward and downward. The length of this bone, from Kimmswick, Missouri, forming a part of the mounted specimen in the U. S. National Museum, is 520 mm. long; the length of that of the Warren mastodon is 26 inches, or 660 mm.

In order to determine to which side a fibula belongs, place the larger end downward with the process that descends the lowest in front; also, with the smooth surface that articulates with the tibia in front. Then the rough external malleolus will look toward the side to which the bone belongs.

The hinder foot (Figures 61 and 62) is made up of the tarsal, or akle bones, the metatarsals, or instep bones, and the phalanges,

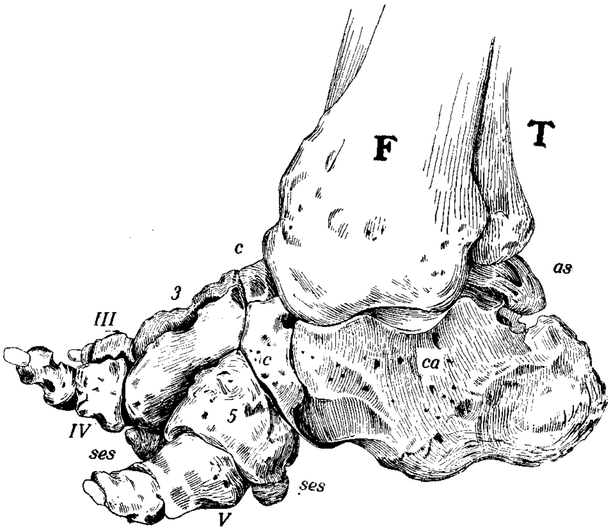


Fig. 62. *Mammut americanum.* Left foot seen from left side. Same explanation as for Fig. 61.

the bones of the toes. The foot, like the hand, is primitive in its construction, but the digits have become shortened and the position known as digitigrade.

The tarsus consists of the astragalus, the calcaneum, or heelbone, the navicular, the three cuneiform bones (internal, middle, and external) and the cuboid. These resemble closely those of the elephants, but doubtless close comparison would enable one to establish differences.

The astragalus is a flattened bone whose smooth upper surface articulated with the lower end of the tibia. Its lower surface articulated with the navicular in front and with the calcaneum

The calcaneum is a great irregular bone, a rough process of which formed the heel of the foot. It articulated with the fibula, the astragalus, the cuboid and the navicular.

The navicular is a flattened bone which articulated with the astragalus above, the calcaneum outwardly and behind, and with all the bones of the second row of tarsals.

Each of the three cuneiform bones articulated with the navicular bone above and with principally its own metatarsal bone below.

The cuboid is on the outside of the foot. It articulated with the navicular and calcaneum above and with the fourth and fifth metatarsals below.

The metatarsals, five in number, are short thick bones, which resembled the corresponding bones of the fore feet. The third and fourth are the largest.

There are supposed to have been two phalanges in the first digit and three in each of the others, but the terminal ones have not been found, and it is possible that some or all of them had become abortive.

As in the case of the fore foot, there are in the hind foot certain small nodular bones that are known as sesamoids. They were placed below the articulation of the metatarsals. There was a pair of these to each of four toes.

Covering of Hair.

In his book, "Animals Before Man in North America," Professor Frederick A. Lucas published a restoration of the American mastodon, in which the animal is represented as being covered with a coat of hair. The plate is a reproduction of a painting, now in the U. S. National Museum, that was made by Mr. J. M. Gleeson.

Whether or not this animal was clothed with hair may be regarded as an undecided question. Or, rather, it may be questioned to what extent they were thus clothed; for even the living elephants have some hair on their bodies.

The belief that the mastodon was a hairy animal rests on a very few and not wholly convincing observations. Unfortunately no cadaver has yet been discovered preserved in frozen soil, as in the case of the hairy mammoth. In 1801 (Medical Repository, New York, IV, p. 213 or 214), Hon. James G. Graham wrote a letter to Dr. S. L. Mitchill, in which, speaking of some mastodon remains found in Orange County, New York, he stated that "in Montgomery there was found hair of the mastodon three inches long and of a dun color."

A judge, Sylvanus Miller, writing to Dr. S. L. Mitchill in the same year and in the same journal, pages 211-213, announced the discovery and appearance of a skeleton found in Ulster County, New York. He wrote: "Around and in the immediate vicinity were locks and tufts of hair of a dun brown, of an inch and a half to two and a half inches long, and, in some instances, from four to seven inches in length."

In volume III of Blainville's Ostéographie des Mammifères, on page 340, is a statement that some bones of a mastodon had been found near the mouth of the Wabash River at a depth of 60 feet. It is further said that with these bones were found some portions of skin and hair. So far as is known none of these specimens of hair were preserved.

Prof. James Hall, in describing the finding of a small molar tooth at Stafford, Genesee County, New York, stated as follows: "Its situation was beneath the muck and upon a deposit of clay and sand. A large quantity of hair-like confervæ, of a dun brown color, occurs in the locality, and so much does it resemble hair, that a close examination is required to satisfy oneself of its true nature."

As to the food of the mastodon, not much is known that is wholly satisfactory. From the numerous sharp cusps on the teeth, it was by the earliest observers concluded that the mastodon was a carnivorous animal, but that idea was soon abandoned. About 1806 some remains of a mammoth were discovered in Wythe County, Virginia. Bishop Madison reported that at a depth of 5½ feet the finders had struck upon the stomach. The contents of the viscus were carefully examined and found to be perfectly preserved. They consisted of half-masticated reeds ("a species of *Arundo,* or *Arundinaria,* still common in Virginia"), of twigs of trees, and of grass and leaves. The bishop was very positive on the subject, but admitted he had not seen these things himself.

In 1846 Prof. Asa Gray, the botanist, reported (Proc. Bost. Soc. Nat. Hist. II, p. 92), on some materials that had been found occupying the place of the stomach of a mastodon skeleton discovered on Schooley Mountain, New Jersey. He found pieces of wood, evidently of branches one, two and three years old, broken quite uniformly into bits of half an inch or so in length, with only now and then traces of bark remaining. The wood was not fossilized and only partly decayed. From the examination of thin slices Professor Gray concluded that the wood was that of some conifer, a spruce or fir, rather than a pine. The structure agreed quite closely with that of similar branches of the common hemlock spruce.

In 1874 Dr. J. G. Hunt, of Philadelphia, gave the results of his examination of some substances which had been supposed to come from the stomach of a mastodon found at Wayland, New York. He found abundant remains of cryptogams and flowering plants, stems and leaves of mosses, and a fragment of probably a rush. Pieces of woody tissue and of bark of herbaceous plants and spiral vessels were abundant. "It thus appears that the animal ate his last meal from the tender mosses and boughs of flowering plants growing on the banks of streams and margins of the swamps, rather than fed on submerged plants; and it is probable, moreover, that the pines, cedars, and their allies formed no part of the mastodon's food."

From Gray's and Hunt's results one may conclude that mastodons varied their diet according to their tastes and circumstances. Other observations, or supposed stomach contents of mastodons have been made, but they lack accuracy of observation and of determination.

LIST OF LOCALITIES WHERE INDIANA MASTODONS HAVE BEEN FOUND.

Allen County.—Richard Lydekker (Foss. Mammals British Museum, Pt. IV, p. 17), states that there is in the British Museum a cast of the left half of the brain of an immature specimen from Ft. Wayne. The cast had been sent by the Chicago Academy of Science.

Prof. C. R. Dwyer (16th Ann. Report Geol. Surv. Ind., p. 129), stated that five skeletons of mastodons had been found in that county. No particulars were given. A note from Professor Dwyer informs me that he had been able to obtain no additional information.

All these mastodons must have lived after the clearing away of the ice of the Wisconsin stage.

Clark County.—In the Fifth Annual Report of the Geological Survey of Indiana, on page 176, Mr. Wm. W. Borden related the finding of a skeleton of the mastodon on tract 55 of the "Illinois Grant." This is not far from Charleston Landing, which is situated on the Ohio River, above Louisville. The bones were found in a sandbank. A part of the skeleton was sent to the old Louisville museum, the remainder were then in the possession of a Mr.

J. Coons. A tusk which belonged to this specimen is said to have been six feet in length, but it soon fell to pieces. Borden stated that mastodon remains and wood were often found in deposits of altered drift of that region at a depth of 30 feet.

The whole of tract 55 is quite level and seems to be covered with a thin layer of Illinois drift. There is no stream indicated on it on Siebenthal's map of this region (25th Ann. Rep. Geol. Surv. Ind.), and the river terraces do not reach back on this tract. It is possible, therefore, that the sandbank in which the mastodon skeleton was found was an Illinoian deposit; but it is more probably of a later date.

In the report just referred to, Mr. Borden stated that mastodon remains had been frequently found in the bank of the Ohio River at New Albany in the same position. It is probable, however, that the deposits along the Ohio at New Albany are of later date than the Illinoian ice-sheet.

Dearborn County.—In 1872, Prof. R. B. Warder (Third and Fourth Ann. Report Geol. Surv. Ind., p. 402), mentioned briefly some remains that had been found in this county. A part of a pelvis, belonging, as it was supposed, either to the mastodon or the mammoth, had been found at a salt spring, on Tanners Creek, below Guilford. A mastodon's tooth is said to have been found on high ground on George Randall's farm, five miles west southwest from Aurora. It was lying on a stratum of blue clay, eight or nine feet from the surface. Where these specimens now are, if in existence, is not known.

The greater part of this county is covered with Illinois drift, but the Ohio Valley contains deposits that resulted from glacial drainage, most of it of Wisconsin age; and this extends up the valley of Tanner's Creek. In this deposit was probably lying the pelvis mentioned above. Besides the Wisconsin drift of the terraces along the Ohio River in this region, there are some deposits beneath the Wisconsin that are suspected to be of Illinois age (Leverett, Monogr., U. S. Geol. Surv. XLI, p. 265).

DeKalb County.—Dr. W. J. Holland (Ann. Carnegie Museum, III, 1905, p. 464) stated that there is in the Carnegie Museum at Pittsburg a nearly complete individual of this species. This was found in a peat-bog about five miles west of Waterloo. Dr. Holland regarded it as one of the most complete and largest hitherto discovered in North America. No details regarding the conditions under which it was entombed have been furnished, nor anything about the structure except that of the hyoid bone. According to a letter sent to the State Geologist, Prof. W. S. Blatchley, by Mr. F. W. Willis, of Waterloo, Indiana, this skeleton was found in 1897 by a Mr. Spindler. One tusk was nearly 9 feet long and 6 inches in diameter. There were two teeth on each side of each jaw.

According to Leverett's map of this region (Monogr. XLI, U. S. Geol. Surv., pl. II), this peat bog mentioned would be on late Wisconsin drift, between two moraines.

Delaware County.—In 1881 Dr. A. J. Phinney (Eleventh Ann. Report Geol. Surv. Ind., p. 131), stated that remains of the mastodon had been found in different parts of Delaware County. He mentions first a tooth whose grinding face measured four by five and a half inches and whose depth was seven inches. It had been found four and a half miles west of Muncie, by Edward Tuhey, on the farm of Edward McKinley. No other data were furnished. A foot bone, which might belong to either the mammoth or the mastodon, had been found in the eastern part of the county and was owned by Dr. G. W. Kemper. About three miles south of Muncie, on the farm of P. Carmichael, parts of a skeleton, the ribs and some of the larger bones were found, all in an advanced stage of decay. It is not known whether any of these were preserved. They might, quite as well, have been bones of one of the mammoths.

The whole of this county is, according to Leverett (Monogr. U. S. Geol. Surv. XLI, p. 485, pl. II), covered with late Wisconsin drift, and the bones which were found lay in deposits, probably swamp muck, that were formed after the last glacial ice-sheet had disappeared from the county. It is, of course, possible that the edge of the glacier existed yet within the State, farther toward the north.

Dubois County.—(*a*) In the Fourth Annual Report of the Geological Survey of Indiana, 1872, page 214, Prof. John Collett stated that a Colonel Edmonston had found a part of a mastodon skeleton near the mouth of Wolf Creek, at "Rock House" ford of White River. This appears to be in Harrison Township. One of the teeth had been presented to Dr. Owen, the State Geologist, and was supposed to be in the cabinet of the State University.

No details were given as to the exact place of discovery, its depth or the character of the deposits. According to Leverett (Monogr. XXXVIII, U. S. Geol. Surv., pl. VI), the locality is on or near the border of the Illinois drift sheet. The valley is indicated as being occupied by alluvial terraces older than the Wisconsin drift deposits. The skeleton may have been in some of these terraces.

(*b*) Somewhere near this locality it probably was that another specimen of mastodon was found many years previously. Samuel J. Mitchell, in his "Observations on the Geology of North America," page 363, stated that a part of a mastodon had been found in July, 1817, on the east branch of White River. The report of the specimen had been sent by a man who lived "near the falls of the east branch." The specimen consisted, among others, of the upper jaw whose width from outside to outside was $20\frac{1}{2}$ inches. The length of the posterior grinder was $7\frac{3}{4}$ inches and there appears to have been five transverse ridges on the third true molar. This account was quoted in Godman's American Natural History, volume II, page 239.

Fountain County.—In the Second Annual Report of the Department of Geology and Statistics, 1880, p. 386, Professor John Collett, then State Geologist, stated that, at some time not mentioned, a skeleton of a mastodon had been found a few miles north of Covington, imbedded in wet peat. It was found while excavations were being made for a canal. It is not stated at what depth the remains occurred. The teeth are said to have been well preserved. Collett quotes a statement that when the long bones were split open it was found that the marrow had been preserved and it was used to grease boots. There were also chunks of adipocere present. The indications are that the remains were destroyed, apparently being of more value to the finders for furnishing boot-grease than as a source of scientific knowledge.

While this report was in press the writer received a letter written by Mr. J. E. Walker, of Attica, Indiana, which stated that a lower jaw of a mastodon was found about October 1, 1895, near Newtown. On further inquiry a letter was received from Mr. Charles R. McKinney, Newtown, who says that the jaw was found in the bank of Coal Creek, about 4 rods from where it crosses into Montgomery County. The location is on the N. E. $\frac{1}{4}$, S. 9, T. 20, R. 6. The soil is described as a very black loam, and the jaw was about 3 feet from the surface. It has been found impracticable to enter this locality on the map.

This region is, according to Leverett's (Monogr. XXXVIII, U. S. Geol. Surv., pl. VI), covered with the deposits of the Champagn till sheet of the early Wisconsin glacial ice-sheet. All that we can be certain of is that the animal lived after the withdrawal of this early Wisconsin time.

Franklin County.—Dr. Rufus Haymond, in 1869 (First Annual Report Geol. Surv. Ind.), reported that parts of three mastodons had been found in the vicinity of Brookville. One of them had been discovered half a mile below the town, another three and a half miles below. These were both found in the gravel in the upper river terrace, some eight or nine feet below the surface. The third skeleton was found three and a half miles northeast of Brookville, on the farm of David Barnard, in a piece of marshy ground which he was ditching.

While most of the region south of Brookville is covered with Illinois drift, the valley of the Whitewater River itself contains deposits that were laid down by water coming from the glacial ice that belonged to the Wisconsin stage.

From Haymond's account it is to be believed that in each case at least several bones were found. If this is so, it is not probable that these had been relaid from earlier deposits. The animal must have lived at the time the gravels were laid down, either where the bones were found or somewhat nearer the edge of the glacial sheet.

From Mr. A. E. Taylor's account of this region (Thirty-fourth Ann. Report Geol. Surv. Ind., p. 125), the terrace in which the mastodon bones were found is 100 feet above the bed of Whitewater River. Since, therefore, those gravels were deposited, with the bones in them, the river has cut down a distance of 100 feet. The writer is inclined to believe that this upper terrace dates from a time considerably prior to the close of the Wisconsin stage.

In the case of the skeleton found in the peat-bog, it is quite certain that the animal lived after the ice had withdrawn which produced the outer moraine of the early Wisconsin; for the locality must be on this moraine. The mastodon may have lived at a time considerably later, even after the close of the glacial period. Dr. Plummer (Amer. Jour. Sci., Vol. XLIV, 1843, p. 302), described two objects called by him "horns," which he found in gravel near Brookville. One of these was figured. They were 10 inches long, an inch and a half in diameter at the base; solid, gently tapering towards the smaller end, and slightly furrowed longitudinally. It is not unlikely that these were the lower tusks of a mastodon or the upper tusks of a young mastodon. The writer has observed tusks of the mastodon which were thus furrowed.

Gibson County.—In 1910 three teeth of a mastodon were found in Princeton, Gibson County, whilst an excavation was being made for a sewer in West Chestnut street. They were met with at a depth of six feet. Three teeth were secured. Of these, two, probably the hinder true molars, are reported to have weighed each three pounds; while another, probably second true molar, weighed a pound and a half. The teeth were in the possession of the City Engineer, Mr. H. H. Neikamp.

In Blainville's Ostéographie des Mammifères, Volume III, p. 340, mention is made of the finding of a lower jaw of a mastodon at some place between Vincennes and New Harmony. This would be Knox County or in Gibson County. The jaw had in it the last two molars of one side. It was placed in the library of the city of Vincennes by M. Badollet, one of its curators. It ought to be now in the University of Vincennes.

Grant County.—In 1883, Dr. A. J. Phinney, on describing the geology of Grant County (Thirteenth Ann. Report Ind. Geol. Surv., p. 143), reported that some years previously the tooth of a mastodon had been found in one of the marshes south of the lake in Fairmount Township. No data were furnished and were perhaps at that time unattainable.

After the clearing away of the ice-sheet of the Wisconsin stage a large part of this region was left in a condition of small lakes and ponds. These gradually filled up with vegetable debris, and with some soil carried in by the water and winds, and at length were converted, partially at least, into swamps. Around these and in them lived mastodons, mammoths, great beavers (*Castoroides*), common beavers, and undoubtedly many other animals. It is just north of this that was found the fine specimen of *Elephas primigenius* that is in the American Museum of Natural History, New York, and near here, at Fairmount, was exhumed a specimen of *Castoroides* that is now in the Field Museum, Chicago. We cannot doubt that all these animals were contemporaries.

Hendricks County.—In the collection of the State Museum, at Indianapolis, there is a second lower molar, much worn, with part of the crown missing, and with strong roots. It was found near Danville and is credited to Dr. Vinnage.

Henry County.—In the collection belonging to Princeton University there are two teeth, the first lower molars, right and left. The length of each is 95 mm. No data are given regarding the exact locality or regarding the condition under which the teeth were found. On the map the dot indicating these specimens is placed arbitrarily.

Jackson County.—In 1874 (Sixth Annual Report Geol. Surv. Ind., p. 59), Prof. E. T. Cox reported that Mr. James Duncan found a large molar of a mastodon on the bank of Judah Creek, a branch of Mill Creek. This was on Section 9, T. 4 N., R. 4 E., and not far north of the Muscatatuk River. Other bones were seen but on exposure they crumbled to pieces. The tooth is said to have been sent to the State cabinet. The locality seems to be an area covered by valley deposits of Illinoian age (Leverett, U. S. Geol. Surv., Monogr. XXXVIII, pl. IX). It might even yet be possible for a competent geologist to determine whether or not these bones were found in this Illinoian material, or in some more recent deposit. Cox reported further that teeth and ribs of a mastodon had been found some years previously at Sparksville, in Jackson County, in the bank of the White River. According to the map referred to above, this valley is occupied by Wisconsin valley drift.

Jasper County.—John Collett, then State Geologist, reported in 1882 (Twelfth Ann. Report, p. 73), that remains of a mastodon had been found at some point in this county. He indicates that this, as well as a mammoth found in the same county, were buried in deposits of peat. It is quite certain that the animals, if correctly identified, both existed after the clearing away of the Wisconsin ice-sheet.

Jay County.—In the Twelfth Annual Report of the State Geologist of Indiana there is, on page 169, a mention by Mr. David McCaslin of various remains of mastodon that had been found in Jay County. In particular, he mentions fragments that had been found in the western part of Penn Township, and which seemed to indicate a complete skeleton. A shoulder-blade of this skeleton was in the possession of Dr. B. G. Arthur. In the same township had been found the antlers of a gigantic elk.

All such remains must have been buried in the soils that accumulated after the clearing away of the last ice of the glacial epoch.

Lagrange County.—Professor Donaldson Bodine, of Wabash College, Crawfordsville, informs the writer that in 1910 one of the students sent to Wabash College some teeth, a part of a jaw, and other fragments of a mastodon that had been discovered during some dredging operations near Lagrange, in Lagrange County.

Mr. F. H. Ward, of Ward's Natural Science Establishment, Rochester, N. Y., has informed me that there is in the stock of that concern a lower jaw of a mastodon from this county. The exact locality where it was found is unknown.

Madison County.—In the Indianapolis Star of July 30, 1911, there appeared an account of the finding of parts of the skeleton of a mastodon on the farm of Louis Webb, near Anderson. An illustration, reproduced from a photograph showed a portion of a jaw with four teeth, apparently the second and third true molars. The remains were found in what had been a swamp and were covered by about three feet of soil.

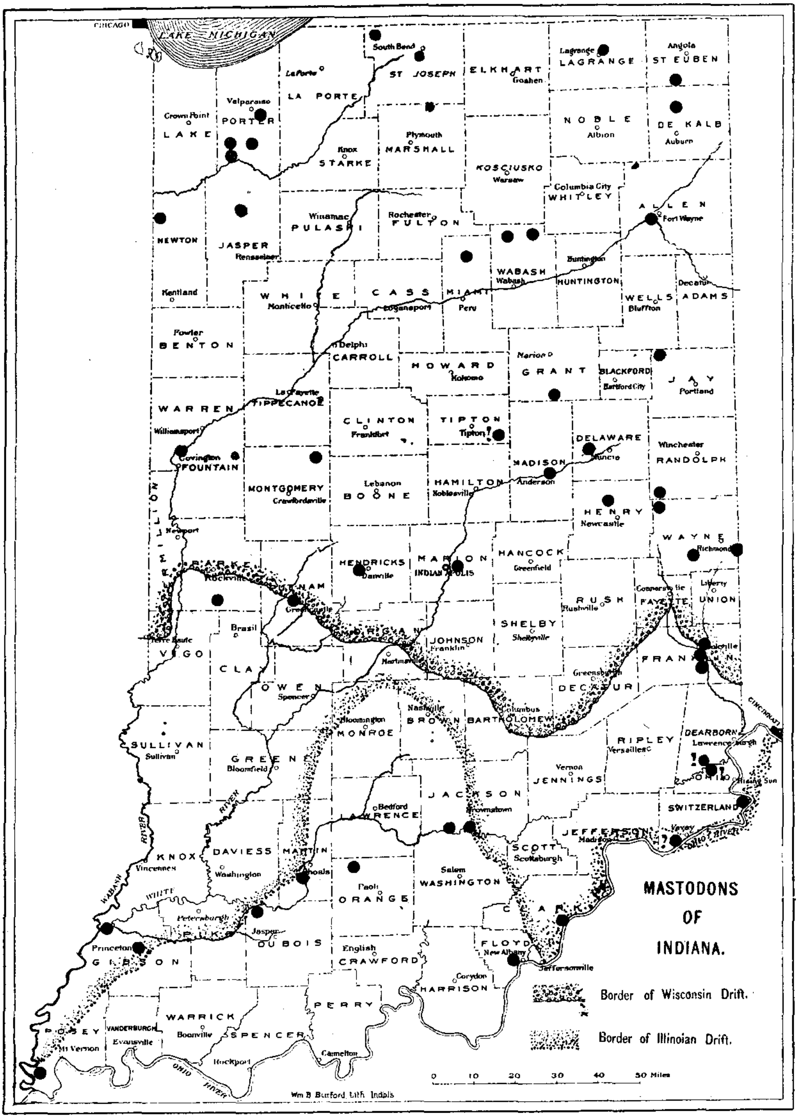
Marion County.—In the State Museum at Indianapolis there is a lower last right molar which is labeled as having been found at Indianapolis at Pennsylvania and Thirtieth streets, while workmen were excavating for a sewer. It was presented to the museum by Mr. Charles Dennis, of Indianapolis. This tooth has five well developed crests and a distinct talon. It is slightly worn on all the crests and has pretty good roots. The length of the tooth is 195 mm.; the width at the third crest, 85 mm.

In the collection there is a tusk about 600 mm. long and 100 mm. in diameter which had been found near the Belt Railroad by Americus Fish. It is probably the tusk of a mastodon.

Marshall County.—Since this report was put in the press the author has received from Rev. A. M. Kirsch, professor of geology in Notre Dame University, notes and photographs of mastodon remains collected by him in the region about South Bend. In 1911, while a ditch was being made near the line between Marshall and St. Joseph counties (Sec. 19, Tp. 35 N., R. 3 E.) mastodon bones were thrown out by the steam shovel. There were secured the lower jaw nearly complete, with the second and third molars; all the cervical vertebræ and some dorsals, lumbars, sacrals and caudals; a humerus, a femur and other bones; also a tusk somewhat more than 4 feet long. These remains are in the collection of the University of Notre Dame. The locality could not be entered on the map. Plate XVIII.

Martin County.—Prof. E. T. Cox, in 1871 (Ind. Ann. Report Geol. Surv. Ind., p. 103), stated that remains of both mastodon and mammoth had been found in Martin County, imbedded in marsh clay, resting on drift. He mentions especially that some years previously a large tooth and probably some other bones of the mastodon had been obtained by Hon. W. E. Niblack, from near Hindostan, and were presented by him to Dr. D. D. Owen, who transferred them to the State University. Hindostan is on the east bank of the East White River, about four and a half miles in a direct line southwest of Shoals. Without data as to the exact

PLATE XVIII.



CHICAGO
LAKE MICHIGAN
South Bend
ST JOSEPH
ELKHART
Goshen
Lagrange
LAGRANGE
Angola
ST EUBEN
La Porte
LA PORTE
Valparaiso
Crown Point
PORTER
LAKE
Plymouth
MARSHALL
Knox
STARKE
NOBLE
Albion
DE KALB
Auburn
KOSCIUSKO
Warsaw
Columbia City
WHITLEY
ALLEN
Fort Wayne
NEWTON
JASPER
Rensselaer
Winamac
PULASKI
Rochester
FULTON
WABASH
Wabash
HUNTINGTON
WELLS
Bluffton
Decatur
ADAMS
Kentland
WHITE
Monticello
CASS
Logansport
MIAMI
Peru
Fowler
BENTON
Delphi
CARROLL
HOWARD
Kokomo
Marion
GRANT
BLACKFORD
Hartford City
JAY
Portland
WARREN
Williamsport
La Fayette
TIPPECANOE
CLINTON
Frankfort
TIPTON
Tipton
DELAWARE
Muncie
Winchester
RANDOLPH
Covington
FOUNTAIN
MONTGOMERY
Crawfordsville
Lebanon
BOONE
HAMILTON
Noblesville
MADISON
Anderson
HENRY
Newcastle
WAYNE
Richmond
Newport
PARKE
Rockville
HENDRICKS
Danville
MARION
INDIANAPOLIS
HANCOCK
Greenfield
RUSH
Rushville
FAYETTE
UNION
Liberty
Terre Haute
VIGO
Brazil
CLAY
PUTNAM
Greencastle
MORGAN
Martinsville
JOHNSON
Franklin
SHELBY
Shelbyville
FRANKLIN
Greensburgh
DECATUR
OWEN
Spencer
Bloomington
MONROE
Nashville
BROWN
BARTHOLOMEW
Columbus
CINCINNATI
SULLIVAN
Sullivan
GREENE
Bloomfield
RIPLEY
Versailles
DEARBORN
Lawrenceburgh
Vernon
JENNINGS
OHIO
Rising Sun
Bedford
LAWRENCE
JACKSON
Brownstown
SWITZERLAND
Vevay
JEFFERSON
Madison
SCOTT
Scottsburgh
KNOX
Vincennes
DAVIESS
Washington
MARTIN
Shoals
Salem
WASHINGTON
Paoli
ORANGE
WABASH RIVER
WHITE RIVER
Petersburgh
PIKE
Jasper
DU BOIS
English
CRAWFORD
CLARK
FLOYD
New Albany
Jeffersonville
Princeton
GIBSON
Corydon
HARRISON
PERRY
WARRICK
Boonville
POSEY
VANDERBURGH
Evansville
Mt Vernon
SPENCER
Rockport
Cannelton
OHIO RIVER
MASTODONS
OF
INDIANA.
Border of Wisconsin Drift.
Border of Illinoian Drift.
0 10 20 30 40 50 Miles
Wm B Burford Lith Indpls

locality where the tooth was found it is impossible to determine its geological level. According to Leverett's map, pls. VI and IX of Monogram XLI of the U. S. Geological Survey, the country east of the river at Hindostan is without drift, but the valley is filled with a deposit of Illinoian age. Of course the mastodon may have lived and been buried at some later time.

Prof. Geo. K. Greene, of New Albany, informs me by letter that in 1878 he bought a mastodon's tooth which had been brought out of White River, near Shoals, on a fishing line. Mr. Greene sold this tooth to Prof. John Collett.

Miami County.—There is in the Milwaukee Public Museum a mounted skeleton of a mastodon that was found at Denver, in Miami County, in 1902. It was discovered under five or six feet of muck. The greater part of the skeleton is present. From a photograph of it the drawing (Pl. XIII), has been prepared. The height at the shoulder of the skeleton, as mounted, is about 2,570 mm. (8 feet 3 inches). The humerus is 900 mm. long; the radius, 725 mm.; the femur, 1,070 mm.; the tibia, 635 mm. The pelvis is 1,625 mm. wide; the pelvic opening is 470 mm. wide and 425 mm. high. There are three teeth in each jaw, but the hinder one had not yet come into use. The tusks have been mounted with the tips of the tusks directed inward.

Montgomery County.—Prof. Donaldson Bodine, of Wabash College, has informed the writer that about 1885 some remains of a mastodon were found on the farm of Mr. Milton N. Waugh, in the northeast part of this county. The exact locality is said to be Section 12, T. 20 N., R. 3 W. These bones were unearthed by a Mr. Parrish, who exhibited them at the county fair.

Another specimen is supposed to be near the cellar of a house, on the farm of Mr. George Lynch, Section 8, 19 N., 3 W. One end of a tusk was exposed on digging the cellar, but it was not unearthed. It may, of course, well be that this is the tusk of a mammoth.

Newton County.—In 1870 Mr. Frank H. Bradley stated (Geol. Surv. Ills., IV, p. 229), that in draining Beaver Lake, in Newton County, Indiana, some mastodon remains had been found, in company with Boötherium; but no particulars were furnished. Where the specimens now are is unknown.

Inasmuch as the region where these remains are found is now or was until recently, a great marsh and probably has been such, or even at times part of a great lake, ever since the clearing away of the Wisconsin ice-sheet, the comparatively late existence of the mastodon and of the Boötherium cannot be doubted. It is conceivable that these animals perished even at a time when the region was a lake, through having ventured out on the ice and either died there through hunger and cold or as a result of breaking through the ice and drowning.

Orange County.—In a letter, Mr. Marion F. Mathers, of Orleans, Orange County, informs the writer that in 1903 he found on his place, five miles west of Orleans and six miles east of the Martin and Orange County line, and two miles south of the line between Orange and Lawrence counties, one-half of the lower jaw of a mastodon with the teeth in it. This is now in the State collection at Indianapolis. In the collection the writer found this jaw, which contains the three true molars. The $m._{\overline{1}}$ is 93 mm. long and has the crests slightly worn; the $m._{\overline{2}}$ is 115 mm. long and has the two anterior crests slightly abraded; $m._{\overline{3}}$ had not yet come through the gum. It has five crests and a small heel.

Mr. Mather has in his possession some teeth and part of a tusk of two other individuals. It appears that all these specimens were found in a valley at a depth of about four and a half feet below the surface.

These remains having been found outside of the drift-covered area, it is impossible to assign them to any particular stage of the Pleistocene period.

Parke County.—In the Forty-first Annual Report of the State Museum of New York, it is reported that, by purchase from L. A. Boyd, there had been received, about 1888, the tooth of a mastodon. It had been found at the junction of Raccoon Creek and Little Raccoon Creek.

In the absence of any data as to the conditions under which this tooth was discovered, it is impossible to determine at what stage of the glacial period it was buried.

Porter County.—In the Twenty-second Annual Report of the Geological Survey of Indiana, Prof. W. S. Blatchley reported mastodons from four localities in Porter County. However, "in each case but a few teeth and one or two bones were exhumed while ditching." Professor Blatchley probably did not see the remains and the identifications must be regarded as doubtful. Nevertheless, it is more probable that the remains belonged to mastodons than to either of the elephants.

One locality was in the Kankakee marsh, on section 25, township 33 north, range 7 west, three miles southeast of Hebron; another in a marsh by the side of Cobb's Creek, just east of Hebron; the third near Sandy Hook Creek, northwest of Kouts; the fourth on the southwest quarter of section 27, township 35 north, range 6 west, 2 miles southwest of Valparaiso. The first two localities would, according to Professor Leverett's map (Plate VI, Vol. XXXVIII, Monographs U. S. Geol. Surv.), be on territory occupied by late Wisconsin till; the fourth locality would be on the Valparaiso moraine system of the late Wisconsin; the third locality is not exactly determined, but it is certainly above Wisconsin drift. A letter received from Mr. C. H. Wolbrandt, of Kouts, informs me that the tooth discovered near that place was found at a depth of about two feet beneath the surface.

Professor Blatchley reported that with this tooth were unearthed the antlers of a large elk. On the same page cited above Professor Blatchley reported a mammoth skeleton that was found between Crown Point and St. Johns, and this would also be on the Valparaiso moraine.

The present writer has photographs of a tooth which almost certainly is that of *Elephas columbi* and which was found by Mr. J. H. Knapp, of Chicago Heights, Illinois, in a creek, 2½ miles east of this place. This would be on the same moraine already mentioned. These facts seem to show that both the mastodon and the Columbian elephant lived after the disappearance of the Wisconsin ice-sheet. Other cases are known.

The writer has been informed that Mr. Jacob Davis, of Hebron, Indiana, in dredging at a point about five miles southeast of Valparaiso ran into the skeleton of a mastodon and secured a large number of the bones, but some were carried off by curiosity hunters. The bones were found at a depth of about eight feet. This locality is on the Valparaiso moraine.

Posey County.—In the second edition of Warren's monograph on *Mastodon giganteus*, page 170, in a quotation from Blainville's (Ostéographie des Mammifères, volume III, p. 340), it is stated that some bones of the mastodon, a fine vertebra, a femur with epiphyses (drawings of which had been shown to Blainville by Le Sueur), had been found near the mouth of the Wabash River and had been deposited in the library of the city of Vincennes. These remains had been found at a depth of more than 60 feet, in digging a well. According to M. Badollet, a curator of the Vincennes library, some portions of skin and hair had been found with these bones. Pres. Horace Ellis, of Vincennes University, has informed the writer that some bones, supposed to be these, are now in Vincennes University.

While the locality is not indicated exactly, it was probably in Posey County. All this region, both in Perry and Gibson counties, is overlain by Illinoian drift or by glacial terraces. If the well noted above had been sunken in Illinois drift, it would have penetrated it or nearly so. The glacial terraces are believed to be the outwash from the Wisconsin ice-sheet. It seems, therefore, that this mastodon was of rather early Wisconsin time, or of a stage still older.

David Dale Owen (Report Geol. Recogn. Indiana, 1862, p. 19), stated that mastodon and mammoth remains had been found in both Vanderburgh and Posey counties, but no details were furnished.

Putnam County.—In the State Museum at Indianapolis there is a lower right last molar which was found near Greencastle and presented to the geological collection by John G. Sweeney. It has four crests and a talon so large that it may be regarded as a fifth crest. The roots are mostly broken off. The length of the tooth is 187 mm., the width 90 mm. at the first and second crests. Whether the tooth was found on Wisconsin drift or Illinoian is not known.

Randolph County.—Prof. Joseph Moore, in the Proceedings of the Indiana Academy of Science for 1896, page 277, described and furnished a figure of a mastodon that had been obtained in a peat bog near Losantville. It was discovered while digging a ditch to drain the bog. The head and tusks were complete, but in exhuming these and other parts, as the pelvis, some damage was done them. They were afterwards repaired by Ward and Company, Rochester, New York. Finally the skeleton was mounted and is now on exhibition in Earlham College at Richmond. The tusks in the mounted specimen are modeled from other specimens, but one belonging to the Randolph County remains is preserved in the collection. It is 1,970 mm. long on the convex border and the diameters at the base are 170 mm. and 155 mm. It is strongly curved, the upper surface at the middle of the length being 525 mm. removed from the line joining the extremities. It is likewise spirally twisted, more so than the tusk of the elephant found at Fort Wayne. It is also finely fluted longitudinally. About half of the vertebræ were secured and about one-half of the ribs. The pelvis has a width of six feet two inches. Both scapulæ were present, the radius and ulna of both sides, one good femur and many foot bones. As mounted, bones of one or more other specimens were introduced. The tusks are artificial, but modeled from the originals. From the pedestal to the top of the highest spine, the height is 11 feet, less half an inch.

Losantville is, according to Leverett (Monogr. U. S. Geol. Surv. XLI, p. 306, pl. XI), on the outer moraine of the late Wisconsin, where it overrides the moraines of the earlier Wisconsin. Hence, the mastodon in question left his bones in a depression on the top of the later Wisconsin drift sheet, and later they became overlain by a deposit of peat.

In Nautilus, volume IV, page 131, Elwood Pleas, of Dunreith, Indiana, gave a list of six species of mollusks that had been found associated with the mastodon. All are yet living.

Dr. A. J. Phinney (Twelfth Ann. Report Indiana Geol. Surv., p. 181), stated that mastodon bones had been met with in this county, but no details were furnished.

In his account noted above, Professor Moore gave a description of a part of a mastodon which had been found at New Paris, Ohio, located very close to the Ohio-Indiana line and a few miles farther north than Richmond. One tusk entire was taken out and this measured nearly 11 feet in length and 10 inches in diameter at the base. On drying it crumbled, so that only 3½ feet of the base was preserved. This, with a pair of molar teeth, half a dozen vertebræ, a femur, a humerus, and some other parts, are now in the collection of Earlham College. This locality is on late Wisconsin drift.

St. Joseph County.—Rev. A. M. Kirsch has sent the author information regarding mastodon remains found in this county. About six years ago some bones, a humerus, radius, ulna-femur, some dorsal and lumbar vertebræ, and a lower third molar were found in the Kankakee marsh, in Olive Township, about 10 miles west of South Bend. About 20 years ago a tooth, fragments of the skull, vertebræ, ribs, and a scapula were found in Portage Township. All these remains are in the collection of Notre Dame. It has not been found practicable to represent these localities in Plate XVIII.

Steuben County.—In the American Museum of Natural History, New York, there is an unusually fine skull of a mastodon that was found in 1908, in Steuben County, near Ashley, by Mr.

Walter Deller. The lower jaw and the tusks are missing. The length of this skull, from the occipital condyles to the front of the premaxillary sheaths, is 1,110 mm., about 44 inches. The width across the back of the head is 780 mm., and the height from the basioccipital, 505 mm. On the right side of the upper jaw there are present the second and third true molars, with a socket for the first. On the left side all these true molars are present and this line of teeth measures 385 mm., or about 15 inches. Mr. Deller has informed the writer that this skull and some bones were found at a depth of five feet from the surface, in what was, until drained, a swamp. The remains were mostly inclosed in a marl and this was overlain by muck. With the skull were found two shoulder-blades, a leg bone three feet three inches long, and about one dozen ribs. These bones are yet in the possession of Mr. Deller.

Switzerland County.—Warder, as cited above, has recorded the finding of a piece of femur and other fragments in a gravel bank at the mouth of Grant's Creek. He was informed that a piece of tusk, five or six feet long, somewhat curved, and about six inches in diameter had been found on the river bank near Patriot; while a tusk 14 feet long, supposed to be that of a mastodon had been found on the river bottom five miles below Vevay. In all these cases there is doubt whether the objects found really belonged to the mastodon; also, while they are probably found in the deposits laid down during the prevalence of the Wisconsin ice-sheet, they may really be somewhat older. Warder was informed by Dr. J. W. Baxter, of Vevay, that bones of some kind of a sloth had been found at Vevay.

Professor Warder has mentioned the occurrence of a tusk of a mastodon or mammoth on Laughery Creek, above Hartford, and of a tooth found on the river bank at Rising Sun. We are left in the same state of doubt as to the identity of the remains and of the level as in the other cases noted by Warder.

Tipton County.—In a letter to the writer, Mr. W. P. Gates states that in 1875 he found on his farm one-half mile west of New Lancaster, Tipton County, a tusk which was about five feet long, with some of the tip missing. The diameter at the large end was five inches; that at the smaller end, three inches. Mr. Gates arranged that the tusk should be prepared and sent to the State Geologist. At the surface, where the tusk was found, there was a black chaffy soil, underlain by a white marl. The age of the tusk, whether it was that of a mastodon or of a mammoth, was quite certainly post-Wisconsin.

Wabash County.—(*a*) In the Seventeenth Annual Report of the Geological Survey of Indiana, page 240, Messrs. Elrod and Benedict stated that a nearly complete mastodon skeleton had been found, in 1872, two miles west of Laketon, near Silver Creek, on the farm of Jesse L. Williams. This farm occupied a part of section 8, township 29, range 5.[1] A ditch was being made at the roadside and in it the bones were met with. After some litigation the skeleton was set up and put on exhibition at Ft. Wayne. What became of this skeleton is not known. It appears from Leverett's map of this region that this mastodon must have been found in or on Wisconsin drift.

(*b*) Messrs. Elrod and Benedict report also that Mr. Simon S. Morrow discovered a jawbone of a mastodon, with two teeth in it, in the northwest quarter of the northeast quarter of section 1, township 29, range 7, in this county, and three miles due east of North Manchester. Evidently the teeth were the second and third true molars. The finder reported that the jaw was found beneath 2½ feet of solid blue-clay, where an elm tree had blown out of root.

Wayne County.—In the Twelfth Volume of the American Geologist, page 73, Prof. Joseph Moore, then of Earlham College, stated that some sound teeth and decayed bones of a mastodon had been found two miles east of Richmond, in scooping out a fish pond. According to a label on a lower last molar the remains were found on the Floyd farm. With them were found a fragment of an incisor of *Castoroides*. According to Leverett (Monogr. XLI, p. 354, pl. XI), the locality would be on the outer moraine of the late Wisconsin drift. Dr. John T. Plummer (Amer. Jour. Sci., ser. i, Vol. XLIV, 1843, p. 302), stated that he had obtained near Jacksonburg, 18 miles west of Richmond, a tooth. It had four cross-ridges and was so well preserved that a dentist attempted to make artificial human teeth from it. According to Leverett's map, the tooth was probably on the surface of early Wisconsin drift. It could, therefore, have lived not earlier than the close of the Wisconsin stage and may have lived after this time. In the Earlham College collection there is a lower jaw which was found near Dalton, in Nettle Creek. It contains the two last molars. The last one has five crests and a talon. The front of the symphysis is rough, but there are no alveoles for tusks.

[1] It seems more probable that the range is 6.

Genus ELEPHAS Linnæus.

Proboscidea whose teeth are composed of deep pockets of enamel enclosing each a compressed core of dentine, the various plates thus formed held together by intervening plates of cement, which also covers the whole exposed part of the teeth. The number of plates varying in the different teeth and in the different species. No tusks in the lower jaw. Skull, high and arched.

Although the teeth of our modern elephants and of most extinct forms differ greatly from those of the American mastodon, there have been found in southern Asia species whose teeth show intermediate conditions. There can be no doubt that the teeth of the elephants have been evolved from teeth resembling those of the mastodon. If the transverse ridges of the latter should continue to increase in height and in number, and to be compressed more and more, and the amount of cement should increase, a tooth would result like that of the elephants.

The skull of the elephants is more elevated, giving the animals a more intellectual appearance; but this is not due to any great increase in the size of the brain, but to the greater development of the air-cells in the bones of the roof of the skull, thus elevating the forehead.

Inasmuch as the structure of the skeleton of the elephants is in general like that of the mastodon, which has been explained, the various bones will not be described, especially since characters for accurately distinguishing the bones of the two genera have not yet been discovered. It is proper, however, to deal somewhat more in detail with the teeth.

The tusks will not be described, since they resemble only too closely those of the mastodon. They are often more curved spirally, but this seems not to be a character that can be relied on. The teeth of the elephants belong to the kind called hypsodont, or high-crowned; that is, the height of the tooth is great in comparison with its length along the plane of wear. The roots are rather feebly developed. The result is that the tooth has a large body that must be worn down before the tooth is no longer useful. If one shall examine an elephant tooth that has been somewhat worn by use. one may see that the worn face is crossed by bands of three different kinds of materials. There are thin plates, often running more or less zigzag across the tooth and standing a little above the other bands. These are composed of enamel. They are arranged in pairs and between the two plates of each pair is a plate of dentine, or ivory. The ivory is not quite so hard as the enamel and is worn down a little deeper. The two plates of enamel and the enclosed flat core of dentine form a composite mass that is often called an "enamel plate" or a plate. Here they will be called *ridge-plates.* These are really flattened tubes, or pockets, of enamel filled with dentine, and the teeth are called "thick-plated" or "thin-plated," according to the thickness of the ridge-plates. They are separated from one another and at the same time bound together by plates of a softer material, the cement. On the sides of the tooth, especially where the cement has been dissolved off, as it is usually in fossil teeth, the ridge-plates appear as rounded ridges rising from the base of the tooth to the summit.

As in the mastodon, there exist in the course of the animal's life six teeth on each side of each jaw. The three anterior of these correspond to the milk-teeth, or deciduous molars, of most other mammals; the hinder ones to the true molars. The three deciduous molars are not succeeded by premolars coming up beneath them. Early in life the front, or first, one appears and begins to wear. Soon afterwards the second one appears behind it and gradually pushes it forward; so that, by the time it is worn down to the roots, it is pushed out of the jaw. The third one comes up behind the second and at length replaces it; and so on with the others until the last one, late in life, has taken sole possession of its side of the jaw. Naturally, the first tooth is small and is formed of a small number of ridge-plates. The succeeding teeth are in their turn larger and have a greater number of ridge-plates. In the African elephant, the first tooth has three plates; the second, six; the third, seven; the fourth, seven; the fifth, eight or 9; the sixth, 10 or 11. In the mammoth, *Elephas primigenius,* the teeth are much more complicated, and the ridge-plates are represented by the formula, d. 1, $\frac{4}{4}$; d. 2. $\frac{6-9}{6-9}$; d. 3, $\frac{9-12}{9-12}$; m. 1, $\frac{9-15}{9-15}$; m. 2, $\frac{14-16}{14-16}$; m. 3, $\frac{18-27}{18-27}$. Thus, it is seen, any teeth in the series may, in different individuals, vary in number of ridge-plates; but the extremes in the formula are rare. In the Indian elephant and the mammoth, the formula is usually given as 4, 8, 12, 12, 16, 24 for both upper and lower teeth. As far as possible, the teeth of our fossil species are here illustrated; so that the student may determine the species and the place of the tooth in the series. Difficulties, however, are likely to arise when the observer has in his hands only a part of a tooth. A tooth may lack a part for one or both of two reasons: It may have been broken after the death of the animal; or, it may have lost its anterior end from being worn down too near the roots in life and breaking off and falling out of the mouth bit by bit.

It is usually possible to distinguish an upper tooth from a lower one by the shape of the worn face. In the upper teeth this face is likely to be convex from before backward; while in the lower teeth it is likely to be concave. The upper teeth are likely to be larger, especially higher-crowned, than a lower one of the same number in the series. A lower tooth is likely to be pretty concave from front to rear on one face, and convex on the other; the upper teeth less so. As to the side of the jaw to which any tooth belonged, in the lower tooth the concave side was directed outward; in the upper tooth the concave or flattened side was directed inward. The front end of a tooth may be known by its being worn down more than the hinder end.

In the United States there existed during Pleistocene times at least three distinct species of mammoths, or elephants. These are known as *Elephas primigenius, E. columbi,* and *E. imperator.* The former appears to have been confined mostly to the glaciated region, ranging thence north to Alaska; but teeth belonging to it occur also in North Carolina. *E. columbi* occupied especially the Southern States, but also its remains are found in the glaciated area and even in Alaska. *E. imperator* was a large species that has been found only in the region of the Great Plains, east to western Iowa. It existed in the early Pleistocene and may have become extinct soon afterwards. The other two species are found in deposits overlying the Wisconsin drift and probably existed until the close of the Pleistocene. Both have been found in Indiana.

ELEPHAS PRIMIGENIUS Blumenbach.

THE HAIRY MAMMOTH.

Tooth formula, $\frac{4}{4}, \frac{6-9}{6-9}, \frac{9-12}{9-12}, \frac{9-15}{9-15}, \frac{14-16}{14-16}, \frac{18-27}{18-27}$. The ridge-plates thin, varying from 7 to 12 in a line 100 mm. long. The plates, of at least the upper teeth, parallel with one another. The rear of the upper molars strongly arched. The sheaths for the base of the tusks very long.

This species is better known than any other fossil elephant. During the Pleistocene it had a range greater than that of almost any other mammal that has not been distributed by man. Its remains occur from Ireland and England across the continent of Europe and Asia to Bering Strait, and from Alaska to the Atlantic Ocean and south over the glaciated region and to North Carolina.

It is the species whose cadavers have in numerous instances been found in the frozen soils of Siberia, so perfectly preserved that it could be eaten by dogs.

Outside of the frozen regions its remains occur usually only in a scattered condition; and it is usually only a tooth or a few of them, or a tusk, that is found. Sometimes scattered limb-bones are discovered. It is only rarely that anything like a considerable part of a skeleton is found; and then this is treated with little re-

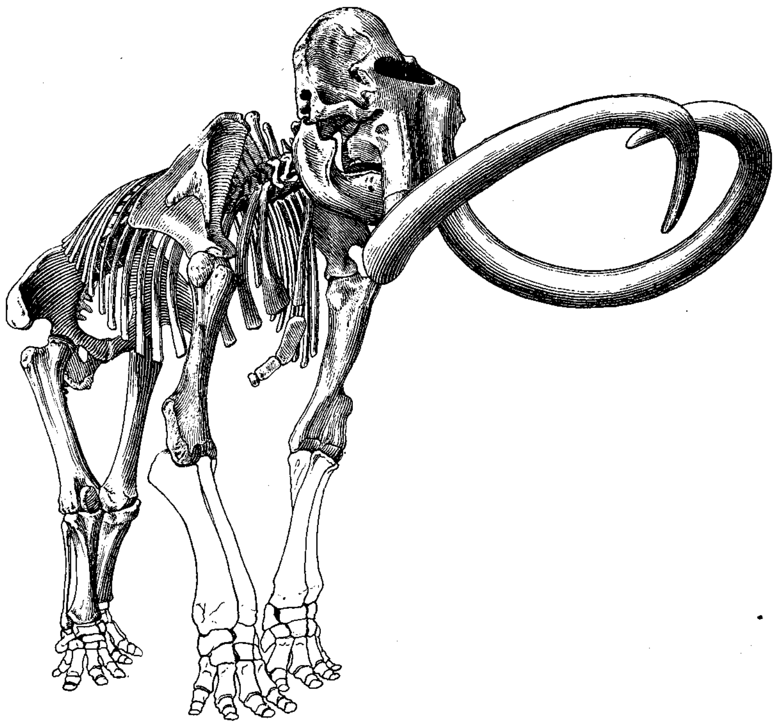


FIG. 63. *Elephas primigenius*. Oblique view of a skeleton found in Grant County, Indiana, and now in the American Museum of Natural History, New York.

spect. While there are in the United States, as Prof. Frederick A. Lucas has said, at least fifteen mounted skeletons of the mastodon, the writer knows of but one mounted skeleton of *Elephas primigenius*. This is the one that was found in Grant County, Indiana, near Fairmount, and is now in the American Museum of Natural History, in New York. Through the liberality of this museum the writer is enabled to produce here a drawing of that splendid skeleton (Fig. 63). Unfortunately there is some difference of opinion regarding the species to which this skeleton belonged. Prof. Henry F. Osborn has published a brief description of it, in which he called it *Elephas columbi.* The present writer, who has examined this skeleton and teeth with much care, regards the specimen as *Elephas primigenius.* The evidence for this will be stated below. It is proposed first to describe the skeleton. As regards the conditions under which it was found, the facts known are given on page 718.

In this skeleton the skull had been damaged slightly, but not so as to injure it for study. All the feet, wrist and ankle bones were gone and both ulnæ and radii. These parts have been restored as seemed to be justified from other species. It seems probable that the radius and ulna have been made too long, with the result of lifting the animal somewhat too high at the shoulders. The shoulder joints stand about 200 mm. higher than the hip joints. In the living elephants these joints are about on the same level. As to the tusks, it has usually been supposed that they curved so as to direct the points outward; but, in mounting the animal, it was found that they would not enter the sockets in any other way than to throw the extremities inward; and this arrangement agrees with recent determinations in Siberian specimens.

The following measurements are taken from the explanatory label of this specimen:

Base of tusks to drop of tail....................	13 ft., 3½ in.=5.43 m.
Length of right tusk, outside curve..............	11 ft., 4½ in.=3.47 m.
Height at the shoulders..........................	10 ft., 6 in.=3.20 m.
Length of thigh bone.............................	4 ft., 1½ in.=1.24 m.
Width across the pelvis..........................	4 ft., 10 in.=1.47 m.

It may be noted that in taking the oblique photograph, the hinder parts of the skeleton are made to appear smaller, and the tusks and foreparts larger, than they should appear.

The following measurements were taken by the writer:

Width of the skull behind	750 mm.
From postorbital processes to ear-opening	335 mm.
From ear-opening to line extended from occipital condyles.......	210 mm.
From nasal opening to bottom of sheath for tusk	715 mm.
From bottom of nasal opening to summit of crown	570 mm.
From summit of crown to occipital foramen	500 mm.
From condyle of lower jaw to the beak, following curve of jaw...	900 mm.
Height of the lower jaw under middle of $m_{\overline{3}}$..................	170 mm.
Thickness of the lower jaw under middle of m	160 mm.
Greatest width of the lower jaw	555 mm.
Lateral extent of the atlas	400 mm.
Vertical diameter of the atlas	210 mm.

The bodies of the anterior dorsal vertebræ are close to 66 mm. long. Gradually they lengthen, until the hinder ones become about 75 mm. long. Twelve of the hinder dorsals, including the intervening plates that represent the intervertebral cartilages, measure 1,030 mm., the average being 86 mm. each. The length of the longest rib, the seventh, is 1,470 mm.; length of first rib, in a straight line, 625 mm.; its distal end, 155 mm. wide.

Length of the front of the scapula	910 mm.
Width from the hinder angle to the front at right angles to the spine	600 mm.
Length of humerus from head to bottom of inner articulation	1,135 mm.
Transverse width of upper end of humerus	300 mm.
Transverse width of lower articulation	250 mm.
Width of pelvis	1,470 mm.
Width of pelvic opening	395 mm.
Height of pelvic opening	445 mm.
Length of pubic symphysis	482 mm.
From tip of acetabulum to uppermost point of ilium	660 mm.
Femur, length from head to distal end	1,240 mm.
Greatest diameter of middle of the shaft	155 mm.
Least diameter of middle of the shaft	92 mm.
Femur, extent of lower articulation from side to side	230 mm.
Tibia, length	735 mm.
Tibia, side-to-side width of upper end	245 mm.
Tibia, side-to-side diameter, middle of shaft	106 mm.
Tibia, fore-and-aft diameter, middle of shaft	100 mm.
Tibia, side-to-side diameter of lower end	205 mm.
Tibia, fore-and-aft diameter of lower end	155 mm.
Fibula, length	710 mm.
Fibula, width of upper end	78 mm.
Fibula, width of lower end	123 mm.
Fibula, greatest diameter of middle of shaft	48 mm.

The teeth are placed in the jaws so that little except their worn faces can be seen. The worn part of the crown of the upper one, the last molar, measures about 285 mm. in length; that of the lower last molar, about 255 mm. Fortunately, shortly after the specimen had been discovered, Prof. A. D. Hole, of Earlham College, visited the locality and took photographs of two of the teeth, apparently, both of them upper ones, and he has allowed the reproduction of the photograph here (Fig. 64). The watch leaning against the tooth has a diameter of 51 mm. It will be seen that the teeth had been relatively little worn, about to the fifteenth ridge-plate, leaving the arched hinder boundary of the tooth intact. If this is compared with similar teeth from Alaskan specimens of *E. primigenius,* they will be seen to agree in form; while the rear of this tooth differs from that of teeth of *E. columbi.*

It is proposed here to give descriptions of the various teeth of this species:

The First Milk-Tooth.—The writer knows of no American specimen of this. It would belong to an elephant that had died probably before it was two years old. Being a small tooth it would be less likely to be observed and saved than the larger teeth. An upper one was figured by A. Leith Adams (Palæontog. Soc., vol. XXXIII, pl. IX, fig. 3), which had been found in England. The length of the crown was 20 mm. and its width 15 mm. It had only four ridge-plates, and a small imperfect plate (talon) in front

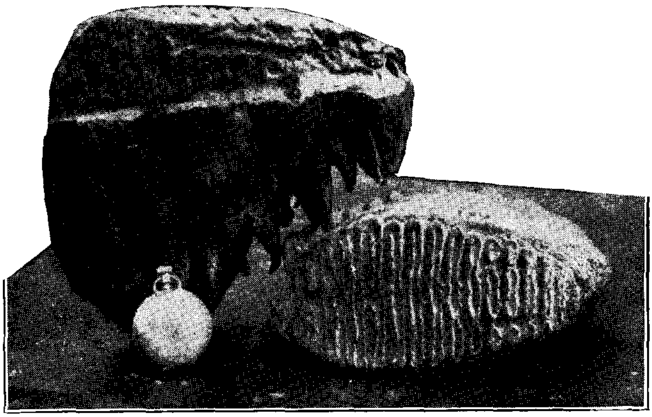


FIG. 64. *Elephas primigenius.* Last upper molars of the Grant County specimen. About $\frac{1}{15}$ natural size.

and another behind. The same writer on the same plate figured the corresponding lower tooth, which resembled closely the upper one.

The second milk-molar teeth are nearly as rare as the first ones. No specimen of the upper second milk-molar is at hand. It would have about the size and number of ridge-plates that belong to the lower tooth. In the U. S. National Museum there is a lower tooth of this order (Pl. XIX, Figs. 1, 2), brought from Alaska. There are eight ridge-plates, with front and rear talons. The length of the crown is 73 mm.; the greatest width, 48 mm. There are two fangs in the root; the anterior short, apparently mostly absorbed and supporting the inner ends of the three front plates. The hinder fang is long and bent backward, and it supports nearly the whole of the crown.

PLATE XIX.

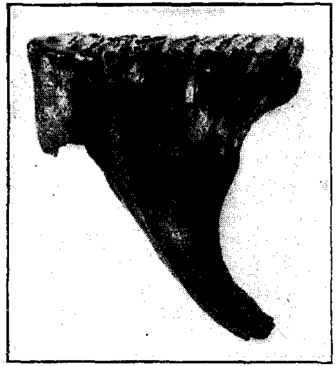


FIG 1

FIG. 2.

FIG. 3.

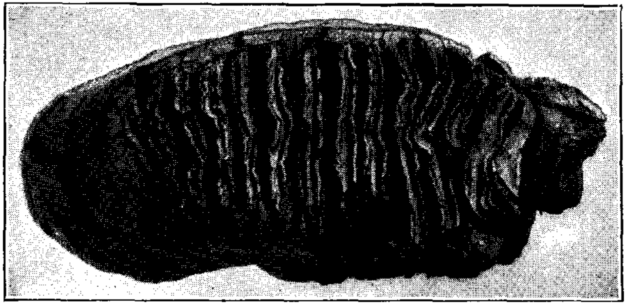


FIG. 4.

Elephas primigenius. Figs. 1, 2. Lower left second milk molar; views from the side and from above. $\times \frac{1}{2}$. Fig. 3. Upper right second molar, with some parts of the jaw; view from outside. $\times \frac{1}{2}$. Fig. 4. Same tooth, showing grinding surface. $\times \frac{2}{3}$.

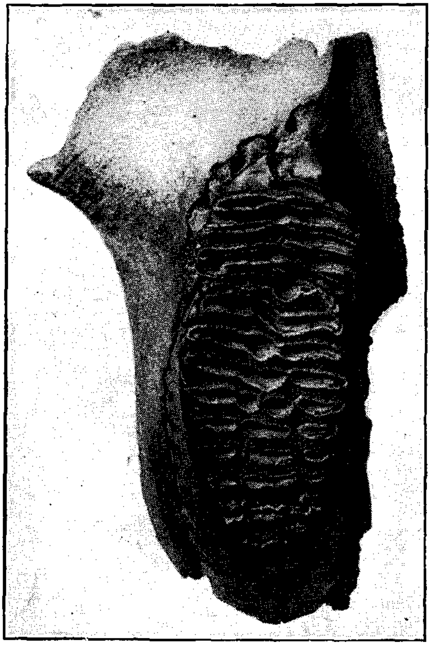


FIG. 1.

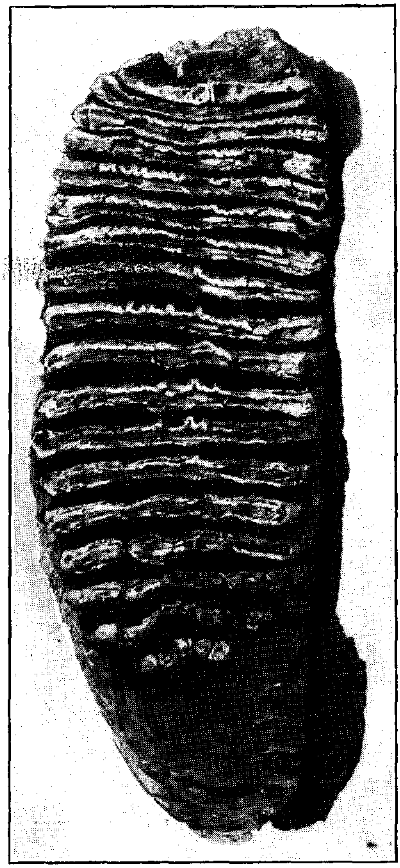


FIG. 3.

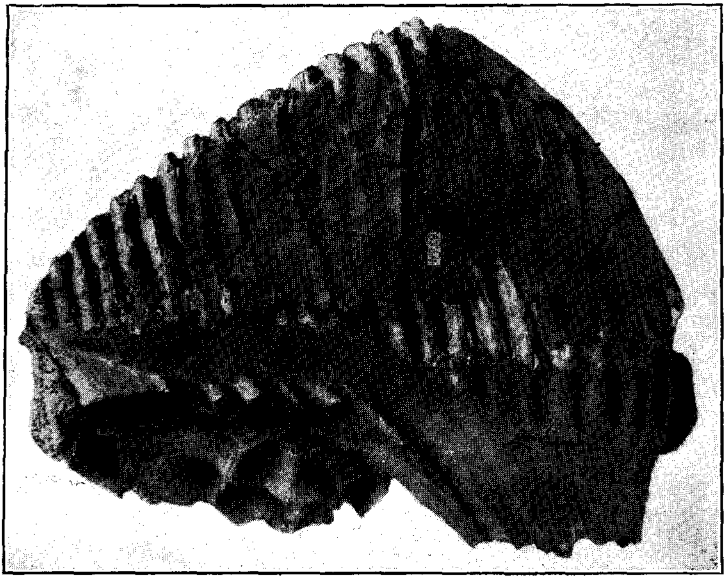


FIG. 2.

The third milk-molar is less rare in collections. The length is about 130 mm., the width, about 60 mm. There will be found usually twelve plates. In Figure 1, Plate XX, taken from No. 6,656, U. S. National Museum, a specimen found in Alaska, the hinder part of the third upper milk-molar is still in the jaw; but the greater part of it had been worn down and had fallen out of the jaw before the death of the animal. In a lower molar from Alaska there appear to have been fourteen plates. The length was probably 120 mm.; the thickness, 56 mm.; the height of the crown, 97 mm.

The first true upper molar is represented in Figure 1, Plate XX, taken from a part of a right upper maxilla from Alaska, No. 6,656, U. S. National Museum. This tooth is 132 mm. long from front to rear and 60 mm. wide. The outer surface, as in many teeth from Alaska, still retains its covering of cement, which has cracked somewhat. There appear to be thirteen ridge-plates with a talon in front and another behind. The wear has extended back on nine ridge-plates. As will be observed, the outer face of the tooth is more convex than the inner. There are ten ridge-plates in a line 100 mm. long. The cement is thin and only slightly crimped. A. Leith Adams stated that the length of this tooth may vary from 125 mm. to even 175 mm. Certainly the extremes are rare.

The corresponding lower molar will have about the same dimensions as the upper one, but they will be worn concave on the grinding face and will be more or less bent laterally.

The second true molar will naturally be larger than the ones which preceded them; but the smallest may not exceed in size the larger second molars; while the largest ones may equal some of the third molars.

The upper second molar is represented by Figures 3 and 4, Plate XIX, taken from No. 6,556, U. S. National Museum; also, an Alaskan specimen. It is to a considerable extent covered with cement, which cracked on drying. There appear to be sixteen ridge-plates besides front and rear talons. Posteriorly the tooth has a backward projection, behind which and the base, or root, is a concavity against which pressed the third molar. The height of this tooth is 205 mm.; the length of the crown, 188 mm.; the thickness, 80 mm. The surface of wear extends back to about the thirteenth ridge-plate. At the base of the tooth is seen a portion of the cellular bone of the maxilla. Had this animal lived long enough the tooth would have been worn down to below the occiput-like protuberance.

Figure 65 represents one view of a nearly complete lower jaw from Alaska, No. 6,666, U. S. National Museum. In it are both second lower molars and behind them, concealed in the jaw, are both third molars. The ridge-plates of these had not united at the base, but are now loose in the cavity of the jaw. Some of them are seen through the opening broken in the jaw. The second molars here are well worn down, every ridge-plate having come into use. In front the ridge-plates are worn down to the base. A few of these are lost. The length of the grinding face, before the loss of any plates, was probably 165 mm.; the breadth is 75 mm. Fourteen ridge-plates are present and at least two or three are missing.

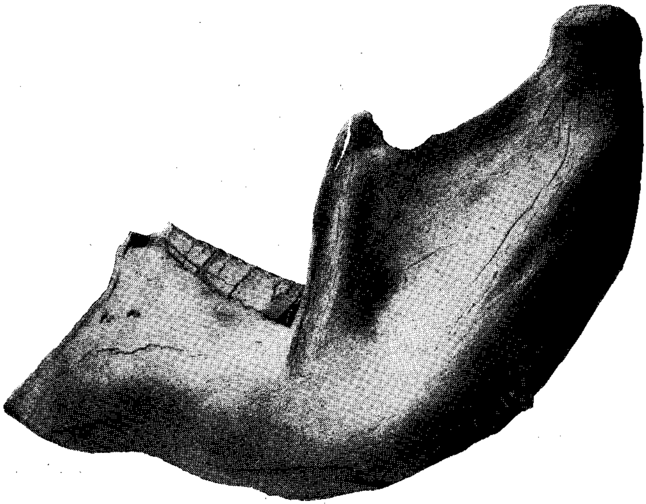


FIG. 65. *Elephas primigenius.* Lower jaw of a specimen from Alaska.

We are to expect about sixteen ridge-plates. Measuring across these plates, we find nine in a line 100 mm. long. This rather small number may be due partly to their being worn down to near the base of the tooth, where the plates are slightly thicker.

The third molars are the ones that are most often found. They are, of course, the largest teeth of the series, and they contain the greatest number of ridge-plates, typically twenty-four. It is stated that the number may vary from eighteen to twenty-seven, but these extremes are of rare occurrence. Figures 2 and 3, Plate XX, are representations of a third upper molar, No. 6,564, U. S. National Museum, from Alaska. The length of the tooth, measured along the bases of the ridge-plates, is 228 mm.; the greatest breadth, 82 mm. On the lateral faces of the tooth there is yet a good deal of cement. At the base in front is seen some of the bone, with its large cells. At the rear is seen the main root of the tooth. In front is a small fang, 30 mm. wide, and four smaller ones. There appears to be twenty-four ridge-plates, besides a front and rear talon. The ridge-plates are thin, a 100 mm. line extending across ten or eleven of them. The summits of the hinder ones are slightly bent forward.

It is to be observed that the hinder border of the tooth is strongly arched just as it is in the same tooth shown in Figure 64, the third upper molar of the Madison County specimen.

In the side view of this tooth there is seen no such occiput-like projection as is seen in Figure 3, Plate XIX. The reason for this

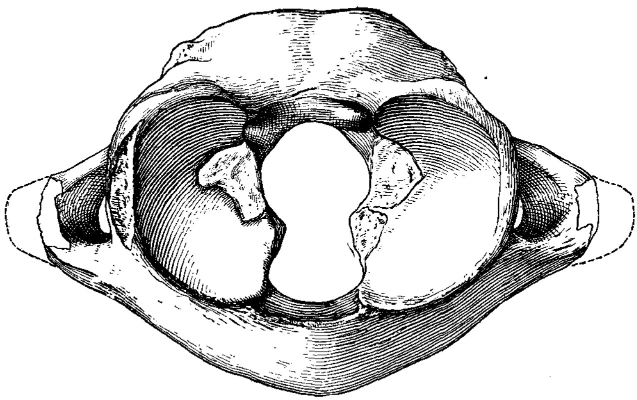


FIG. 66. *Elephas premigenius*. Atlas, seen from in front. × ¼.

is that there was no tooth behind the third molar to press against it.

Figure 3, Plate XX, presents a view of the grinding face of the tooth. It shows the ridge-plates and the intervening plates of cement. Other third molars of this species reach a larger size, that of the Madison County specimen having a length of over 285 mm.

The third lower molars have about the same length as the upper ones, but they are usually bent pretty strongly, so that the outer face is distinctly concave, the inner face strongly convex. The worn grinding surface becomes concave. The ridge-plates cross the face rather diagonally, passing from the inner face outward and somewhat backward. The hinder ridge-plates sometimes lean forward at their summit, making an angle with the anterior plates.

Figure 66 presents a view of the atlas of what is very probably *E. primigenius.* It was brought from the Old Crow River, Yukon, near the Alaska line. The view is from the front. Figures 67a and 67b give views of an atlas from the same region. These are to be compared with similar views of the atlas and axis of the mastodon (Figs. 56 and 57).

As to the form, size, external appearance and habits of the mammoth, we know more than we have learned of these characteristics in any other extinct animal. This comes about from the fact that many more or less complete cadavers have been discovered in the frozen regions of Siberia. At some time during the Pleistocene the mammoth inhabited in vast numbers those seemingly inhospitable regions and left there their tusks, teeth, and bones, sometimes nearly whole skeletons, and occasionally their frozen bodies. So abundant and so well preserved are the tusks, that for two hundred years they have been an article of commerce as a source of ivory.

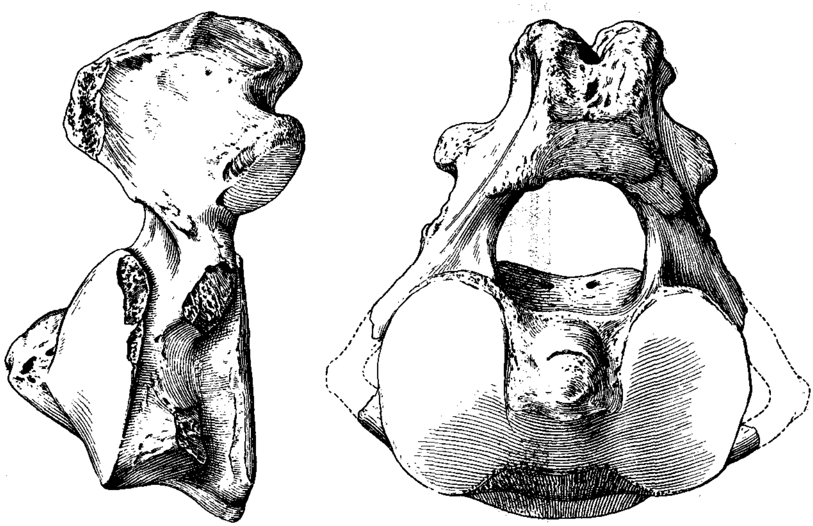


FIG. 67*b*. FIG. 67*a*.

FIG. 67. *Elephas primigenius*. View of axis, *a*, from front; *b*, from left side. × ¼.

Probably the most instructive cadaver that has been discovered is that known as the Beresowka mammoth. The details of the securing of this specimen and of the results of its examination may be found in the reports made by O. Herz (Report of Smithsonian

Institution, for 1903, pp. 611-625), by W. Salensky (6th Internat. Congress Zool., Berne, 1904, pp. 67-86), and by E. Pfizenmayer (Report Smithson. Instit., for 1906, pp. 321-333). This cadaver was discovered in 1901, on the banks of the Beresowka River, a branch of the Kolyma, in eastern Siberia. An expedition was sent out and the remains were secured and brought to St. Petersburg. It appears that this mammoth, while quietly grazing, had fallen into a hole in the treacherous soil and had been injured so badly that it died within a few minutes. The body was soon frozen and had remained so for thousands of years. So well had it been preserved that the internal organs have been studied by dissection and the histology by means of microscopic sections. Of course, much had been learned from previously found cadavers. Salensky states that it may be concluded that the hairy mammoth was somewhat larger than the living elephant, and that the skull was somewhat longer in ratio to the length of the body than it is in the living elephants, being somewhat more than half as long as the body. The greater size of the head would naturally give a somewhat different appearance to the living animal. The head was also somewhat broader than in the living elephants. The feature that must have rendered the mammoth a striking object, even alongside of our elephants, was the thick covering of hair. The whole body was covered with hair, that on the breast and sides of the neck being long. It has been thought that there was present a mane; but this is not yet certain. Three kinds of hair have been recognized. These may be called wool, hair, and bristles. The wool formed a dense coat over the whole body and consisted of fine filaments two inches or less in length, sometimes crinkled, sometimes straight. According to Pfizenmayer, this was sometimes four inches long. The coarse hair was scattered over the body, in the wool. In places, as on the cheeks, under the chin, on the shoulders, on the thighs, and on the belly, the coarse hairs seem to have been rather dense; and, according to Salensky, it formed on each side a fringe extending from the cheeks to the hind feet and resembling the fringe seen on the yak. These hairs had, in some cases, a length of 20 inches. Apparently what was called bristles were found only at the end of the tail. They were flattened filaments from 14 to 20 inches long. As to color of the hair, Salensky says that in general it may be regarded as yellowish-brown, varying from light blond to almost brown. Pfizenmayer says that the bristles must originally have been of a rusty brown.

The Beresowka cadaver shows that there was present a very thick subcutaneous layer of fat, attaining, for example, under the belly a thickness of nearly four inches. Such a layer must have furnished a great protection against the cold to which the animal was subjected. The true skin, too, was extremely thick, more than twice as thick as that of the living elephants, being in some places 30 mm. With the thick epidermis the thickness of the skin was in places 41 mm. The tusks of the animal were larger than those of the African elephant. They were often spirally twisted, so that the free end was sometimes directed inward, sometimes downward. One in St. Petersburg has a length of 4.17 meters (13 feet 8

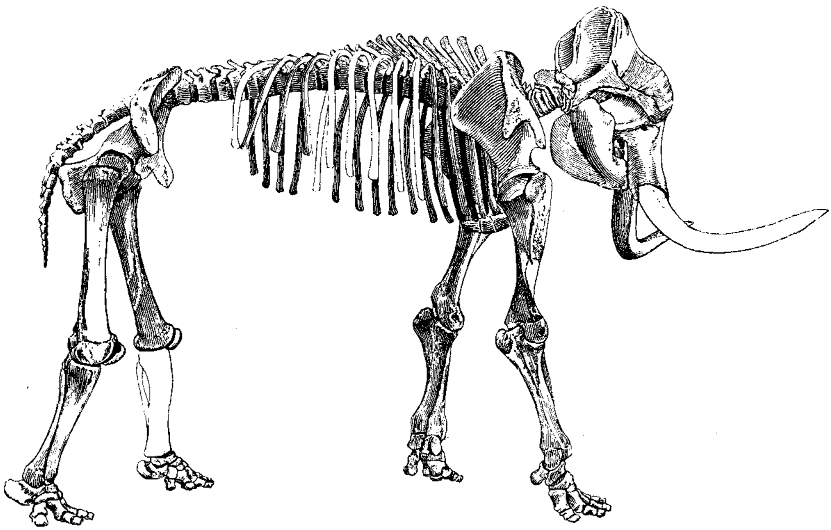
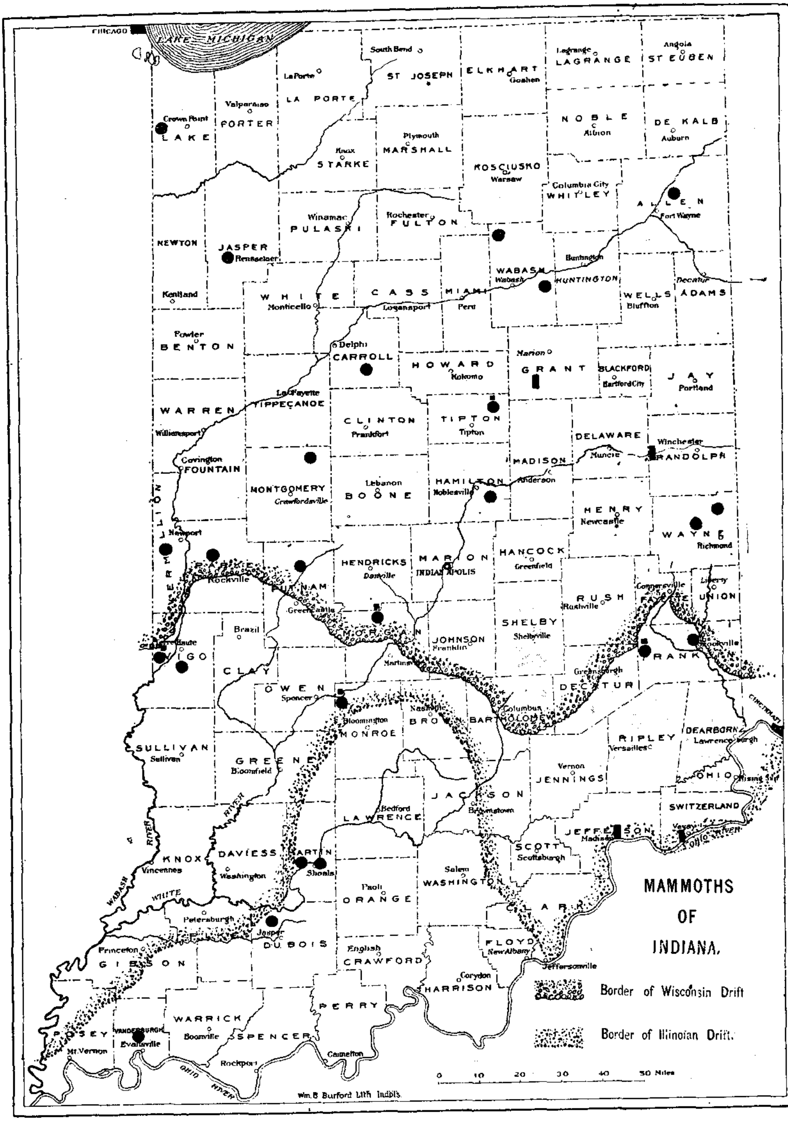


FIG. 68. *Elephas primigenius.* Skeleton of the mammoth found on the Beresowka River, Siberia. After Salensky.

inches). It is supposed that the proboscis resembled that of the living elephants, but it appears that in all the known cadavers this organ has been destroyed. The ears appear to have been smaller than in the living elephants, only about fifteen inches long and half as wide. They were densely hairy. The tail is described as being rather short but broad, forming a sort of cover for the hairless parts beneath it.

The stomach of the Beresowka mammoth was filled with the food it had just eaten; and between the jaws there was a mass which the animal had not had time to swallow before it died. It had been conjectured that formerly, while that country was oc-



Map showing localities where remains of species of elephants have been found in Indiana. The round dots ● indicate remains not specifically determinable. The character ▮ indicates *Elephas primigenius;* one of these ought to be placed in the southern part of St. Joseph County. The character ⁚● indicates *Elephas columbi.*

cupied by the mammoths, the climate was considerably warmer than it is today. The Russian botanists examined with care the vegetation found in the Beresowka mammoth, and they found that the plants were identical with those that grow in that region today. This means that the climate has not changed since that time, and that the mammoths were adapted for a severe climate. This fact explains why the remains of this species are found in our own country scattered over the glaciated portion. They probably lived around the border of the great glaciers and enjoyed the cool and

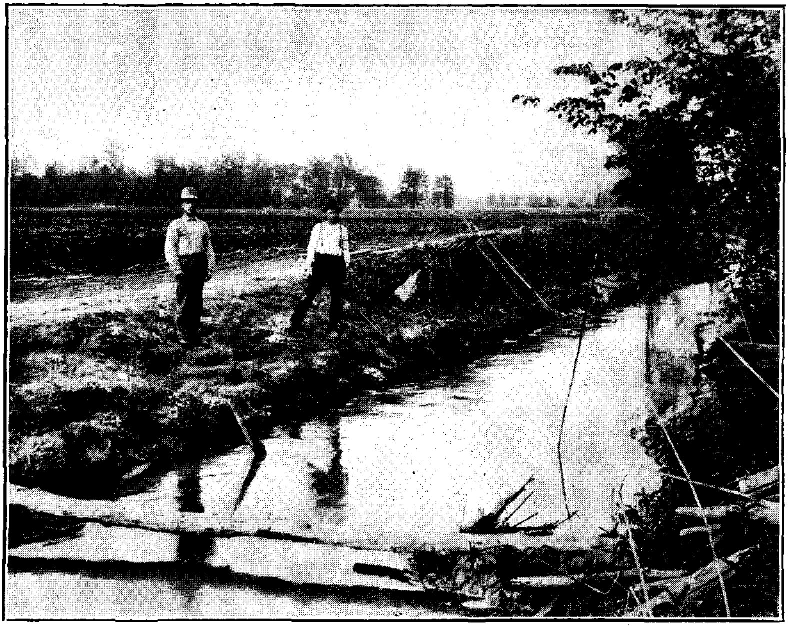


FIG. 69. View of locality, about four miles east of Fairmount, Grant County, where was found the skeleton of *Elephas primigenius*, now in the American Museum of Natural History, New York.

the cold winds that descended from the fields of ice. Even those found not far from the coast in North Carolina had, at the height of one of the glacial stages, been probably driven down from the mountains during a winter. No whole cadavers have yet been found in Alaska, but portions of one, furnishing some bones, flesh, skin, and hair, were discovered there by L. S. Quackenbush a few years ago. Figure 68 is a drawing made from a plate in a work by Salensky and others giving the scientific results of the expedition after the Beresowka mammoth. This work is printed in Russian.

In Indiana remains of the hairy mammoth have been found at several places. From the reports furnished it is in most cases impossible to determine whether the materials found belonged to this mammoth or to *Elephas columbi.* Nor have we yet learned how to distinguish the limb bones of the one species from those of the other. The few finds that can be with considerable certainty referred to *E. primigenius* are indicated on the map (Plate XXI) by a black parallelogram ▮. The most important of these finds is, of course, that of the large mammoth which was found in Grant County and which has been already described and figured. This skeleton was found by some farmers while making a deep ditch for draining land. The bones were found in a mucky clay at a depth of about 10 feet. The whole country thereabout is level or gently undulating. The figure here presented, engraved from a photograph furnished me by Prof. A. D. Hole of Earlham College, will give the reader an idea of the surroundings. The skeleton was found where the slender pole is standing near the right hand side of the ditch. In the Academy of Natural Sciences in Philadelphia there is a large lower last molar of the right side that was presented by Dr. Hallowell in 1840 and which had been found near Madison, Jefferson County. Its length is 245 mm. and there are nine plates in a 100 mm. line. This tooth was mentioned by Dr. Joseph Leidy in 1869. Prof. Ernest Danglade, of Vevay, Indiana, has shown me a tooth considerably weathered which was found a mile and a half below Vevay, on the shore of the Ohio River. It appears to be an upper tooth, probably the second true molar. Another tooth was found with it, but this the writer has not seen. They were found by Mr. Wm. Lawson, of Vevay. In the collection of the State Museum at Indianapolis there is a tooth which appears to be the last lower molar of the right side. It was found in 1893, in the bed of Stony Creek, near Windsor, Randolph County. It was presented by S. B. Templin. There are six plates in 50 mm; so that it appears to belong to *E. primigenius.*

After this report was sent to the printer, the author received from the Rev. A. M. Kirsch, Professor of Geology in the University of Notre Dame, a photograph of a tooth of *Elephas primigenius,* which had been found in Liberty Township, in St. Joseph County. This is about sixteen miles southwest of South Bend. The tooth has a length of 215 mm. and has about 20 ridge-plates. It is in the collection at Notre Dame.

ELEPHAS COLUMBI Falconer.

THE COLUMBIAN MAMMOTH.

Tooth formula not exactly known; in general like that of *E. primigenius,* but the true molars probably not so variable; may, for the present, be taken as $\frac{4}{4}\ \frac{8}{8}\ \frac{12}{12}\ \frac{16}{16}\ \frac{24}{24}$. The ridge-plates usually much thicker than those of *E. primigenius;* the enamel thicker and more crimped. Teeth relatively and absolutely larger than those of the hairy mammoth. The sheaths for the base of the tusks shorter than in *E. primigenius.*

FIG. 70. *Elephas columbi.* Side view of a skull now in the American Museum of Natural History New York.

This species, which has often been confounded with the hairy mammoth, is entirely distinct from it. Instead of being a rare species, its remains are, even in the glaciated region, fully as abundant as those of the hairy mammoth; while in most of the Southern States it is the only species found. On the Great Plains it is more often found than the Imperial mammoth, *E. imperator.* Teeth found in the Pacific Coast seem to belong to it; while several teeth in the U. S. National Museum indicate its presence at some time during the Pleistocene in Alaska.

Notwithstanding the wide distribution of the species and the numerous remains that have come to light, nothing like a complete skeleton has yet been found and such remains of the limbs as have come to light have not yet been sufficiently studied to enable us to distinguish them in all cases from those of the hairy mammoth.

Through the generosity of the American Museum of Natural History, the writer has the privilege of presenting here a reproduction of a photograph taken from a mounted skull in that museum (Fig. 70). This skull was obtained many years ago, it is thought, in Whitman County, in the southeastern part of Washington State, but its origin is somewhat uncertain.

As will be observed, the skull has suffered some injury. Above, the outer plate of the bones of the brain-case has been weathered off; but this has the advantage of exposing some of the numerous large cells which occupy the space between the outer and the inner plate. The zygomatic arch has been mostly restored in plaster, as well as the articular process of the lower jaw and the top of the coronoid process. Only a part of each tusk is preserved, about 400 mm.

The following measurements of it were taken by the writer:

From the vertex to the lower floor of the external nares........	490± mm.
From the nasal opening to the end of the sheath for the tusk, the distal ends of the latter being somewhat damaged......	490 mm.
Width of the occipital region	840 mm.
Width at the postorbital processes	776 mm.
Height from the occipital condyles to the vertex...............	690 mm.
Anteroposterior diameter of the base of the tusks..............	155 mm.
Side to side diameter of the base of the tusks.................	150 mm.

It will be seen that the lower jaw has a long pointed chin, extending beyond a perpendicular from the front of the tooth about 175 mm.; also, this chin falls much below the distal end of the sheath for the tusk. The lower jaw is 160 mm. thick below the front of the coronoid process. Its depth at this point is 150 mm.; and at the front tooth, 195 mm. This lower jaw probably belonged to another individual, since the teeth are in different stages of wear. In the upper jaw the front tooth seen is the second true molar. It shows only about 12 ridge-plates, but three or four anterior ones had probably been used up and shed; for there must have been about 16. The last true molar is partly hidden by the coronoid process. Only the front of it had yet come into use. The tooth in the lower jaw is the third true molar in a more advanced stage of wear, being worn back to the twelfth ridge-plate or farther.

A comparison of this skull with those of the hairy mammoth will disclose some differences: (1) In the latter there is a large angle between the plane of the forehead and that of the sheaths of the tusks. (2) In most specimens of *E. primigenius* the forehead is quite concave. In *E. columbi* it is nearly flat. (3) In *E primigenius* the sheaths of the tusks are much longer than they are in *E. columbi,* usually in the former as long as distance to the vertex, and extending downward below the chin.

When we come to compare the teeth there are certain differences which appear to be quite constant. The teeth of *E. columbi* are larger and coarser-plated than the corresponding teeth of *E. primigenius.* In *E. columbi* usually the hinder ridge-plates lean forward toward the anterior ones, while in *E. primigenius* the plates are all, or nearly all, parallel. However, in the lower teeth of *E. primigenius,* the hinder ones may lean forward. In *E. columbi* the base of the crown of the teeth is convex, while in *E. primigenius* it is nearly straight. This is more nearly true of the upper teeth in *E. primigenius,* than of the lower ones, where it may be curved. The hinder border of the upper molars of *E. primigenius* is strongly arched in the little worn teeth; in *E. columbi* the outline of this rises gradually from the front to the rear. In *E primigenius* the various ridge-plates are nearly flat; while in *E. columbi* they are often concave on one face and convex on the other.

The separate teeth of this elephant will be briefly described, as far as they are known. Of the first milk-teeth, both upper and lower, the writer has seen no specimen. They would quite certainly have four ridge-plates and would be about 25 mm. long.

The writer has at hand no second milk-molar of the upper jaw. It would have eight plates. The corresponding tooth of the lower jaw is represented by Figure 3 of Plate XXII, taken from a tooth of the left side, in the U. S. National Museum, No. 6662, from Afton, Oklahoma. A view of the grinding face is shown. The tooth has suffered some injury. The roots are more or less broken. Apparently one plate, possibly only a "talon" is missing from the front. The enamel is black, while the cement which yet partly covers the sides is light brown. The length is 135 mm.; the width, 65 mm. It is worn down in front nearly to the root. There are six plates in a line 100 mm. long. There was a small anterior and a large posterior root.

As the third upper milk-molar of this species, the writer indentifies a tooth which is in the collection of the Philadelphia Academy. It was brought there from Big Bone Lick, Ky. It is a wholly unworn tooth and shows well the form of the upper teeth of this species before being worn. The tooth presents 12 ridge-plates besides front and rear talons. Its length, taken at right angles with the plates, is 145 mm.; the thickness, 75 mm.; the height of the first plate, 143 mm. There are eight ridge-plates in a 100 mm. line, rather more than we might expect. This tooth, however, with its sloping line along the summits of the plates, is wholly different from those of *E. primigenius*. Figure 1, Plate XXII represents it.

Figure 2 of Plate XXII represents a tooth brought by Mr. A. G. Maddren, of the U. S. Geological Survey, from Old Crow River, in Yukon Territory, within two degrees of the Arctic Ocean. It is believed to belong to this species, and it certainly is not *E. primigenius*. It is interpreted as the left lower third milk-molar. The hinder ridge-plates are damaged and had not yet been fully developed at their bases. The tooth had only recently come through the gum, for it is only worn slightly on four ridge-plates. No roots had been formed. On the front end is an oblique flat surface which had been produced by pressure and wear against its predecessor. It will be observed that the hinder plates lean strongly forward. There are counted 13 plates. From the angle of inclination of the hinder fragment, it is believed that none are missing. The greatest length is 180 mm.; the width, 67 mm.; the height, 135 mm. There are seven ridge-plates in a 100 mm. line.

No upper first true molar is available for figuring. In the U. S. National Museum is a pair of these teeth that were collected by Professor Cope many years ago in New Mexico. They are worn down in front to the base of the ridge-plates. The length of the teeth along the base of the crown was originally about 230 mm. The grinding face is 93 mm. wide. The height of the teeth plate is about 160 mm. These teeth are unusually thick.

The first lower true molar is shown by Figures 1 and 2 of Plate XXIII, a tooth, No. 2256, U. S. Nat. Museum, of the left jaw, from Afton, Oklahoma. It is worn down in front nearly to the base and backward to nearly the last ridge-plate. A part of the small anterior root is preserved, but most of the hinder root is gone, although it had not been completely developed. The length of the tooth is 200 mm.; the width of the grinding face, 75 mm.; the height of the hinder plates, 132 mm. There are 11 plates, with

PLATE XXII.

Fig. 2.

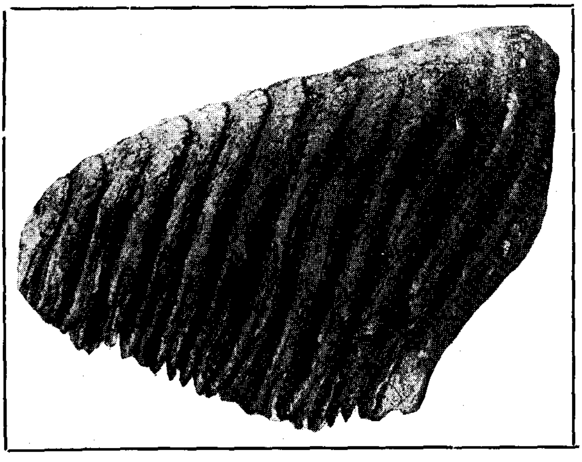


Fig. 1.

Fig. 3.

Elephas columbi. Fig. 1. Upper third milk molar. × ⅔. Fig. 2. Lower left second milk molar. × ½. Fig. 3. Left lower third milk molar. × ½.

PLATE XXIII

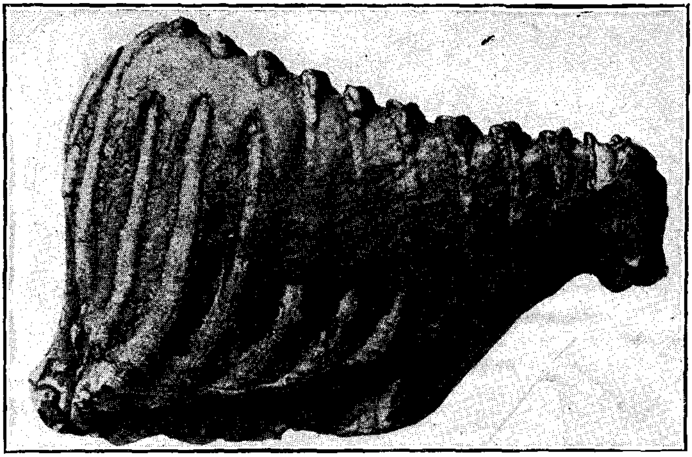


FIG. 1.

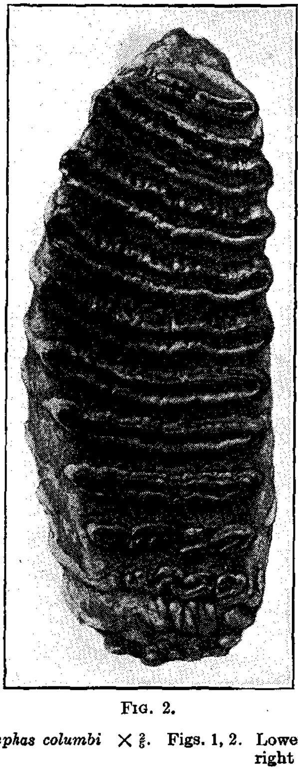


FIG. 2.

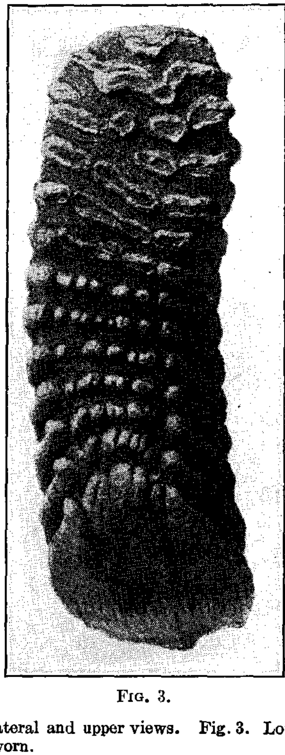


FIG. 3.

Elephas columbi $\times \frac{2}{3}$. Figs. 1, 2. Lower right first molar, lateral and upper views. Fig. 3. Lowe right second molar, little worn.

front and rear talons. On the grinding face there are six ridge-plates in 100 mm. As will be observed, the sides of the tooth are yet, to a great extent, covered with cement. The enamel of the ridge-plates is thick and crimped.

The second upper permanent molar appears to be represented in the U. S. National Museum by No. 287, without known locality. In front, this tooth is worn down to the bottom of the first ridge-plate and backward to the thirteenth. There are 18 or 19 plates present, a number slightly larger than expected; but we do not yet know well the extent of variation in this species. The length of the tooth along the base, in a straight line, is 300 mm.; the width, 78 mm.; the height of the thirteenth plate, 195 mm. The plates are bent as they ascend, as seen on the sides of the tooth. There is an unusually small amount of cement between the various plates. There are eight plates in a 100 mm. line. The base of the crown is strongly concave.

The lower second molar seems to be represented by No. 2254, U. S. National Museum, from Afton, Oklahoma (Plate XXIII, Fig. 3; Plate XXIV, Fig. 1). The hinder part, probably about three plates, is missing. There are 13 present, besides the short one, the talon, in front. The tooth is worn but little, only on the anterior five plates. There are seven plates in a 100 mm. line. It will be seen from the figure that they are curved as they ascend, while the anterior and the hinder ones converge toward their summits. This tooth shows well the way in which the unworn plates end in a lot of separate processes, or digitations.

The third permanent molars, upper and lower, are more numerous in collections than any of the other teeth. They are large and powerful teeth. Before the writer is an upper tooth from near Virginia City, Montana. Its greatest length is 370 mm.; along the base of the crown, about 325 mm.; the width of the grinding face is 85 mm. The attrition of the ridge-plates extends backward to the seventh. This plate has a height of 190 mm. There are 22 plates counted, with front and rear talons.

The lower last molar is seen in the U. S. National Museum in a tooth that was found in Montana, somewhere along the Missouri River. It has been damaged somewhat, as shown by the twisted parts of the figure. The tooth belonged to the left jaw and it is much bent from side to side. There are 20 ridge-plates present, but a few, probably four, possibly fewer, are missing from the rear. Measured in a straight line from front to rear the tooth is about 300 mm. long. The width is 80 mm.; the height of the

PLATE XXIV.

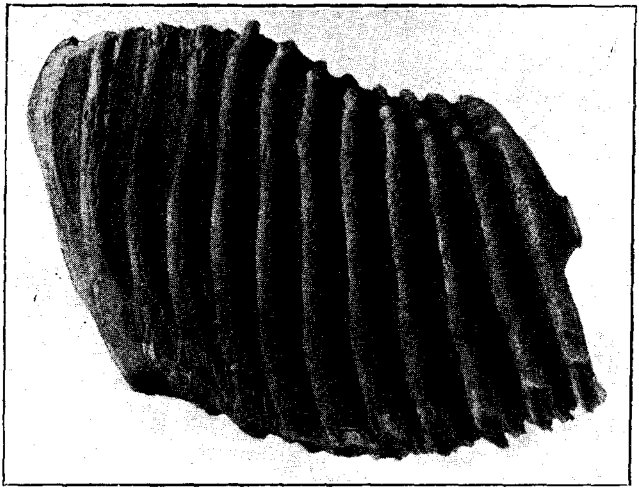


FIG. 1.

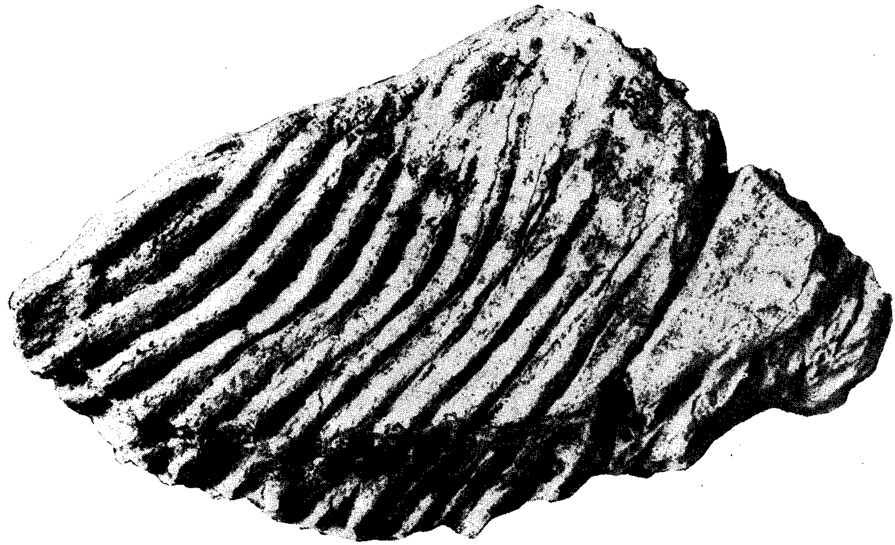


FIG. 2.

Elephas columbi. Fig. 1. Lower left second molar, seen from side. × $\frac{3}{5}$. Fig. 2. Upper right third molar, showing inner face. × .3. Exact locality unknown. No. 287, U. S. Nat. Mus.

seventh plate, yet unworn, is 155 mm. There are six and seven plates in a 100 mm. line.

Plates XXV and XXVI represent two teeth which belong to the Charles H. Morrill collection, of the State Museum, in the University of Nebraska. Prof. E. H. Barbour, Curator of the Museum, collected these teeth near Windfall, Tipton County, Indiana, in 1893. Figure 1 of Plate XXV presents a side view of the upper right last molar, while Figure 1 of Plate XXVI shows the grinding surface. There are 16 plates present, but several, perhaps eight, are missing behind. The tooth was just beginning to be worn. Figure 2 of the two plates mentioned presents views of the lower left last molar, in which 22 plates are present. These teeth are shown about one-half the size of nature. With them was found a much worn lower second molar.

Localities Where Elephants Have Been Found in Indiana.

Remains that appear to the writer to belong to *Elephas columbi* have been found in the following counties. The locality of each is indicated by a round dot with a small square above it:

Carroll County.—In the collection at Indianapolis there is a tooth which seems to belong to this species. It was found near Bringhurst, and presented by Mr. John Flora. There are 27 ridge-plates. From the front of the first plate to the rear of the twenty-sixth is 320 mm. This animal in all probability lived after the passing away of the Wisconsin drift.

Franklin County.—In 1844, Dr. Rufus Hammond, of Brookville, Franklin County, reported (Amer. Jour. Sci., Ser. 1, XLVI, p. 294), the finding of a tooth which he regarded as that of a megatherium, but which was evidently a third true molar, of probably the low jaw, of an elephant. The tooth was found, it is said, about 15 miles west of Brookville, in the gravelly bank of Salt Creek. This would be, according to the geological map of Indiana, which accompanies the Thirteenth Annual Report, on Butts Fork of Salt Creek. As to the age of the alluvial gravel in which it was found, all that can be said with certainty is, that it is post-Illinoian. It is more probable, however, that this material, as well as the tooth, was laid down at some time whilst the Wisconsin ice-sheet occupied the region northward or shortly after its disappearance.

According to Hammond, the tooth was 13 inches long, 6 inches deep, and 3½ inches across the grinding surface. It was somewhat curved also, the middle of the side rising an inch above a flat sur-

PLATE XXV.

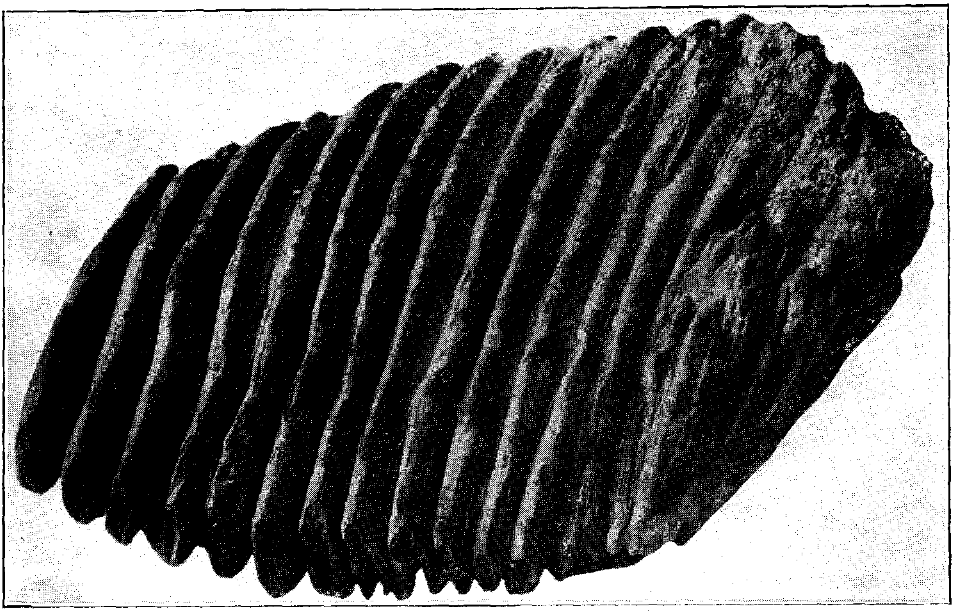


FIG. 1.

FIG. 2.

Elephas columbi. Side views of an upper and a lower molar in the State Museum, Lincoln, Nebraska. Photographs furnished by Prof. E. H. Barbour. Fig. 1. Upper last molar. Fig. 2. Lower last molar.

face which supported the ends. The lower ends of the enamel plates or "ridges" were separated one-half an inch.

The description furnished seems to indicate that the tooth was that of *Elephas columbi*.

What became of this tooth is unknown.

Monroe County.—In 1859, Prof. T. A. Wylie, of the State University, reported (Amer. Jour. Sci., Ser. 2, XXVIII, p. 283), the discovery of some remains of a mammoth about a mile southeast of Gosport, Owen County, Indiana. The locality appears, however, to be in Monroe County, and in the bank of the White River. The bones found consisted of two tusks, four molar teeth and fragments of bones. These are said to have been located at a depth of eight or nine feet in a bed of sand which was overlain by a bed of plastic bluish clay. The bones were badly decayed and the tusks were much broken, and required to be bound with cords to keep them from falling into pieces. Some parts of the ivory were very soft. One of the tusks was eight feet long on the outside of the curvature and some of it was missing. The diameter of the root was eight inches. It was curved into nearly a semi-circle whose radius was 30 inches. The curvature was nearly in a plane.

There were four molar teeth, two larger and two smaller. These were probably the second and third true molars. The largest measured, "in the longer diagonal from crown to base," 11 inches and contained 20 plates of enamel. The smaller teeth comprised 14 enamel plates.

The present writer is inclined to believe that this specimen belonged to *Elephas columbi*, there being apparently seven or fewer enamel plates in a 4-inch line. The great size of the tooth confirms this conclusion.

The immediate upland is covered with Illinoian drift, but the alluvium of the valley probably had its origin during or after the close of the Wisconsin stage.

Morgan County.—In the geological collection at Indianapolis is a tooth which appears to be the lower last molar of the right side. It was presented January 11, 1911, by David M. Hobson of Monrovia, and was found one mile and a half west of that town on a gravel bar in Sycamore Creek. This region is covered with Wisconsin drift and unless this had been cut through by the creek to older deposits, the animal belonged to post-Wisconsin times.

Tipton County.—In the museum of the University of Nebraska. at Lincoln, the writer examined three molar teeth which had been

PLATE XXVI.

Fig. 1.

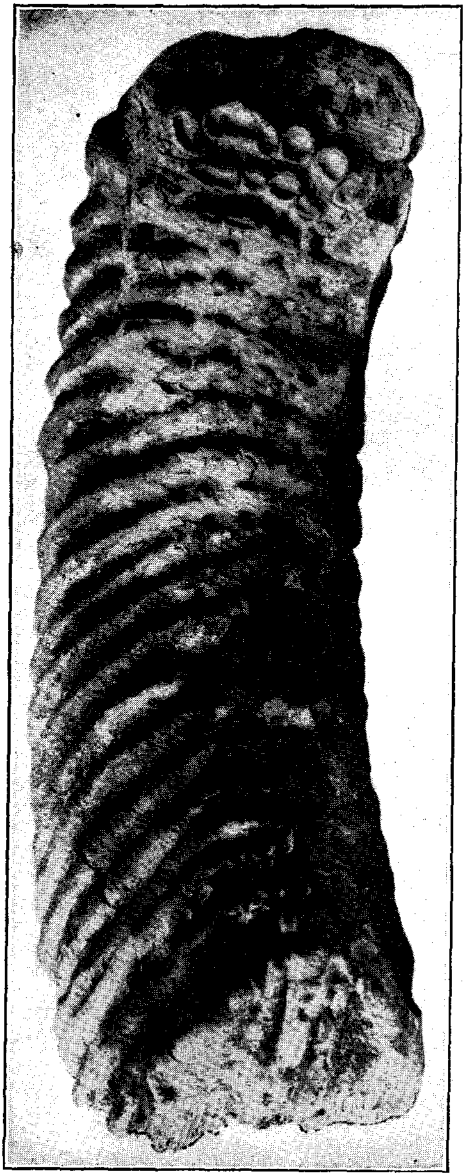


Fig. 2.

Views of the grinding faces of the molars shown in Plate XXV. Fig. 1. Upper last molar. Fig. 2. Lower last molar.

collected near Windfall by Prof. Erwin H. Barbour. The teeth form a part of the Chas. H. Morrill collection. They consist of the lower second permanent molar and of the upper and lower third molar. They are described on page 742.

Vigo County.—In the Second Annual Report of the Bureau of Statistics and Geology, on page 385, Prof. John Collett stated that bones of the mammoth had been found in this county; but there were no details given. In the collection at Indianapolis the writer found a fine large lower left molar of the left side, which had been found, in 1896, near Terre Haute, on the farm of Aaron Conover. It was discovered at a depth of 18 feet. It had been presented to the collection by Earl Conover. The length of the tooth from its front to the base of the last ridge-plate, is 380 mm.; the width of the worn face is 100 mm.; the height of the eighteenth plate, to which the upper face is worn, is 145 mm. The hinder plates lean strongly forward. There are six of the plates in a 100 mm. line. Without more details, it is impossible to conjecture the stage of the Pleistocene during which this animal lived.

Remains of elephants which are indeterminable for various reasons, mostly because of no or insufficient data regarding the materials found, have been found as noted below. They are indicated on the map each by a round dot:

Allen County.—In the Sixteenth Annual Report of the Geological Survey of Indiana, on page 129, Prof. Charles R. Dwyer stated that a single mammoth tooth had been found in Allen County, but no further particulars were presented. The animal must have been of post-Wisconsin age.

Dubois County.—Some remains of an elephant have been found in this county, but the writer has not at hand the record.

Franklin County.—In 1843, Dr. John Plummer (Amer. Jour. Sci., Ser. 1, XLIV, p. 302), described a tusk that had been found in gravel at a depth of 15 feet below the surface, near Brookville, Indiana. This was in the digging of the Whitewater Canal. The tusk was nearly six feet long and must have been originally still longer, for the author says that at the ends were exhibited about a dozen concentric laminæ of variable thickness. The base had a diameter of four inches. This tusk was curved to form a segment of a circle whose radius was two and a half feet. It thus formed about two-fifths of a complete circle. From the amount of this curvature it seems possible that the tusk was that of one of the mammoths. The specimen was said to be deposited in the "Atheneum" at Richmond.

Near the spot where this tusk was found there was taken out of the gravel at a depth of 10 feet a stone pestle-like object nearly 17 inches long.

Hamilton County.—In 1880, John Collett, then State Geologist, in the Second Annual Report of the Bureau of Statistics and Geology, page 385, gave a detailed account of the conditions under which was found, in that year, a part of the skeleton of a mammoth. The remains consisted of two well preserved teeth, one hip bone, one femur, and small parts of two vertebræ. These were scattered a distance of 80 feet along the line of a ditch that was being dug. The width of the space in which they occurred is said to have been less than two feet, but this was probably the width of the ditch, and there were probably other bones on each side of it that were not seen. Unfortunately, Collett did not think it necessary to say what disposition was made of these remains, so that at present it is impossible to determine whether they belonged to *E. primigenius* or *E. columbi.*

The ditch that was being dug was on the farm of Mr. John H. Caylor, about four miles southeast of Noblesville, being on the east half of the northeast quarter, Sec. 16, T. 18, R. 5 (given as 9) W. The ditch was for the purpose of draining a morass which was situated in a valley or depression 20 rods wide and which extends for several miles in a direction from southeast to north L. 10° west, and is about 20 rods wide. This is described as crossing the present valleys and streams. Prof. Frank Leverett informs me that it was probably originally a subglacial drainage channel.

Jasper County.—In the Twelfth Annual Report of the Geological Survey of Indiana, page 73, Prof. John Collett stated that the mammoth and the mastodon had both been found in Jasper County, but no details are given. On the map showing finds of mammoths, the black dot indicating the locality is placed near the South Branch of White River and near the Illinois moraine, as being most probably right.

Lake County.—In 1897, Prof. W. S. Blatchley, then State Geologist, reported that an almost complete skeleton of a mammoth had at some time previously been found in a marsh on the head waters of Deep River, in the north half of Sec. 35, T. 35, R. 9. about two miles east of St. Johns. Professor Blatchley probably received this account from some one in that region. The identification is uncertain, and the present writer has been able to learn nothing more about the specimen.

Whatever the animal was it seems to have been buried in a marsh on or close to the Valparaiso moraine of the late Wisconsin ice-sheet.

Martin County.—In 1871, Prof. E. T. Cox reported (Second Annual Report Geol. Surv. Ind., p. 103), that mammoth and mastodon remains had been found in this county, imbedded in marsh clay, resting upon the drift; but, as regards the mammoth, nothing was added. The dot indicating this mention is placed on the map near Shoals as being most probable.

Mr. Marion T. Mathers, of Orleans, Orange County, has informed me that in 1880 he and some others were at Shoals fishing and found a part of an upper jaw of a mammoth. He states that this jaw contained two very large teeth with very flat grinding surfaces and that they were teeth very different from those of the mastodons found by him in Orange County. He does not know what became of this upper jaw.

Montgomery County.—Mr. W. H. Thompson, in 1886 (Fifteenth Annual Report Geol. Surv. Ind., p. 159), reported that a lower jaw containing two teeth in fine preservation, two tusks each nearly 11 feet in length, and a number of fragments of ribs of an elephant had been found in the northern part of Montgomery County. They had been discovered in the bed of Black Creek, a small stream running along the border of a flat bog, on the land of Milton N. Waugh. Mr. Thompson could not secure these specimens for the State collection. The writer has learned from Prof. Donaldson Bodine that the locality was on Sec. 12, T. 20 N., R. 3 W. The teeth and bones were unearthed by a Mr. Parrish. They were afterwards sold by him, but it has been found impossible to trace their history further.

Professor Bodine states that on the farm of Mr. George Lynch, Sec. 8, T. 19 N., R. 3 W., one end of a tusk was exposed in excavating a cellar. No effort was made to secure it and it is now inaccessible. It is impossible to say whether the tusk belonged to a mammoth or to a mastodon.

Parke County.—In the Second Annual Report of the Bureau of Statistics and Geology, page 385, published in 1881, the State Geologist, John Collett, stated that teeth of a mammoth had been found in this county, but no particulars were furnished. The dot indicating this mention is placed on the map arbitrarily.

Putnam County.—The former State Geologist, John Collett, stated in the Second Annual Report of the Bureau of Statistics and Geology, page 385, that bones of the mammoth had been found in this county, but nothing definite about materials and localities was given. The black dot is placed arbitrarily on the map.

Vanderburgh County.—John Collett, State Geologist in 1876, stated in a general way (Seventh Ann. Report Geol. Surv. Ind., p. 246), that the mammoth had been found in this and adjoining counties. However, in 1880, he affirmed definitely (Second Ann. Report Bur. Statistics and Geol., p. 385), it had been found in Vanderburgh County. Beyond this, no statements were made.

Vermillion County.—In the Second Annual Report of the Bureau of Statistics and Geology, the then State Geologist, John Collett, stated that mammoth remains had been found in this county, but no details were given.

Vigo County.—Mr. F. H. Ward, Rochester, New York, has informed me that there are in Ward's Natural Science Establishment, two teeth of an elephant from Vigo County. The more exact locality is stated to be the farm of W. N. Stewart, Otter Creek Township. The teeth were found in April, 1885. Not having seen these teeth, the present writer will not attempt to identify them specifically.

Wabash County.—In the Seventeenth Annual Report of the Geological Survey of Indiana, page 241, Messrs. Elrod and Benedict stated that Mr. John H. Pefley, on the east half of Sec. 18, T. 27, R. 8, near Dora, found two large teeth which the writers saw and identified as those of *Elephas primigenius.* What has become of these teeth is not known. Their age is certainly post-Wisconsin.

Messrs. Moses N. Elrod and A. C. Benedict reported (Seventeenth Ann. Report Geol. Surv. Ind., p. 240), that some mammoth bones were found some years ago in Pleasant Township, Wabash County, by some workmen who were throwing up an embankment for a bridge over Silver Creek. The bones were found under five feet of muck. It is stated that some of these are in Wabash College at Crawfordsville, Ind. It was near the banks of the same creek and evidently not far from the same place that a mastodon skeleton was found in 1872 by Mr. Jacob Stevenson while digging a ditch by the roadside. If these bones were all correctly identified, it is evident that both species lived about the same time, and that this was after the Wisconsin ice had withdrawn from that county.

Wayne County.—In the Second Annual Report of the Bureau of Statistics and Geology, page 385, John Collett reported the finding of mammoth teeth in Wayne County, but here, also, no details were furnished.

On the mammoth map, the black dot indicating this find is placed arbitrarily near the center of the county.

In the collection of Earlham College are two teeth which are credited to Jehiel Bond, and which were found on Nolans Fork, near Webster, Wayne County. One of these teeth appears to be the upper second true molar; the other, the third, and apparently having belonged to the same individual. With these teeth is a tusk which measures 1,800 mm. along the convex curve. The writer is at present unable to assign this tooth to either *E. primigenius* or *E. columbi*.

Order RODENTIA.

SQUIRRELS, RATS, FIELD-MICE, PORCUPINES, BEAVERS, RABBITS, ETC.

Animals varying in size from very small to median. Digits usually five on all the feet and furnished with claws. Teeth reduced in number; two functional incisors in each jaw; no canines; never more than three premolars. Incisors growing from persistent pulps, usually with enamel on only the front face, so that those teeth are chisel-like. A long space between the incisors and the cheek-teeth. Mandibular condyles elongated fore and aft. Auditory bullæ developed. Orbit opening freely into the temporal fossa. Premaxillæ reaching the frontals.

The Rodentia may be said to swarm over the whole habitable globe. In time they are known to us from the early Eocene. By systematists they are divided into two suborders: (1) *The Duplicidentata,* including the hares and rabbits and the picas. (2) The *Simplicidentata,* containing all the other rodents. Inasmuch as the hares and rabbits have inhabited North America since the Miocene it seems remarkable that no specimens have yet been discovered in Indiana. It can only be because the small size of their skulls and bones has caused them to be overlooked. The same is true of a host of animals that undoubtedly lived in Indiana during the Pleistocene. The *Duplicidentata* differ from the other rodents in many ways, but conspicuously in the fact that just behind the upper incisors is another pair of small size.

Suborder SIMPLICIDENTATA.

No rudimentary incisors behind the functional pair in the upper jaw. An alisphenoidal canal present. Fibula not articulating with the calcaneum.

The Simplicidentata are divided into at least three subfamilies; the *Sciuromorpha* (squirrels, beavers, etc.), the *Myomorpha* (rats, field-mice, etc.), and the *Hystricomorpha* (porcupines, guinea-pigs, etc.). These divisions are based especially on the structure of the zygomatic arch, the size of the infraorbital foramen, and the manner of origin of the angular process of the lower jaw.

Superfamily SCIUROMORPHA.

Infraorbital foramen small, the zygomatic arch mostly formed by the jugal; the process of the maxillary, which reaches backward under the jugal, lacking much of reaching the temporal process. Angular process proceeding from the lower side of the mandible. Tooth formula, i $\frac{1}{1}$, c. $\frac{0}{0}$, pm. $\frac{1}{1}$, m. $\frac{3}{3}$.

Under this superfamily come the squirrels, the chipmunks, the spermophiles, and the groundhogs, none of which are yet known to occur fossil within the State, but all of which may be confidently looked for in cave and fissure deposits, as well as in alluvial and peat deposits, and even in drift, into which they may have burrowed.

In the group Sciuromorpha the writer places without hesitation the family Castoroididæ, notwithstanding the fact that most authors have relegated it to the Hystricomorpha. Its relationships are too close to the beavers to permit it to be removed far from them.

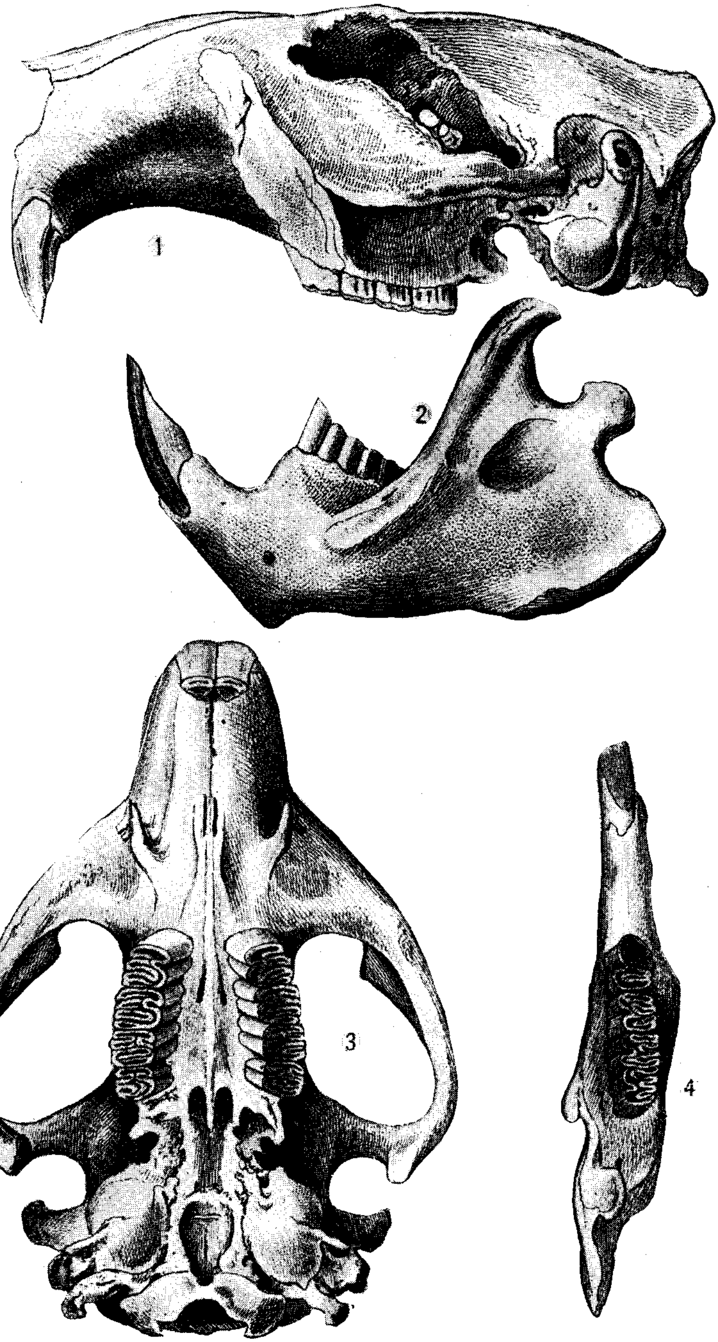
Family CASTORIDÆ.

THE BEAVER-LIKE RODENTS.

Infraorbital foramen very small. No postorbital process. Angular process of lower jaw rounded, with its lower edge turned inward. Teeth, i. $\frac{1}{1}$, pm. $\frac{1}{1}$, m. $\frac{3}{3}$. The premolars resemble the molars, it and the molars consisting each of two compressed more or less transverse lamellæ of enamel surrounded by cement.

Besides the existing genus *Castor*, this family includes three or four extinct genera, one of which, *Steneofiber*, lived from the Oligocene into the Pliocene.

PLATE XXVII.



Castor canadensis. Views of the skull and teeth; about ⅔ the size of nature. Fig. 1. Skull seen from left side. Fig. 2. Lower jaw from left side. Fig. 3. Skull presenting palatal surface. Fig. 4. Lower jaw with teeth.

Genus CASTOR Linnæus.

The Beavers.

Skull strongly constricted. Basioccipital with two deep excavations on its lower surface. Teeth single-rooted and continuing to grow until late in life. Cheek-teeth in a series which converges forward, the teeth diminishing in size backward. Face of crown traversed more or less completely by three plates of enamel, besides a loop which enters from the inner face in the upper teeth and the outer face in the lower teeth. Feet five-toed.

In the beavers the incisors are large, much curved, and the hinder end extends back to the anterior cheek-tooth. The enamel is confined to the front of the tooth and is of a deep orange color which, however, may disappear in the fossil. Of the four cheek-teeth, the premolar on each side is the largest. The worn crown is surrounded by a coat of enamel which on the inner face of the upper teeth and the outer in the lower, sends inward a deep inlet. In the upper teeth this is nearer the front of the tooth; in the lower ones, nearer the hinder end.

CASTOR CANADENSIS Kuhl.

The American Beaver.

On the arrival of white men on this continent the beaver occupied the region from Mexico and the Gulf of Mexico north to about the limits of forests, extending northwesterly as far as Alaska. Its range now is much restricted.

Geologically it occurs in deposits which we must believe belong to very early Pleistocene, as Hay Springs, Nebraska; the Aftonian deposits of western Iowa, and at the Port Kennedy Cave in Pennsylvania. The only mention that the writer recalls of the presence of the beaver as a fossil in Indiana is that made by the State Geologist, John Collett (Twelfth Ann. Report, p. 73). He stated that in Jasper County the bones of the buffalo, the beaver, and the bear were common. This is very indefinite, indeed. We know nothing about the parts of each animal found, or the localities, or at what depths, or the kind of deposit. Figures 1 to 4 of Plate XXVII, taken after Baird, illustrate the structure of the skull and teeth of this species.

As remains of the beaver will certainly be found in the State, some measurements are here given to facilitate identification:

Length of skull from rear of condyles to front of premaxillæ.... 143 mm.
From rear of condyles to rear of hard palate .... 47 mm.
Width across mastoids .... 69 mm.
Least width in front ear-openings .... 46 mm.
Greatest width across zygomatic arches .... 105 mm.
Interorbital space .... 26 mm.
Width across snout at middle of nasals .... 33 mm.
Distance from the incisors to first of premolars .... 50 mm.
Length of series of cheek-teeth .... 31 mm.
Width of palate between the premolars .... 7 mm.
Width of palate between the hinder molars .... 16 mm.
Lower jaw from rear condyle to front of symphysis .... 101 mm.
Lower jaw from rear of angle to front .... 108 mm.
Lower jaw from width across condyle .... 68 mm.
Lower jaw from width across angular processes .... 92 mm.

Upper Teeth.	Measurements.	Lower Teeth.	Measurements.
Pm.^{4}	Length of crown, 9 mm.	Pm.$_4$	Length, 11 mm.
Pm.^{4}	Width, 10 mm.	Pm.$_4$	Width, 7 mm.
M.^{1}	Length, 7 mm.	M.$_1$	Length, 8 mm.
M.^{1}	Width, 9 mm.	M.$_1$	Width, 9 mm.
M.^{2}	Length, 7 mm.	M.$_2$	Length, 8 mm.
M.^{2}	Width, 8 mm.	M.$_2$	Width, 9 mm.
M.^{3}	Length, 6.5 mm.	M.$_3$	Length, 8 mm.
M.^{3}	Width, 7 mm.	M.$_3$	Width, 7 mm

Scapula, length from glenoid fossa, along spine .... 84 mm.
Scapula, greatest breadth .... 48 mm.
Humerus, length .... 86 mm.
Humerus, width at lower end .... 34 mm
Ulna, length .... 118 mm.
Radius, length .... 85 mm.
Pelvis, length .... 187 mm.
Pelvis, width at acetabula .... 104 mm.
Pelvis, greatest width at hinder end .... 103 mm.
Femur, length from head to inner condyle .... 110 mm.
Femur, width at lower end .... 42 mm.
Tibia, length .... 132 mm.
Fibula, length .... 121 mm.
Caudal vertebræ, breadth of 4 anterior, across processes........ 75 mm.

The scapula may be distinguished from any others of its size by the long process which descends from the outer border of the high spine, to a point below the head, leaving a broad notch between the latter and itself. The humerus is characterized by its flattened shaft and lower end, and by having on its outer border, just above the middle, strongly projecting deltoid process. The femur likewise is flattened and has on its outer border, at the middle, a process known as the third trochanter.

Family CASTOROIDIDÆ.

Infraorbital foramen very small. No postorbital process. Angular processes greatly developed. Teeth, i. $\frac{1}{1}$, c. $\frac{0}{0}$, pm. $\frac{1}{1}$, m. $\frac{3}{3}$. Incisors enormous and longitudinally grooved. The premolars resembling in structure the molars. The cheek-teeth composed of from three to five compressed plates of enamel held together by plates of cement. Fore feet unknown; the hinder 5-toed.

Besides the genus *Castoroides* of North America this family is made to include *Amblyrhiza,* a not well-known genus found on some of the islands of the West Indies.

Genus CASTOROIDES Foster.

Form and proportions beaver-like, but larger. Cheek-teeth composed of plates (apparently flattened tubes) of enamel united by plates of cement; the upper premolars and first two molars with three, the last molar with four of the enamel plates; the lower premolar of four enamel plates, the molars of three. Upper and lower cheek-teeth in series that diverge strongly backward. Hinder part of nasal passage divided into two, an upper and a lower.

So far as known, this genus includes only a single species, the one here described.

CASTOROIDES OHIOENSIS Foster.

THE GIANT BEAVER.

The first account of this remarkable animal, accompanied by a scientific name, was published by the geologist, J. W. Foster, in the Second Annual Report of the Geological Survey of Ohio, 1838, page 81. It had, however, been mentioned, with figures, by S. R. Hildreth in 1837 (Amer. Jour. Sci. XXXI, p. 80). These accounts were based on a somewhat damaged skull that had been discovered near Nashport, Muskingum County, Ohio, in excavating a canal through a peat swamp. The bones found consisted of a radius, an upper incisor, and a lower jaw containing an incisor and the four cheek-teeth. Where these remains now are is not known to the present writer.

Since that time numerous specimens of the species have been found in the country from Central New York to the Great Plains, and from Florida to Minnesota. Indeed, in the U. S. National Museum is a part of a femur which was brought by Mr. A. G. Maddren, of the U. S. Geological Survey, from Yukon Territory, nearly up to the Arctic Ocean.

As to its continuance in time, it has been found in deposits that belong very near the beginning of the Pleistocene, notably at Hay Springs, Nebraska, accompanied by fossil horses and camels, and in the Aftonian deposits of Iowa. It is possible that these early forms belonged to a different species, but this has not been proved. On the other hand, numerous specimens have been found in deposits that overlie the last or Wisconsin drift, notably in Indiana, Ohio, and Michigan. This shows that the animal was present in our region long after the glacial ice had disappeared.

The finest specimen of this species that has been discovered is that now in the museum of Earlham College. It was found in a swamp, known as the Dismal, in the eastern part of Randolph County, Indiana. Moore stated the locality is about six miles nearly east of Winchester and about the same distance southwest of Union City, on the farm owned by John M. Turner. It was reported by the finders to have been "standing in the natural position." The bones were secured for Earlham College by Prof. Joseph Moore, whose active interest in such things was instrumental in obtaining for Earlham College many valuable fossils. This individual was one not quite grown and many of the bones lack their epiphyses.

This specimen furnished a more or less damaged skull, but the lower jaw was complete. The fourth to the seventh cervicals are missing. The second, third, fifth and sixth dorsals are gone. However, Moore (Amer. Geologist, XII, p. 68), stated that 19 were present. Of the caudals there are 14 present. It was believed by Moore that the last one of these 14 was about the seventh from the sacrum. Of the sternum, the presternum and the xiphisternum were recovered. The essential parts of both scapulæ are present. The fore feet are wholly missing and are known in no other specimen. The pelvis lacks only the symphysis of the ilia, and a part of the pubic region. The hinder feet lack all the ankle bones except both astragali and one calcaneum. All the metatarsals are present except one. The right hind foot lacks all the digital bones, except the first phalanx of the third digit; the left foot lacks all the digital bones except the first phalanx of the third digit and the first and second of the fourth digit.

This skeleton was described and figured by Joseph Moore in the American Geologist, Vol. XII, pp. 68-74, with Plate XII, and in the Journal of the Cincinnati Society of Natural History, Vol. XIII, pp. 138-169, with 25 text-figures.

The bones of the specimen were mounted, and in doing so the parts missing were restored in some material which was made to imitate as nearly as possible the color and appearance of the bone. It is, therefore, sometimes difficult to determine whether a particular part is real or artificial. This is a practice that ought to be discouraged.

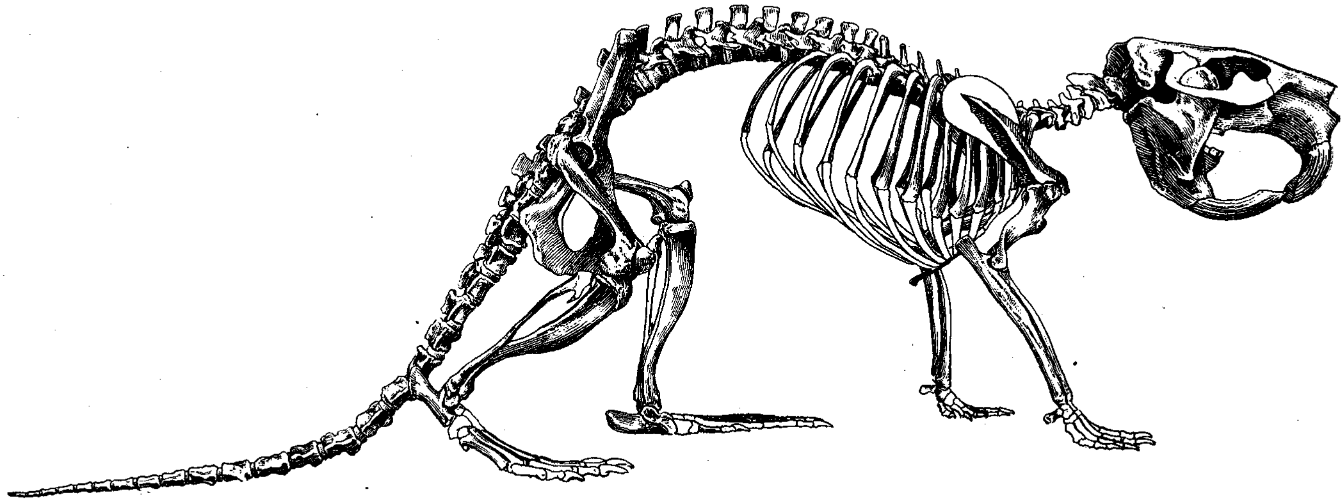
The line-drawing shown here (Pl. XXVIII), has been made by Mr. R. Weber, after a photograph of this specimen at Earlham College. However, where a part, as in the skull, is known from other specimens, it is represented as known. Where any part is unknown, as in the case of the hinder cervical vertebræ, some of the caudals, the forefeet and parts of the hinder feet, the bones are traced only in outline. Such parts were restored after the beaver.

The total length of this specimen, measured along the curve of the back, mounted, is seven feet and two inches, 2,185 mm. This is about twice the length of a good-sized beaver, but the specimen was probably not quite full grown. A specimen hereafter to be mentioned is in the Field Museum of Natural History, Chicago, whose limb bones are larger. It is probable that large individuals attained a length of eight or nine feet; that is, more than twice the length of the beaver, and therefore of more than eight times the bulk of the latter.

Of the skull of the Earlham specimen there are present the lower jaw complete, with all of its teeth; the maxillæ, with all the grinding teeth except the right premolar and the last right molar; the premaxillæ and their incisors; the vomer, the palatines and the right malar. The rear of the skull has, therefore, been restored.

From the front of the premaxillæ to the line joining the hinder ends of the last molars is 195 mm. Just in front of the malar bones, the width of the face is 77 mm., the height 88 mm. Each nasal bone is 32 mm. wide. In the maxilla the antorbital foramen is 11 mm. high. From the front of the maxilla to the rear of the last molar the distance is 120 mm. At the anterior molar tooth the width of the palate is only about 10 mm.; between the last molars it is 36 mm. From the rear of the incisors to the front of the first grinding tooth the distance is 105 mm. The great upper incisors are complete. When the nasal bones are lifted these teeth are seen to extend backward somewhat behind the suture between the maxillæ and the premaxillæ. Each forms about a semicircle and is about 210 mm. long, measured along the outer curve. On this curve they project forward and downward 100 mm. beyond the premaxillæ. The width of each is 24 mm., the fore and aft thickness, 23 mm.

PLATE XXVIII.



Castoroides ohioensis. Skeleton. The figure is based principally on the specimen at Earlham College, Richmond, Indiana.

The length of the row of grinding teeth, measured on the worn faces, is 66 mm. In the case of a specimen in the U. S. National Museum, No. 1634, found at Logansport, the series of teeth measure 67 mm. (Plate XXIX, Fig. 1.)

The following are the dimensions of these teeth on the worn faces:

TEETH.	Earlham Specimen.	Logansport Specimen.
Pm.[4]	Length, 15 mm.; width, 17 mm	Length, 17 mm.; width, 16 mm.
M.[1]	Length, 12 mm.; width, 16 mm	Length, 16 mm.; width, 14 mm.
M.[2]	Length, 13 mm.; width, 14 mm	Length, 15 mm.; width, 13 mm.
M.[3]	Length, 16 mm.; width, 12.5 mm	Length, 18 mm.; width, 14 mm.

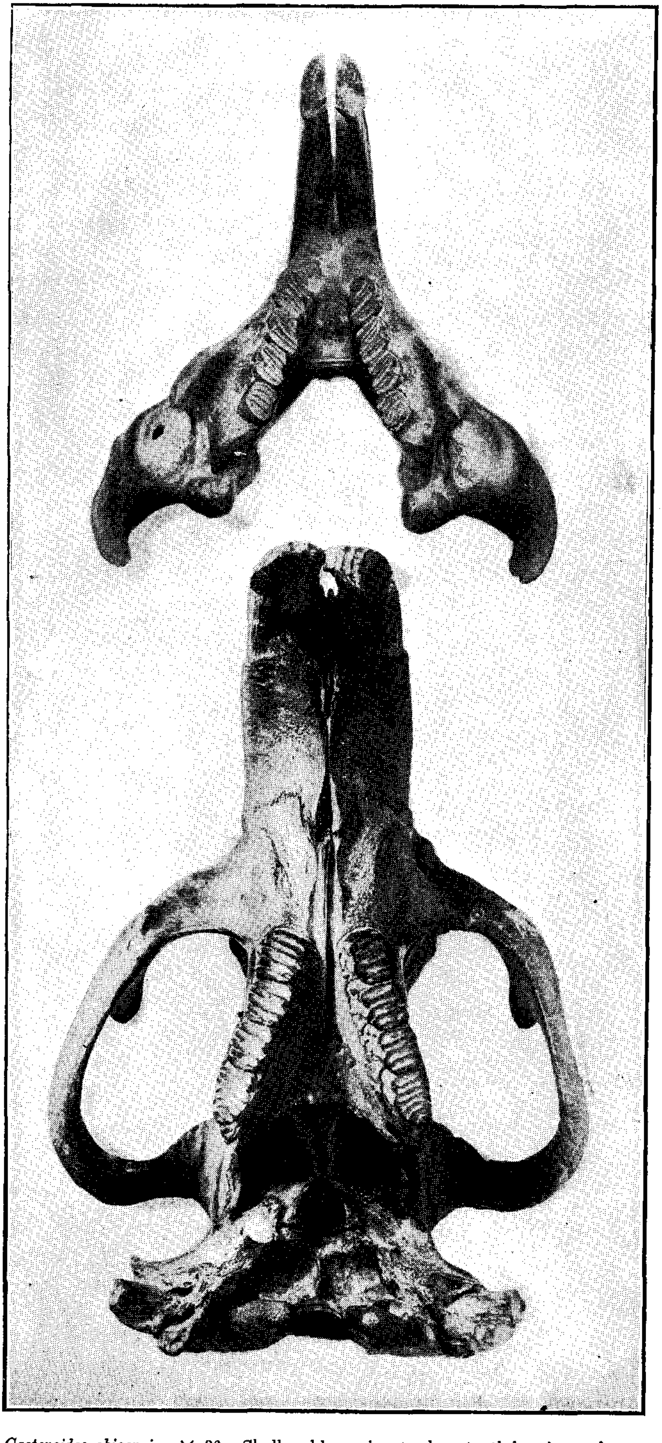
In the lower jaw (Pl. XXIX Fig. 2), the distance from the front to the line joining the angular processes is 161 mm.; to the angle itself, 185 mm. From the outside of one condyle to the other is 110 mm.; from one angular process to the other, 210 mm. The length of the symphysis along its upper face is 65 mm. At the anterior grinding tooth the height is 70 mm. The distance between the anterior grinding teeth is 18 mm.; between the last molars, 50 mm. The teeth measure as follows:

TEETH.	Measurements.
Pm.[1]	Length, 20 mm.; width, 12 mm.
M.[1]	Length, 17 mm.; width, 13 mm.
M.[2]	Length, 17 mm.; width, 13 mm.
M.[3]	Length, 16 mm.; width, 12 mm.

At its insertion each incisor has a width from side to side of 20 mm.; fore and aft, of 21 mm. It projects beyond the bone 140 mm.

The atlas has a maximum width of 93 mm. and a height of 45 mm. The articular surfaces for the skull indicate a motion in this joint mostly up and down. The axis is consolidated with the third cervical. The same is true in beaver at hand. The axis is nearly as wide as the atlas. Professor Moore described with some detail the dorsal vertebræ. He concluded that the length and bulk of the spinal column from the atlas to the sacrum did not differ much from that of an adult man, being 21 inches in length. However, a few pieces were missing and most of the epiphyses are gone also. In general, the structure of the vertebræ is the same as in the beaver. There were doubtless, as in other rodents, 19 dorsals and lumbars, taken together. Moore concluded that there were probably 14 thoracic vertebræ and five lumbars. On the upper side of the centrum of each of the dorso-lumbars is a pair of large fora-

PLATE XXIX.



Castoroides ohioensis. × .36. Skull and lower jaw to show tooth-bearing surfaces. Lower figure from skull found at Logansport. Upper figure from the mounted specimen at Earlham College.

mina opening into the spongy interior, as in the beaver and some other rodents. The lateral extent of the first thoracic vertebra is given as fully 75 mm., but the width of the succeeding ones diminishes to the fifth. The last, or fifth, lumbar has strong lateral processes and measures, from the tip of one process to the other, 92 mm.

In the beaver there are four sacral vertebræ, and Moore stated that that is the number in the mounted specimen of *Castoroides*. The lateral wing-like processes of the hinder ones are broken off. Moore gave as the length of the four sacrals 5.12 inches. So far as the writer could see, there are in the sacrum, as mounted, only three sacrals, and the free vertebræ behind the third one was included by Moore among the caudals. These three sacrals measure 90 mm. in length. As already stated, there are preserved 14 caudal vertebræ. Moore concluded that there were originally about 23 or 25, as in the beaver. These vertebræ resemble much those of the beaver, but the centra of the proximal ones and the transverse processes are not so long, thus indicating that the tail was not so broad. For example, the greatest width of the seventh in a beaver is 60 mm.; in the *Castoroides,* 75 mm.; whereas, its proportional width would be at least 120 mm. Of ribs, Moore stated that there were eight right and 12 left. As the writer determined, there are in the mounted animal 11 on the right side, eight on the left. It is possible that parts of ribs joined to artificial materials were overlooked. The parts of the sternum present resemble the corresponding parts in the beaver. The acromion process of the scapula is relatively shorter than in the beaver, and is compressed parallel with the axis of the body. In the beaver it is compressed on the opposite plane.

The humerus has a length of 135 mm. from the head to the inner side of the articulation for the ulna. Moore's statement, that the length is 7.36 inches, is probably a typographical error for 5.36 inches. The width across the upper end is 55 mm.; across the lower end, 53 mm. On the outer border just above the middle is a strong deltoid process. The ulna had, in life, a length of about 230 mm. On the outer face, as in the beaver, there is a deep longitudinal fossa, extending from the sigmoid cavity to beyond the middle of the length of the bone. The radius, with its missing distal epiphysis, probably measured 170 mm. The length of the radius to that of the humerus is 1.33; in the beaver, 1.06. This appears to be due to the fact that the humerus of *Castoroides* is, relatively to the length of the animal, shorter than in the beaver.

The anterior extremities of the pelvis are restored. The original length of the pelvis was close to 300 mm., extending over the length of 10 vertebræ; whereas, in the beaver, it extends along eight of them; nevertheless, it appears to be relatively shorter than that of the beaver. The structure of the innominate bones resembled closely those of the beaver.

The femur, with its restored distal epiphysis, measures 165 mm. from the head to the distal articular surface; from the greater tuberosity, 185 mm. The bone is broad and flat, being 70 mm. wide across the condyles at the lower end. Where the shaft is narrowest, about the middle, the diameter, from side to side, is 30 mm.; the thickness, 22 mm. It will be seen that the shaft is much more constricted at the middle than it is in the beaver. Likewise, the third trochanter is placed above the middle, not as it is in the beaver. In proportion to the length of the animal, the femur is shorter in *Castoroides* than in the beaver.

The greatest length of the tibia is 253 mm.; the breadth of the upper end, 56 mm. It resembles greatly the same bone in the beaver. The fibula had a length originally of 218 mm. It is coössified with the tibia for a distance of about 95 mm., differing thus from that of the beaver.

So far as the bones of the hinder foot are preserved, they indicate a foot greatly like that of the beaver, but shorter relatively to the length of the body. A skeleton of a beaver, before the writer, has its length contained in that of the mounted specimen of *Castoroides* just $2\frac{1}{8}$ times. Its whole leg measures 360 mm., omitting the claw phalanx of the fourth digit. The leg of *Castoroides,* omitting the same phalanx, ought then to measure 763 mm.; it measures only 655 mm. The femur ought to measure 230 mm.; it measures only 185 mm.; the tibia ought to measure 285 mm.; it measures only 253 mm. The foot, omitting the unknown claw phalanx, ought to measure, from the heal, 308 mm.; it measures only 252 mm. It appears evident, therefore, that the giant beaver was a relatively shorter legged animal than the beaver.

In the U. S. National Museum is a beautifully preserved skull of this species which was found two or three miles north of Logansport, Indiana. (Pl. XXIX, Fig. 1.) The lower jaw is lacking and both målar bones; otherwise, there is only trifling injury. It is thought well to give some description of this skull. Some measurements will first be presented. The measurements of the teeth have already been given on page 759.

Rear of occipital condyles to front of premaxillæ	262 mm.
Rear of occipital condyles to rear of hard palate	88 mm.
Rear of occipital condyles to rear of premaxillæ, at midline	180 mm.
Height of rear of skull above bottom of condyles	68 mm.
Width of rear of skull	145 mm.
Width of skull in front of ear-opening	80 mm.
Width of brain-case at anterior end of frontals	55 mm.
Width of face at front of maxillæ	65 mm.
Width across the zygomatic arches, greatest, restored	193 mm.
Height of skull between premolars	98 mm.
Height of skull at middle of nasals	87 mm.
Distance between incisors and the premolars	110 mm.
Outside to outside of incisors on emergence from premaxillæ	58 mm.
Outside to outside of incisors at 75 mm. distance	46 mm.
Length of exposed part of incisors along outer curve	116 mm.

The skull of *Castoroides* resembles rather closely that of the beaver, but there are important differences, as has been pointed out by others. In the beaver the width of the rear of the skull is almost exactly one-half the length of the skull; in the giant beaver the width is about a tenth more than half the length. In the beaver the auditory bullæ are much inflated and the basioccipital is deeply hollowed out on the underside; in the giant beaver the bullæ are little inflated and the basioccipital has two shallow excavations separated by a median ridge. In the beaver the jugal bone extends forward to the lachrymal, while the malar process of the maxilla reaches backward a little behind the orbit; in *Castoroides* the jugal reaches forward to the middle of the orbit only, while the malar process passes about as far backward as in the beaver, indeed, somewhat farther. If we leave out of the account the anterior extension of the malar, we shall find that the latter bone is fully as much supported by the malar process of the maxilla as in the beaver.

In the beaver the interorbital foramen opens out at the premaxillo-maxillary suture in front of a sharp descending ridge; in *Castoroides* the ridge is not developed and the opening is at a considerable distance behind the suture. In the beaver the narrowest part of the brain-case is in front of the middle of the skull, in front of the little developed postorbital processes; in the giant beaver it is at the middle of the length of the skull and just behind the almost imperceptible postorbital processes.

The most remarkable structure in the giant beaver is the hinder part of the nasal passage, which is divided into two, an upper and lower. Pl. XXIX, Fig. 1.) There is nothing of the sort in the beaver. The distance between the roof of the nasal passage (formed by the basisphenoid and presphenoid), and the floor of it (formed by the palatines and maxillæ), had become much higher than in the beaver, relatively twice as high, being 40 mm. or more. At the front of the basioccipital the axis of the skull suddenly rises, so that the basisphenoid is at a much higher level. All the changes in this region appear to have come about in order to accommodate the development of the large internal pterygoid muscles which had their insertion in the pterygoid fossæ. In the beaver these fossæ are small; in *Castoroides* they are enormous, each having a transverse diameter of 23 mm.; a horizontal extent of 67 mm., and a height of 32 mm. In front the hinder end of the palatine has been deeply excavated; behind, the pterygoid fossa had encroached on the anterior end of the auditory bulla. The external pterygoid plate grew outward and backward so as to lie outside of the hinder end of the alisphenoid canal and the foramen lacerum anterius. To further accommodate the internal pterygoid muscle, the internal pterygoid plate was pushed inward, so as to reach the midline at the middle of its height and to come into contact with its fellow. In this way the hinder end of the nasal passage was constricted into an upper and a lower passage.

Posteriorly the upper passage opens out by a horizontal, pear-shaped, opening just in front of the basioccipital. (Pl. XXIX, Fig. 1.) Its length is about 25 mm.; its width is 16 mm. From this opening the passage rises and runs forward. The opening of the lower passage is in front of the other and at a lower level. It is triangular in shape and is bounded in front by the palatine; at the sides by the internal pterygoid plates. At the midplane the partition between the two passages is, as already stated, formed by the inner pterygoid plates. In front of these the partition is continued by ascending plates from the right and left palatine bones, which plates touch at the midplane. Still in front of these it appears that plates from the maxillæ continue the partition somewhat further forward. Then, just behind the bases of the upper incisors the inner walls of the maxillæ part and permit the lower canal to rise into the nasal cavity, meeting here the anterior end of the upper canal.

Some further description of the teeth of this species ought to be presented. The incisors are relatively much larger than in the beaver. In a specimen of the latter the teeth project a distance beyond the bone equal to hardly .25 the length of the skull; in the Logansport specimen the exposed part equals .42 the length of the skull; while in a specimen from Lenawee County, Michigan, the exposed part is a little more than one-half the length of the skull. In the mounted specimen at Earlham the whole length of the upper teeth was about 210 mm.; in the Michigan specimen, about 150 mm.

The lower incisors are still longer. Those of the mounted specimen at Earlham are about 250 mm. long; another tooth in that institution, from Greenville, Ohio, is 280 mm. long, is somewhat spirally curved, and is twisted on its axis. It forms nearly a semicircle.

Contrary to what is usual in rodents, the enamel is not confined to the front of the tooth, but passes around on its whole outer face. The enamel is longitudinally grooved, with the grooves separated by sharp ridges. The enamel may be more or less wrinkled transversely, so as to make that part of the tooth rough. The inner face of each incisor is flat, but these faces are not applied to each other, except at their distal ends. At their bases they are separated by processes of the premaxillæ. The hinder face of the incisor is slightly concave from side to side. At the extremity they are not worn off like the sloping face of a chisel, as they are in the beaver, but in such a way that there is formed in the two a deep pit which received the ends of the lower incisors.

The grinding teeth of the upper jaw all lean strongly backward; those of the lower jaw, forward; just as in the beaver. Each one seems to be composed of a number of flattened tubes of enamel which contain each its portion of dentine. The several tubes of enamel is held together by a mass of cement. In the three anterior upper teeth there are three of the enamel tubes; in the last molar there are four. These cross the tooth obliquely, passing from the outside inward and backward. In the lower teeth the anterior one —the premolar—there are four plates, or tubes; in the other, three. The plates are directed here, also, inward and backward.

The angular process of the lower jaw is strongly developed. The inner face is deeply excavated, and there is a wide shelf of bone along the lower border. Thus a large surface was furnished for the insertion of the powerful internal pterygoid muscle.

As to the habits of this animal, we can only make inferences. We may be sure that it was a vigorous gnawer of hard substances. It was almost certainly an aquatic animal. Probably like the beaver, it was addicted to cutting down trees; and, like the beaver, it probably built dams and lodges for the protection of itself and young from cold and enemies. The tail was less expanded than that of the beaver, and possibly the animal had not learned yet to slap the water with it as a signal of danger and in its sport. It may have been more flexible and therefore a better aid in swimming than that of the beaver.

So far as the writer knows, the following are the finds of *Castoroides* that have been made known in Indiana. Doubtless many remains have been observed, but not recognized or reported. If the localities are sought out on the map showing the distribution of the drift areas in the State, it will be seen that all occur within the area of the Wisconsin drift except one, Vanderburgh County. This means that these animals lived after the termination of the Glacial epoch. The northern half of Indiana appears to have been especially favorable for these animals, or at least offered favorable conditions for the preservation of their remains.

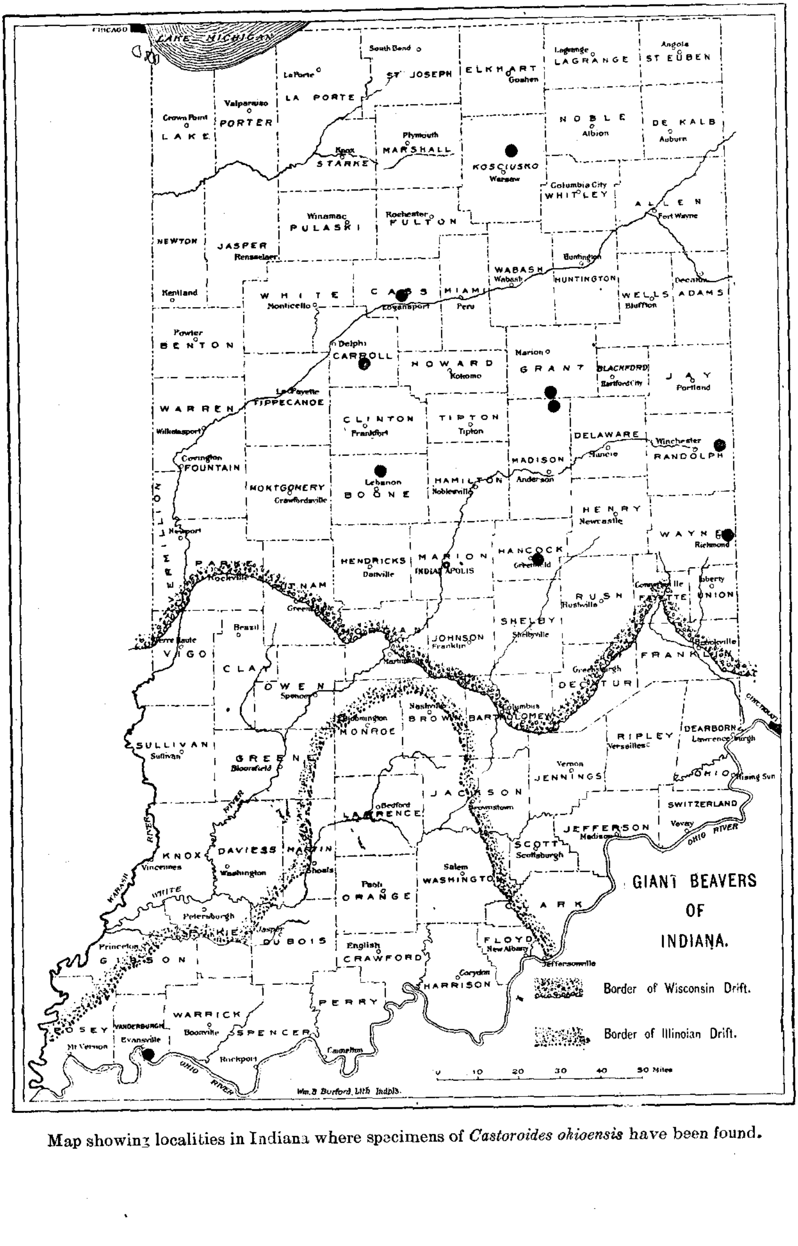
Boone County.—In the collection of the Geological Survey, at Indianapolis, there is a lower jaw with the bases of the incisors. At their insertion in the jaw, the fore and aft diameter is 23 mm.; the transverse, 19 mm. The molars are all present and the series measures 70 mm. The lower jaw, measured from the hinder surface of the incisors to the angle, is 214 mm.

Carroll County.—In a foot note (probably by John Collett) to Cope and Wortman's paper in the Fourteenth Annual Report of this Survey, p. 37, it is stated that remains of *Castoroides ohioensis* have been found in this county, but nothing further was said.

Cass County.—In this county was found the fine skull, without lower jaw, which has already been described on page 762. According to the newspaper account accompanying it, dated January 30, 1894, this was found two or three miles north of Logansport by Mr. S. L. McFadin and sold to the U. S. National Museum. It was discovered at a depth of seven feet, lying in a fine sand. Above the sand was a foot of solid gravel, and this was overlain by three feet of solid clay and by three feet of alluvium. According to Leverett's map (Mon. U. S. Geol. Surv. XXXVIII, Pl. VI), this would be on the moraine which lies on the southern border of the Iroquois till sheet, belonging to the late Wisconsin. After the retirement of the Wisconsin ice this animal lived and was buried. Since that event enough time has elapsed to permit the deposition of seven feet of sand, gravel and alluvium.

Grant County.—In this county, near Fairmount, was found considerable parts of the skeleton of a giant beaver. These remains are now in the Field Museum of Natural History, at Chicago. Nothing has yet been published regarding them. They were discovered in making a ditch, but the present writer has not re-

PLATE XXX.



Map showing localities in Indiana where specimens of *Castoroides ohioensis* have been found.

ceived exact data. The locality is not far from the place where the large mammoth described on page 719 was found.

Hancock County.—In the collection at Earlham College is part of a skull which was found near Greenfield. This belonged to Dr. M. M. Adams, who transferred it to Earlham College. This skull was described and figured by Professor Moore in the Proceedings of the Indiana Academy of Sciences for 1899, p. 171, Pls. I, II. The premaxillæ are not present, but the skull shows better on that account some of the internal structures. Greenville is situated on one of the moraines of the Wisconsin drift.

Kosciusko County.—In a foot note to Cope and Wortman's article in the Fourteenth Annual Report of the Geological Survey of Indiana, p. 37, which foot note was probably written by John Collett, then State Geologist, it is stated that bones and teeth of the giant beaver had been found in this county. Unfortunately no details were given.

Madison County.—In the collection of the Geological Survey at Indianapolis there is a right upper incisor which was found near Summitville and presented by Mr. T. F. Cartwright. The tooth is 250 mm. long.

Randolph County.—In this county was found the skeleton that is mounted at Earlham College and which has been described above (Pl. XXVIII). The locality was six miles nearly east of Winchester, on the farm of John M. Turner. The skeleton lay at a depth of eight feet from the surface, in a bluish-gray silt, which underlay five feet of alluvium very rich in vegetable mold.

Vanderburgh County.—In the Seventh Annual Report of the Geological Survey of Indiana, the State Geologist, John Collett, stated that remains of *Castoroides* had been found in this county. The exact locality is not given, but it is to be inferred that it was along the Ohio River. He stated that remains of *Megalonyx* had been found in the same deposits. It may be that these remains of *Castoroides* antedate the Wisconsin drift, but nothing certain can be deduced from the data given.

Wayne County.—In the collection at Earlham College is a fragment of an upper incisor which Prof. Joseph Moore picked up two miles east of Richmond, where a farmer was scooping out the wet earth for a fishpond. With this fragment were found teeth and some decayed bones of a mastodon. (Amer. Geologist, Vol. XII, p. 73.)

Order CARNIVORA.

FLESH-EATING MAMMALS.

Flesh-eating mammals with not less than four digits on any of the feet, mostly furnished with sharp claws. Canine teeth projecting beyond the others and fitted for seizing and tearing; the premolars and some molars for cutting flesh.

This group includes three suborders, the extinct Credonta, and the yet existing Fissipedia and Pinnipedia. We have to do only with the second of these.

Suborder FISSIPEDIA.

THE CATS, DOGS, HYENAS, BEARS, ETC.

Carnivora with the first digit on all the feet shorter than the others. Incisors, with rare exceptions, $\frac{3}{3}$. Canines large. The fourth premolar in the upper jaw and the first molar in the lower forming a special sectorial, or cutting, tooth feebly developed in bears. The hinder teeth usually adapted to grinding.

This suborder includes all the existing Carnivora except the sea-bears, sea-lions, seals and walruses.

Family URSIDÆ.

THE BEARS.

Clumsily built carnivores, with plantigrade feet. Teeth, i. $\frac{3}{3}$, c. $\frac{1}{1}$, pm. $\frac{3 \text{ or } 4}{4}$, m. $\frac{2}{3}$. The canines strongly developed, premolars small, molars large with flat tuberculated crowns; the sectorial teeth feebly developed, the upper one without the third, or internal, root. Auditory bullæ little inflated. Humerus without a foramen at lower end on inner side.

The bears have today a wide distribution, being found in Europe, Asia, Northern Africa and South America. In the latter continent there is found only a single species. In time they may be traced back to the middle Miocene of Northern Africa and to the upper Miocene in Europe. None are known in America before the beginning of the Pleistocene. They probably reached this country from Asia over some land connection in the region of Bering Strait.

Many of the bears are omnivorous in their habits and a few seem to live mostly on vegetable matter.

Genus URSUS Linn.

Bears with the premolars typically $\frac{4}{4}$, but the three anterior very small and sometimes missing, especially the second above and below; the first premolar close to the canine. Upper and lower sectorials smaller than the succeeding molars. Crowns of the molars broad, flat, and tuberculated. All the feet with five well developed digits, armed with large, compressed claws.

URSUS AMERICANUS Pallas.

This bear has been found fossil in the United States at a considerable number of places, as Port Kennedy Cave, Pennsylvania; at Natchez, Mississippi.

The State Geologist, John Collett (Twelfth Annual Report Ind Geol. Surv., 1883, p. 73), stated that in Jasper County the bones of the buffalo, the beaver, and the bear were common. No details were offered and the statement might refer to bones of rather recent animals, for undoubtedly all of these occupied the country a hundred years ago. However, since the animal has been reported from the State and is quite certain to be found fossil in some of the Pleistocene deposits, a description of the skull and of some of the principal bones will be given. At hand is a skull, No. 3798, U. S. National Museum, which was killed some years ago in the State of New York.

For the measurements of the skull, see under *Ursus procerus*, where they are compared with those of the just mentioned species. The measurements of the teeth and of the lower jaw and other parts of the skeleton are given here:

Fore-and-aft diameter of canine	22 mm.
Transverse diameter of canine	15 mm.
From front of pm. ^{1} to rear of m. ^{2}	81 mm.
Fore-and-aft diameter of pm. ^{1}	6 mm.
Fore-and-aft diameter of pm. ^{3}	4.5 mm.
Length of crown of pm. ^{4}	13 mm.
Width of crown of pm. ^{4}	9 mm.
Length of crown of m. ^{1}	18 mm.
Width of crown of m. ^{1}	13 mm.
Length of crown of m. ^{2}	27 mm.
Width of crown of m. ^{2}	14 mm.
Greatest diameter of lower canine	21 mm.
Transverse diameter of lower canine	13.5 mm.
Diameter of pm. $_1$	4 mm.
Length of crown of pm. $_4$	9 mm.

Width of crown of pm.$_{\overline{4}}$	4.6 mm.
Length of crown of m.$_{\overline{1}}$	19 mm.
Width of crown of m.$_{\overline{1}}$	10 mm.
Length of crown of m.$_{\overline{2}}$	21 mm.
Width of crown of m.$_{\overline{2}}$	12 mm.
Length of crown of m$_{\overline{3}}$	13.5 mm.
Width of crown of m.$_{\overline{3}}$	11 mm.
Length of the lower jaw from front to line joining condyles	183 mm.
Outside of one condyle to that of the other	155 mm.
Height of coronoid process from bottom of angle	81 mm.
Length of symphysis, lower face	60 mm.

The skull of the bear differs from that of the dog and the wolf in its greater size, actually and relatively greater breadth; in the position of the front of the orbits, being much farther in front; in the shorter and thicker snout, the smaller premolars; and in the very small, instead of very large, sectorials. In the wolf the hard palate ends at the rear of the last molar; in the bear it extends an inch behind the molar. The bear has only two upper molars; the wolf and the dog, three.

The following measurements of the limb bones is taken from a specimens in the U. S. National Museum. The epiphysis had not yet united with the shaft of many of the bones and the animal may have lacked a little of having its full size:

Scapula, length, along the spine	168 mm.
Scapula, width of upper end	127 mm.
Humerus, total length	250 mm.
Humerus, from head to distal end	250 mm.
Humerus, fore-and-aft diameter at middle of shaft	32 mm.
Humerus, transverse diameter at middle of shaft	23 mm.
Radius, length	218 mm.
Radius, diameter at middle of shaft	20 mm.
Ulna, total length	255 mm.
Ulna, diameter at middle of shaft	23 mm.
Femur, length from head to inside of lower end	292 mm.
Femur, length from top of great trochanter to lower end	282 mm.
Femur, diameter at middle of shaft	25 mm.
Tibia, total length	227 mm.
Tibia, fore-and-aft diameter at middle of shaft	21 mm.
Fibula, total length	200 mm
Fibula, diameter at middle of shaft	7 mm

URSUS PROCERUS Miller.

This species was described by Mr. G. T. Miller in 1899 (Proc. Biol. Soc. Wash., XIII, 1899, p. 55).

At present the only known specimen belonging to this species is the skull that forms the type. This is in the United States National Museum and has the catalogue number 4214. The specimen was found several years ago by Mr. H. J. Dinnie, while digging a

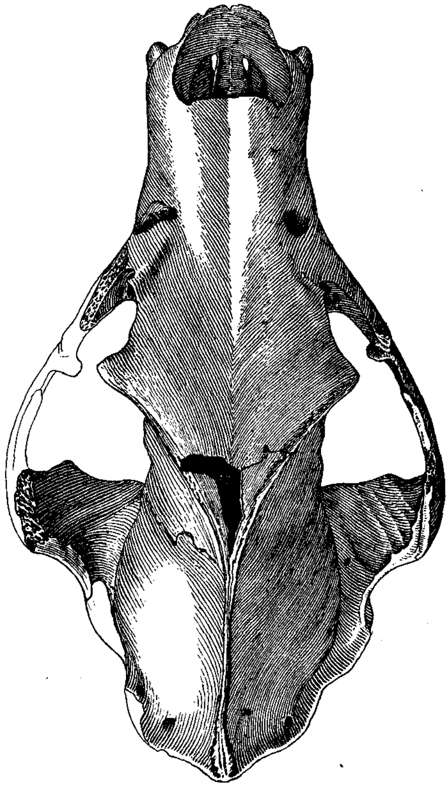


FIG. 71. *Ursus procerus*. Upper view of the skull. × ⅛. Drawing by R. Weber.

well one mile east and about one-eighth of a mile south of Overpeck Station, Butler County, Ohio. The well is a few rods east of the north and south road.

The skull lacks the lower jaw. The greater part of the left zygomatic arch is gone. The hinder part of the palate is broken away and also the roof of the posterior nares. The left occipital condyle and the adjoining mastoid region is missing. A small hole

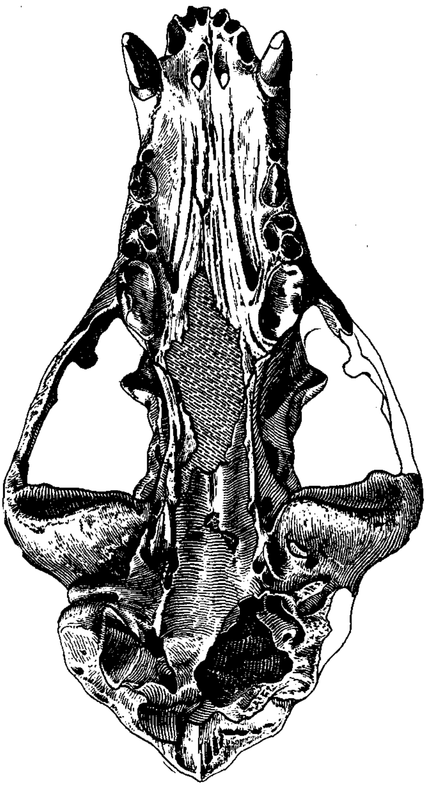


FIG. 72. *Ursus procerus*. Skull, showing palatal surface. × ⅓. Drawing by R. Weber.

is present in the upper surface of the skull. The incisor teeth, the third premolars, and both anterior molars, have fallen out of the sockets. Otherwise, the skull is in good condition. The injuries mentioned doubtless occurred before it became buried beneath the Wisconsin drift.

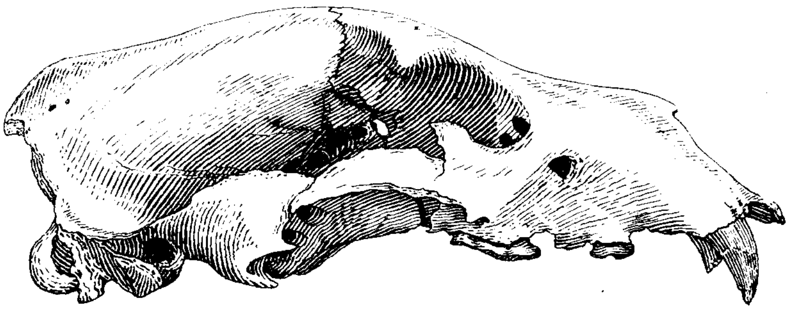


FIG. 73. *Ursus procerus*. Side view of skull. × ⅓. Drawing by K. Ito.

The animal was old when it died, the premolars and molars present having been worn down so as to efface all their cones and tubercles. As compared with the common black bear, *Ursus americanus,* the skull is slender, the snout longer, its upper outline more concave, and the three hinder teeth larger (Figs. 71-73).

The following measurements of the skull are given, and with them, for comparison, the same measurements of the skull of a specimen of *Ursus americanus* from the State of New York, No. 3778, U. S. National Museum:

Measurements.	U. procerus.	U. americanus.
Length from front of premaxillæ to rear of occipital condyle	302 mm.	283 mm.
Distance from front of premaxillæ to lower border of foramen magnum	283± mm.	261 mm.
Distance from front of premaxillæ to rear of sagittal crest	317 mm.	301 mm.
Front of premaxillæ to front of nasals	65 mm.	63 mm.
Tips of nasals to line joining tips of post-orbital processes	110 mm.	93 mm
Tips of premaxillæ to line joining post-orbital processes	166 mm.	154 mm
From line joining tips of post-orbital processes to rear of sagittal crest	173 mm.	178 mm.
Breadth of snout, across bases of canines	68 mm.	68 mm.
Least breadth of snout behind canines	63 mm.	60 mm.
Breadth at upper border of lachrymals	75 mm.	66 mm.
Breadth across post-orbital processes	97 mm.	97 mm.
Width across mastoid processes	130 mm.	148 mm.
Width across zygomatic arches	176 mm.	185 mm.
Breadth of palate between first molars	43 mm.	43 mm.
Breadth of palate between hinder ends of last molars	45 mm.	44 mm.
Width across palatine bones at front of palatine notch	40 mm.	40 mm.
Width of palatine notch between the pterygoids	29 mm.	21 mm.
Greatest depth of palatine notch between the pterygoids	30 mm.	24 mm.
Depth of snout at midline at front of m.[1]	53 mm.	58 mm.
Depth of skull at midline between auditory bulla	85 mm.	75 mm.
Length of palate from front of premaxillæ to line joining the hinder ends of m.[2]	136 mm.	121 mm.
Distance from front of premaxillæ to front of palatine notch	170± mm.	144 mm.
Width across occipital condyles	63 mm.	60 mm.
Width of each occipital condyle	17 mm.	16 mm.
Width of the mastoid process	24 mm.	32 mm.

Teeth.	U. procerus.	U. americanus.
Length of base of canine	19 mm.	22 mm.
Breadth of base of canine	13 mm.	15 mm.
Length of pm.[4]	15 mm.	13 mm.
Breadth of pm.[4]	12 mm.	9 mm.
Length of m..[1]	20± mm.	18 mm.
Width of m.[1]	17± mm.	13 mm.
Length of m.[2]	35 mm.	27 mm.
Breadth of m.[2]	17 mm.	14 mm.
Length from front pm.[4] to rear of m.[2]	72 mm.	56.5 mm.
Outside to outside of sockets of i.[3]	35 mm.	35 mm.

From these measurements it becomes obvious that although the skull of *U. procerus* is 19 mm. longer than that of the black bear measured, the part of the skull behind the postorbital processes is shorter. The width of the interorbital region is greater in the fossil, while the width across the zygomatic arches is less. The width and depth of the palatine fossa in the fossil exceeds those of the black bear. The distance from the tip of the snout to the front of the palatine notch is evidently much greater in *U. procerus* than in *U. amercianus,* although in the former the exact position of the front of the notch cannot be determined.

In *U. procerus* the lower surface of the auditory bulla is much less concave than in the black bear. The mastoid process is shorter, narrower, and is directed forward and downward, not also outward as in *U. americanus.* The side-walls of the hinder end of the interpterygoid fossa are not directed so strongly toward each other as they are in the black bear, and the roof of the mouth is not so much arched from front to rear.

It is not unlikely, as suggested by Mr. Miller, that the relative slenderness of the canine is due to the individual having been a female. The sockets for the incisors show that they were of the same size as those of the black bear used for comparison. The socket for pm. ^{3} is small. There are no traces of the first and the second premolars. The distance from the front of the premaxillæ to the line joining the front of the third premolars is exactly the same in the two specimens here measured, so that the lengthening of the snout is in the region of the great grinding teeth.

This bear is evidently different from that found in the Aftonian beds of western Iowa and represented by a lower jaw. The latter bear is so closely related to *U. americanus* that so far no certain characters have been found to justify separating it.

In December, 1911, the writer visited the locality where the type of *U. procerus* was found and made some observations on the typography and geology. The region is covered with drift belonging to the Wisconsin epoch and the surface is undulating. The mouth of the well is on a slope which descends from nearly level ground on the north to a valley on the south. The top of this slope is about 10 feet above the valley. The valley, opposite the well, is about four rods wide and on the opposite side the ground rises to a level somewhat higher than on the north. Through the valley runs a wet-weather rivulet that is now near the slope opposite that on which the well is situated.

If, now, it be insisted that the bear lived after the withdrawal of the Wisconsin ice-sheet, it must be assumed that, at the time, there existed here a valley extending 28 feet below the mouth of the well, and that the valley has since then become filled to its present condition. The writer does not think that there is anything in the topography to justify such an assumption. It seems more probable that the animal existed at some time previous to the Wisconsin ice-stage, possibly even before the Illinoian stage, and that its skull, buried perhaps in a mass of vegetable matter and soil in the bed of some stream, was later buried still more deeply by the deposits of the Wisconsin ice-sheet. That the skull may have been lying beneath even the Illinoian drift is rendered possible by the fact that solid rock lay only 3 or 4 feet below the skull. At the mouth of the well were observed pieces of quartz, trap and granitic rocks, and pieces of limestone that contained characteristic Cincinnati fossils.

Mr. Dinnie told the writer that the black soil in which the skull was found extended outward on each side of the well a few feet, and that it contained what resembled petrified sticks, and that on exposure to the air these crumbled into dust. What these supposed sticks were it is impossible to say.

Of the bears that now inhabit the eastern United States, it is that one, *U. luteolus*, inhabiting the canebrakes of the Southern States, which most closely resembles *U. procerus*. However, the snout of *U. procerus* is a little longer and narrower than that of *U. luteolus*, the molars larger and the region of the pterygoids wholly different.

Family CANIDÆ.

The Dogs, Wolves and Foxes.

Carnivora with skeleton adapted for active, vigorous life; the feet digitigrade; first digit of forefoot very short; that of hind feet, vestigial; digits with moderate, nonretractible claws. Skull usually rather elongated. Auditory bullæ inflated. Teeth i. $\frac{3}{3}$, c. $\frac{1}{1}$, pm. $\frac{4}{4}$, m. $\frac{2 \text{ or } 3}{3}$. The sectorial teeth large, with cutting ridge; the front upper one large and transversely extended; the lower ones with a talon of two tubercles. The second upper molar, small and transversely extended; the third missing. Premolars increasing in size backwards.

The Canidæ have at present a world-wide distribution. In Europe numerous genera have existed; the earliest known beginning with the upper Eocene. In North America the earliest known genus came in during the Lower Miocene. During the Pleistocene several species are known to have existed, some of which are extinct. Two species have been recorded from Indiana.

Genus CANIS Linn.

Dogs with teeth formula i. $\frac{3}{3}$, c. $\frac{1}{1}$, pm. $\frac{4}{4}$, m. $\frac{2}{3}$. Upper molars wider than long, the last one small. Last two molars of lower jaw small, often wanting.

CANIS DIRUS Leidy.

This species was first described by Joseph Leidy in 1854 under the name of *Canis primævus*. The species was based on a right upper maxilla, with teeth that had been discovered at the mouth of Pigeon Creek, a few miles below Evansville, in Vanderburgh County. This maxillary bone is now in the collection of the Philadelphia Academy. In 1858 (Proc. Phila. Acad. Nat. Sci., p. 21), Leidy, having discovered that the specific name *primævus* was preoccupied, proposed for his species the name *dirus*. Then again, in 1873 (Monogr. U. S. Geol. Surv. Terrs. I, p. 315), he proposed the name *indianensis*, remarking that *primævus* had been used for another dog, and appearing to forget his action of 1858. The writer

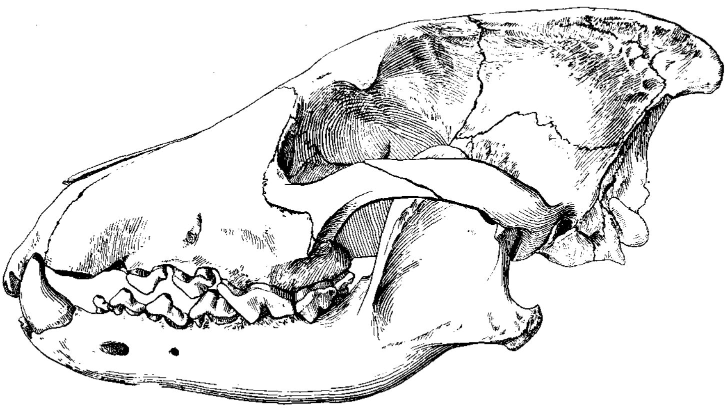


FIG. 74. *Canis dirus*. × .3. Lateral view of a skull. From Rancho La Brea, California.

has been unable to discover that the specific name *dirus* has ever been used for any other species of the genus *Canis*, and he believes that it must be retained for the species here under consideration. He must here acknowledge a blunder of his own. In his Bibliography and Catalogue of the Fossil Vertebrata of North America, p. 775, he listed *Canis dirus* as a species distinct from *C. indianensis* and credited it to J. A. Allen. *Canis dirus* was only another name for *C. primævus* Leidy.

In Leidy's work of 1873, just referred to, he described and figured a part of a lower jaw of a wolf from Livermore Valley, California, and this he referred to *C. indianensis*. This jaw ought to be in the collection of Wabash College, Indiana.

In the old asphalt lake of Rancho La Brea numerous remains regarded as belonging to this species have been discovered, so that now the osteology of the species is well known through the descriptions given by Dr. John C. Merriam of the University of California. Some of the skulls and bones found there have been sent to institutions in the East, especially Princeton University and the U. S. National Museum.

Through the generosity of Dr. Merriam the writer is able to present a description of some of the fine remains of this species and

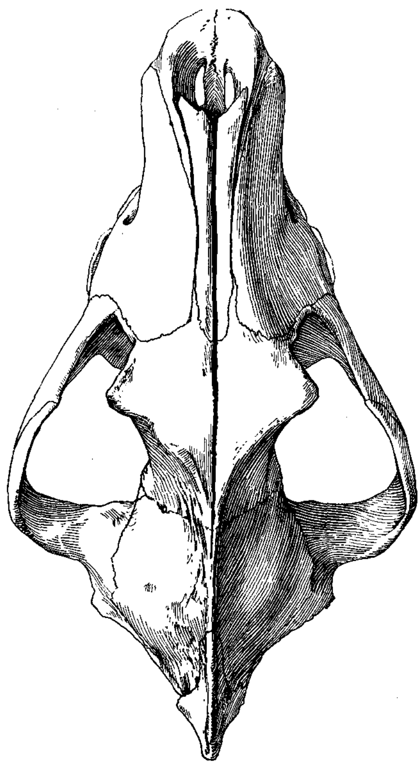


FIG. 75. *Canis dirus*. × .3. Upper side of skull. From Rancho La Brea, California.

to give figures of one of the skulls. This skull belongs to the paleontological department of Princeton University, where the writer has examined it. Opportunity, too, has been used to examine another skull at Princeton and two more which Dr. Merriam has sent to the U. S. National Museum. The drawings of the skull were made by the artist, Mr. Bruce Horsfall, of Princeton, N. J.

In the skull figured (Figs. 74-77), all the incisors are missing, both first premolars (restored from the other skull in the side view), and the left second premolar. The hinder true molar is also restored from another skull. The zygomatic arches are partly restored. The following measurements were taken, and in the second column the corresponding measurements from a skull of a large wolf from Texas:

MEASUREMENTS TAKEN.	C. dirus.	C. occidentalis.
Front of premaxillæ to hinder end of occipital crest	300 mm.	253 mm.
Front of premaxillæ to hinder end of occipital condyles	260 mm.	235 mm.
Width of skull across zygomatic arches	170 mm.	128 mm.
Width of skull at rear of pm.^{4}	100 mm.	78 mm.
Width of skull at rear of pm.^{1}	53 mm.	44 mm.
Width at interorbital space, least	62 mm.	41 mm.
Width across postorbital processes	85 mm.	54 mm.
Width at constriction behind postorbital processes	50 mm.	43 mm.
Fore-and-aft diameter of orbit	45 mm.	37 mm.
Distance from m.^{2} to front of articulation for lower jaw	55 mm.	50 mm.
Width of posterior nares	30 mm.	21 mm.
Long diameter of auditory bulla	29 mm.	29 mm.
Outside of one bulla to that of the other	75 mm.	65 mm.
Front of premaxillæ to posterior nares	138 mm.	123 mm.
Front of canine to rear of m.^{2}	123 mm.	101 mm.
Canine, diameter fore and aft	18 mm.	15 mm.
Canine, width	13 mm.	9 mm.
Pm.^{2}, length	16 mm.	15 mm.
Pm.^{2}, width	8 mm.	7 mm.
Pm.^{3}, length	19 mm.	16 mm.
Pm.^{3}, width	9.5 mm.	7 mm.
Pm ^{4}, length	32 mm.	25 mm.
Pm.^{4}, width behind the claw	13 mm.	12 mm.
M.^{1}, length	19.5 mm.	16 mm.
M.^{1}, width	25 mm.	22 mm.
M.^{2}, length	11 mm.	9 mm.
M.^{2}, width	16 mm.	13 mm.
Lower jaw from front to rear of condyle	212 mm.	185 mm.
Height of jaw between pm.$_2$ and pm.$_3$	33 mm.	26 mm.
Height of jaw between m.$_1$ and m.	40 mm.	32 mm.
Canine tooth, fore-and-aft diameter	18 mm.	15 mm.
Canine tooth, transverse diameter	13 mm.	10 mm.
Pm.$_1$, length	6 mm.	6 mm.
Pm.$_1$, width	5 mm.	5 mm.
Pm.$_2$, length	16 mm.	14 mm.
Pm.$_2$, width	7 mm.	6.5 mm.
Pm.$_3$, length	16.5 mm.	14.5 mm.
Pm.$_3$, width	8 mm.	6.5 mm.
Pm.$_4$, length	20 mm.	16 mm.
Pm.$_4$, width	10 mm.	9 mm.
M.$_1$, length	35 mm.	29 mm.
M.$_1$, width	13 mm.	12 mm.
M.$_2$, length	13 mm.	12.5 mm.
M.$_2$, width	10 mm.	9 mm.
M.$_3$, length	10 mm.	....
M.$_3$, width	15 mm.	....

A comparison of the measurements of the two skulls shows that that of *C. dirus* is considerably larger than that of the living wolf. Also, there are other differences. The skull is wider across the zygomatic arches, across the snout and across the interorbital space; the posterior nares are relatively wider, and the premolar-molar series of teeth is longer. The canines are thicker from side to side. The forehead of *C. dirus* is more concave in profile than is that of the Texas wolf.

In the Fourteenth Annual Report of this Survey, Cope and Wortman discussed this wolf under the name of *Canis lupus.* They presented a table of measurments designed to show the great variability of the existing wolves comprehended under this name,

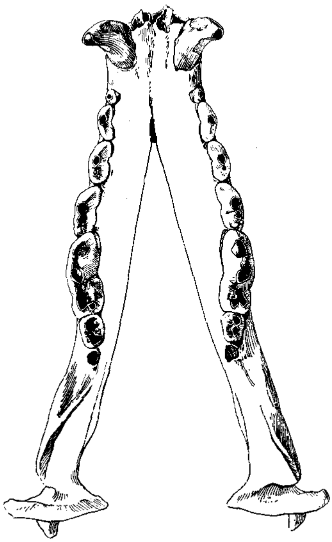


Fig. 77.

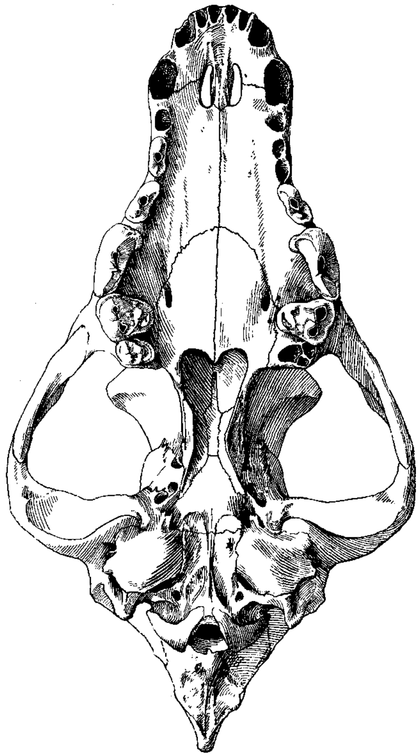


Fig. 76.

Figs. 76, 77. *Canis dirus.* × .3. Views showing tooth-bearing surfaces.

and they concluded that Leidy's type belonged to the existing species, notwithstanding the fact that it was considerably larger than any of the known living American forms. One error into which they fell was that of including in their calculations more than one species of living wolf.

In the U. S. National Museum there is a skull of *Canis pambasileus* Elliot, No. 9001, from Fort Simpson, Mackenzie. Its length from the snout to the occipital condyles is 265 mm., a little larger than the Princeton skull measured above. The forehead is concave in *C. dirus.* It is only 158 mm. wide across the zygomatic arches; only 91 mm. wide at pm.^{4}, and 50 mm. at pm.^{1}. The hinder nares are not so wide as in *C. dirus,* only 21 mm., and the anterior inwardly directed claw of pm.^{4} is much larger than in *C. dirus.*

The present writer has had no opportunity to examine other parts of the skeleton of *C. dirus* than the skull. The animal was evidently larger than any of the wolves living in the United States, but was about the size of some of the wolves of the Arctic regions.

As the type of the species was discovered below Evansville in company with a vertebra of a horse, it is probable that the wolf lived before the Wisconsin ice stage.

CANIS LATRANS Say.

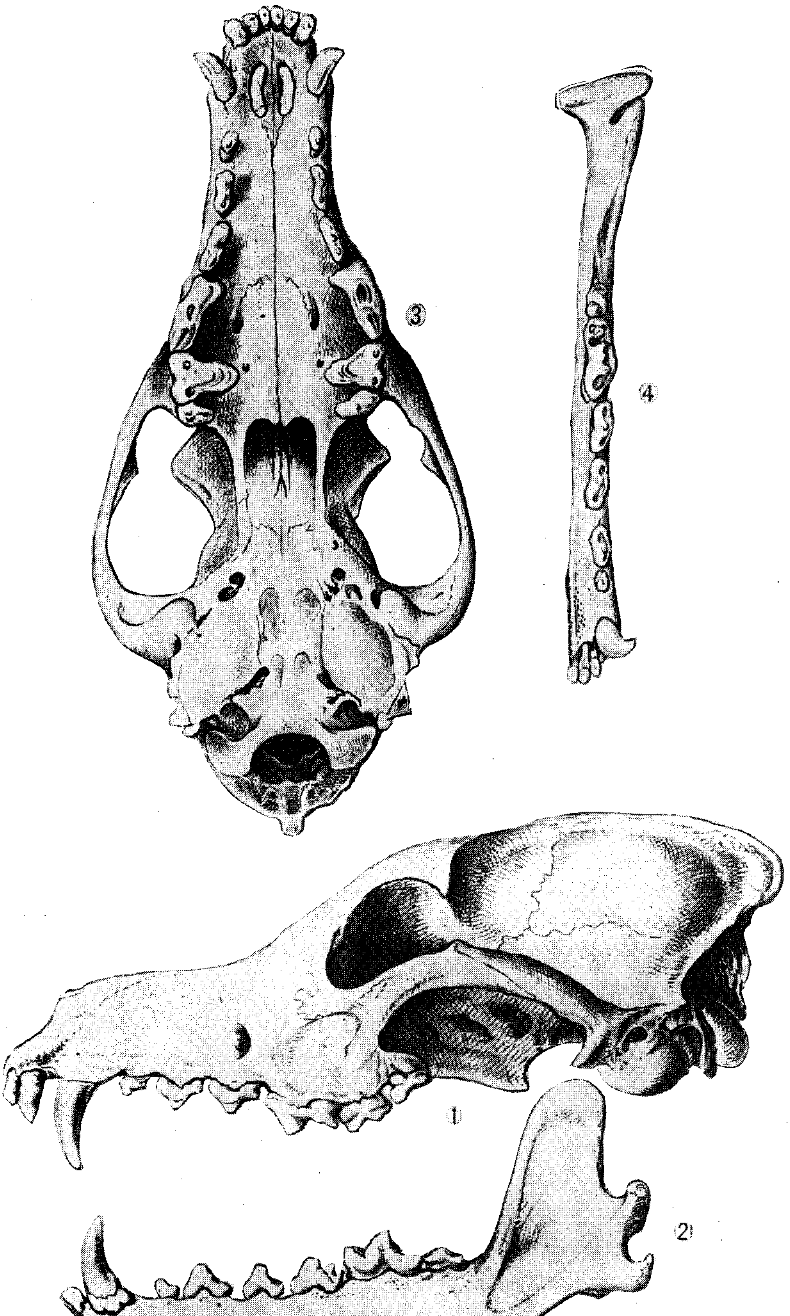
THE COYOTE.

The coyote belongs among the smaller species of wolves. Its present range is from northwestern Indiana to Missouri and northwest to the headwaters of the Mackenzie River. For a history of occurrences in Indiana within historical times, the reader may consult Walter L. Hahn's article in the Thirty-third Annual Report of this Survey. As late as 1870 it was observed at Vincennes. At one time it seems to have become nearly extinct in Indiana, but in recent years it has been increasing in numbers and extending its range.

Geologically, it seems to have existed since the early part of the Pleistocene, having been found in Oregon and Nebraska in company with extinct horses and camels. The reference to this species of remains found in California, and even those found in Oregon, may be erroneous.

In the Fourteenth Annual Report of this Survey, Cope and Wortman published an article on the Pleistocene mammals of Indiana. On page 7 of this report they stated that some remains of what appeared to be a coyote had been discovered in Boone County, in association with the remains of a mammoth. The remains consisted of the proximal parts of both humeri, the distal extremity of the left humerus, the shaft of a radius, and the distal parts of a left tibia. They say, however, that these bones cannot be distinguished from those of certain breeds of domestic dogs. Inasmuch, on the other hand, as it is stated that the bones were found associated with those of the mammoth, it is hardly probable that they belonged to a domestic dog. That the coyote should occur

PLATE XXXI.



Canis latrans. × .55. Views of the skull. After Baird. Fig. 1. Side view. Fig. 2. Lower jaw, side view. Fig. 3. Palatal surface of skull. Fig. 4. Lower jaw, to show the teeth.

there is not particularly remarkable. However, since the bones and teeth of the various wolves resemble closely those of domestic dogs it is necessary that finders should note well the conditions of soil, depth, etc., under which the bones are discovered, not rejecting, however, too readily bones that may resemble those of dogs.

For purposes of distinguishing remains of this species the following measurements are furnished. Those of the skull are taken from No. 12893, U. S. National Museum:

Front of premaxillæ to end of occipital crest	190	mm.
Front of premaxillæ to end of occipital condyles	178	mm.
Width of skull at ear-opening	55	mm.
Width of skull across zygomatic arches	93	mm.
Width of skull at $pm.^4$	58	mm.
Width of skull at $pm.^1$	28	mm.
Width of skull at interorbital space, least	30	mm.
Width of skull across postorbital processes	44	mm.
Width of skull behind postorbital processes	32	mm.
Diameter of orbit, fore and aft	28	mm.
Distance from $m.^2$ to front of articulation for lower jaw	28	mm.
Width of posterior nares	16	mm.
Long diameter of auditory bulla	21	mm.
Front of premaxillæ to rear of hard palate	92	mm.
Front of canine to rear of $m.^2$	89	mm.
Canine, upper, diameter fore and aft	13	mm.
Canine, upper, diameter side to side	6.5	mm.
Canine, lower, diameter fore and aft	9	mm.
Canine, lower, diameter side to side	6	mm.

TEETH.	Measurements.	TEETH.	Measurements.
$Pm.^2$	Length... 11 mm.	$Pm._2$	Length.... 11 mm.
$Pm.^2$	Width..... 4 mm.	$Pm._2$	Width..... 4 mm.
$Pm.^3$	Length.... 12.5 mm.	$Pm._3$	Length.... 12 mm.
$Pm.^3$	Width..... 4.4 mm.	$Pm._3$	Width..... 5 mm.
$Pm.^4$	Length.... 20 mm.	$Pm._4$	Length.... 13 mm.
$Pm.^4$	Width, behind claw. 7.5 mm.	$Pm._4$	Width..... 6 mm.
$M.^1$	Length.... 13 mm.	$M._1$	Length.... 23 mm.
$M.^1$	Width..... 17 mm.	$M._1$	Width..... 8 mm.
$M.^2$	Length.... 7 mm.	$M._2$	Length.... 10 mm.
$M.^2$	Width.... 11 mm.	$M._2$	Width..... 6 mm.
		$M._3$	Length.... 4.5 mm.
		$M._3$	Width..... 3.3 mm.

The following measurements are taken from a specimen in the U. S. National Museum, the skull of which had a length to the condyles of 165 mm. Therefore the skeleton may be slightly undersized.

Scapula, length parallel with spine	107 mm.
Scapula, width of upper end	82 mm.
Humerus, total length	155 mm.
Humerus, from head to distal end	150 mm.
Humerus, fore-and-aft diameter at middle of shaft	11 mm.
Radius, length	160 mm.
Ulna, total length	255 mm.
Pelvis, from front of ilium to rear of ischium	112 mm.
Pelvis, width at acetabulum	55 mm.
Pelvis, width near hinder end of ischium	83 mm.
Femur, length from head to distal end	160 mm.
Femur, length from great trochanter to distal end	158 mm.
Femur, diameter at middle of shaft	10 mm.
Tibia, total length	178 mm.
Tibia, diameter at middle of shaft	10 mm.
Fibula, total length	168 mm.

In the effort to determine whether a particular canine skull belonged to the coyote or to some breed of common dog, one must take into account first the size of the skull and then its general form. The skull of the coyote is long, relatively narrow, with elongated narrow snout. The canine teeth of the coyote are relatively longer and thicker than those of the domestic dogs. In fact, all of the teeth are larger in proportion to the length of the skull than in the domestic dogs, and the cusps and ridges are more prominent, as seen in the little worn teeth.

Since Boone County, Indiana, the place where the specimens examined by Cope and Wortman, is within the area of the Wisconsin drift-sheet, it is probable that the animal lived after the passing of the last glacial ice.

Report of State Natural Gas Supervisor.

OFFICE OF STATE NATURAL GAS SUPERVISOR,
FORTVILLE, INDIANA.

Hon. Edward Barrett, State Geologist, Indianapolis, Indiana:

SIR—I hereby transmit to you the twentieth annual report of this department. I began the duties of this office January 1, 1911. Since that time, for reasons explained in this report, it has not been possible for me to give much time to either collecting material for report, or compiling data. However, I will endeavor to report to you conditions found in the field at the time of taking the office, and such data regarding the field as should concern those who are interested in the natural gas industry.

In closing this, my first year's work, I am pleased to acknowledge the very cordial support and valuable suggestions that I have received from you from the beginning.

Very respectfully,

W. E. MORSE,
State Natural Gas Supervisor.

Report of State Natural Gas Supervisor for the Year 1911.

Under the law, it is the duty of the State Natural Gas Supervisor to make a personal inspection of all gas and oil wells so far as it is practical, and see that every precaution is taken to insure the health and safety of all workmen engaged in the work of opening gas wells and laying mains and pipes, and of all those who in any manner use natural gas either for mechanical, manufacturing, domestic or other purposes. I have inspected all wells and lines possible while attending to more important duties, at least enough in the different sections of the field to give me accurate ideas of the condition of the gas supply and of the safety of all workmen engaged in the gas industry. However, I find that the contractors of gas companies and manufactories employ the most skilled workmen possible, men who understand the dangers attending the handling of natural gas.

My especial attention has been paid to the husbanding of gas and the plugging of abandoned wells which, up to this time, have bettered the condition of the field to a great extent.

In my visits over the field during the months of January, February and March, I found the following conditions in the southern field where there are about one hundred twenty-five (125) wells that are producing both oil and gas. In the greater number of those wells where there was a surplus of gas, there had been no arrangements made for husbanding the extra gas which could not be used in operating the machinery in pumping oil. I found wells that were making from five (5) to forty (40) barrels of oil per day and wasting from five thousand (5,000) to three million (3,000,000) feet of gas per day. When these conditions were discovered, I proceeded at once to have these wells closed in. I found that the law is inadequate to reach the purpose for which it was intended, the penalty for violations being omitted, but by keeping after violators and using the laws that were good I have accomplished the following: There are no wells standing open and but very little gas being wasted. The operators are now piping the gas to small villages, and farmers are utilizing it for domestic purposes.

Greene County.

I found the same conditions in Greene County as in Pike County with not so *much* waste of gas, but more in proportion. One well on Moses Kaufman's farm, which had been standing open for four years, making about one million feet of gas and flowing about sixty barrels of salt water, I proceeded to plug and close in, as nearly as could be done under the conditions which the well was left in, using four yards of gravel, two wooden plugs and two lead plugs.

OLD FIELDS.

In the old fields where there are but a few oil operators I have not had one single complaint of waste of gas, and leases are now being closed down that would pay a good royalty if there was gas with which to operate their machinery. In opening up a new field for oil, one of the principal things which is looked for is the gas, without which it is very expensive to operate.

The thing which I have most to look after in the old fields is the plugging of the abandoned wells and those which are standing open and allowing the fresh water to leak down into the oil and gas-bearing rock. It has often been said that forty acres of farm ground could be drained into one abandoned gas well and by such methods as were used years ago and continued until this date (implying both gas and oil wells), both lime and gravel water would have been ruined for use. Also the water would have been lowered to such an extent that the average man would not have been able to have wells of his own. Statistics show the water has been lowered now twenty-six (26) feet by the old method of plugging gas wells.

NEW DEVELOPMENT.

There is no great attraction at any point of the State at this time and less work is in progress now than for some time, mainly for two reasons. The oil market has been too low to justify investments, and when oil is found there has been a great amount of gas for which there has been no market until within the last few months. There have been several deep tests made. One in Howard County, another in Owen County. The Howard County well was drilled to more than four thousand feet, where two different pays of gas were struck, the first at about sixteen hundred feet, and another at about twenty-nine hundred feet, with a great amount of water. The Owen County well was drilled to thirty-three hundred feet. At this point an obstruction was encountered and further drilling stopped. At two thousand eight hundred feet, sand was struck, which produced some oil and gas with a pressure of three hundred fifty pounds. This sand was drilled through and water raised in the well twenty-four hundred feet.

In Daviess County, near Alfordsville, the Graham Brothers of Loogootee have drilled six wells, which range in depth from four hundred sixty to four hundred eighty feet. They produce six million feet of gas per day.

In Sullivan County there have been some new developments. About seven miles southwest of Sullivan there has been some oil found which promises that there will be some very early drilling done there. At this time there are seven wells which are producing about seventy barrels daily, and north and east of the oil wells some very good gas wells are being found.

In Knox County there seems to be some excitement which promises some very deep drilling.

In the old field there has been some drilling which has been profitable to the investors, both in gas and oil wells.

Value of Natural Gas Produced in Indiana, 1886 to 1909.

Year.	Value.
1886	$300,000
1887	600,000
1888	1,320,000
1889	2,075,702
1890	2,302,500
1891	3,942,500
1892	4,716,000
1893	5,718,000
1894	5,437,000
1895	5,203,200
1896	5,043,635
1897	5,009,208
1898	5,060,969
1899	6,680,370
1900	7,254,539
1901	6,954,566
1902	7,081,344
1903	6,098,364
1904	4,542,409
1905	3,094,134
1906	1,750,715
1907	1,572,605
1908	1,312,507
1909	1,616,903
1910	1,702,243

Production of Oil.

Year.	Barrels.
1889	33,375
1890	63,496
1891	136,634
1892	698,068
1893	2,335,293
1894	3,688,666
1895	4,386,132
1896	4,680,732
1897	4,122,356
1898	3,730,907
1899	3,848,182
1900	4,874,392
1901	5,757,086
1902	7,480,896
1903	9,186,411
1904	11,339,124
1905	10,964,247
1906	7,673,477
1907	5,128,037
1908	3,283,629
1909	2,296,086
1910	2,159,725
	97,866,951

Number of producers, 1,010.

Number of wells closed in, ranging from ten pounds to five hundred pound pressure, 89.

Number of wells in use, 2,643; with an average pressure of 79½ pounds.

The average price of gas is 28½ cents per thousand.

Number of wells abandoned, both oil and gas, 2,032; of which some were dusters.

EXPENSES OF MAINTAINING AND FEES COLLECTED BY THIS DEPARTMENT.

Appropriated by the State—		
For salary Supervisor of Natural Gas per year	$1,800 00	
For expenses Supervisor of Natural Gas	1,500 00	
For Assistant Supervisors of Natural Gas	1,000 00	
Fees collected	10,150 00	
Total		$14,450 00
Expenses—		
For salary Supervisor of Natural Gas per year	$1,800 00	
For expenses Supervisor of Natural Gas	466 34	
For Assistant Supervisors of Natural Gas	518 85	
Paid to assistants from fees collected	10,135 00	
Total		$12,920 19
Summary—		
Amount returned to State from appropriation for assistants		$481 15
Amount returned to State from appropriation for traveling expenses		1,033 66
Amount returned to State from fees collected		15 00
Total returned to State		$1,529 81
Total cost to State to maintain office for one year		$2,770 19

Reports of Frank W. Boren, Owensville, and W. J. Richardson, Winslow, Assistants, Who are in the Southern Field Every Week.

The first of the year the condition of the Oakland City oil field was bad. Gas was wasted by the millions of feet in various ways. Gas lines were leaking, and in many instances on fire. Flambeau lights were numerous and oil wells that produced gas, the gas was allowed to escape into the air. One well was not pumped, and gas was often used to force oil in tanks, then blown into the air.

The field at this time shows great improvement. All gas lines are in good condition. No lights and little waste in any other way. Oil and gas producing wells are either shut in or piped to gas mains and used for leases and small towns adjoining the field.

There is no decrease in the gas, and with proper care will be plentiful for several years.

W. J. Richardson,
Assistant Supervisor of Natural Gas.

THE SOUTHERN INDIANA FIELD.

Contrary to expectations, the year 1911 has been a discouraging one for the operators in the Southern Indiana field. The Oakland City or Pike County territory, which a year ago showed prospects of developing into the greatest oil and gas field in the State, has proved a disappointment, despite every effort of the operators and an enormous outlay of money.

On account of the uncertainty of finding oil or gas in tested territory, the great expense of drilling coupled with the gradual decline in oil production of the older wells (many of which have been plugged the past season), there has been a general exodus of contractors and workers. Experienced oil operators are of the opinion that so far as the production of oil is concerned the territory has spent itself, and present conditions therein bear them out in the idea. Another serious detriment which confronts the oil operator in this field is the finding of wells producing both oil and gas.

In conforming with the present gas laws, it is impossible to operate a mixed well without a market for the gas. Until recently there has been very little effort to market the apparent inexhaustible supply of gas found in this field; however, they are at present taking steps to overcome this difficulty by laying pipe lines to neighboring towns in all directions. While it is true that there are perhaps one hundred gas wells (some of the strongest in the State) capped, waiting for a market, the manufacturing interests are slow to invest their money in that locality, fearing a repetition of conditions which occurred in the upstate fields.

In the Princeton or Gibson County field which was opened up in 1903-1904, the supply of gas is practically exhaused and the oil supply greatly diminished. The Ohio Oil Company is making an effort to increase its production here by shooting and cleaning its wells. At this time we are unable to determine the result of this experiment. In noting the difference in conditions in the southern territory during the past year, we find the year opened with perhaps no less than fifty or sixty strings of tools in operation, while today they will not exceed six or eight.

This office has experienced very little trouble in its dealings with the operators in this territory, as they not only show a willingness to conform with the State laws governing operations, but manifest a great interest in the preservation and development of the territory in general.

FRANK W. BOREN,
Assistant Supervisor of Natural Gas.

Hypsometry of Indiana.

By Edward Barrett.

The importance of a complete topographic survey of the State is strikingly set forth in a bulletin issued in 1910 by the U. S. Geological Survey, George Otis Smith, Director, as follows:

The State gains a complete topographic map of its area, which is of importance to the development of its economic resources and greatly facilitates the study and perfection of all engineering plans and works within it. Among other uses of the topographic maps are the following:

1. As preliminary maps for planning extensive irrigation and drainage projects, showing areas of catchment for water supply, sites for reservoirs, routes of canals, etc.

2. For laying out highways, electric roads, railroads, aqueducts, and sewage systems, thus saving the cost of preliminary surveys.

3. In improving rivers and smaller waterways.

4. In determining and classifying water resources, both surface and underground.

5. In making plans for the disposal of city sewage, garbage, etc.

6. In determining routes, mileage, location of road-building material, and topography in country traversed by public highways.

7. In selecting the best routes for automobiling tours and intercity runs.

8. As guide maps for prospectors and others in traveling through little-known regions.

9. As bases for the compilation of maps showing the extent and character of forest and grazing lands.

10. In classifying lands and in plotting the distribution and nature of the soils.

11. In compiling maps in connection with the survey and sale of lands.

12. In making investigations for the improvement of the plant and animal industries, and in a comprehensive study of physical and biological conditions in connection with the stocking of interior waters with food fishes and the locating of fish culture stations.

13. In locating and mapping the boundaries of the life and crop zones, and in mapping the geographic distribution of plants and animals.

14. In plotting the distribution and spread of injurious insects and germs.

15. As base maps for the plotting of information relating to the geology and mineral resources of the country.

16. In maneuvers of the national guard, in the development of military problems, and in the selection of routes for road marches or strategical movements of the troops, particularly of artillery or cavalry.

17. In connection with questions relating to State, county, and town boundaries.

18. As a means of promoting an exact knowledge of the country and serving teachers and pupils in geographic studies.

19. As base maps for the graphic representation of all facts relating to population, industries, and products or other statistical information.

20. In connection with legislation involving the granting of charters, rights, etc., when a physical knowledge of the country may be desirable or necessary.

This is an age of exact knowledge. Those responsible for private, corporate, and public enterprises are no longer satisfied with guess work. Before investment is ventured, exact scientific and mathematical facts are demanded. The wiseacre who "knows the ground like a book" has given way to the surveyor's transit and chain.

In the absence of a complete topographic survey, the following distance and altitude tables are incorporated in this report, with the hope that they will be useful to parties interested in this work, and that their publication may be a step toward a larger and more perfect survey that the State will make in the near future. Every railroad in the State responded cheerfully with profiles, except four branch roads, as follows: New York Central, from Connersville south to Indiana-Ohio State line; Cincinnati, Bluffton and Chicago, from Portland, Indiana, through Bluffton to Huntington; Louisville, New Albany and Corydon, from Corydon Junction to Corydon; Louisville and Nashville from Evansville west through Mt. Vernon to the Indiana-Illinois State line. The management of these branch roads had no exact profiles to furnish us.

To the chief engineers, Presidents, Superintendents and managers of all the railroads operating in Indiana our kindest thanks are extended for courtesies and help in the preparation of these tables.

ILLINOIS CENTRAL RAILROAD.

Branch Between Wabash River and Evansville.

Distances from Chicago.	Stations.	State.	County.	Elevation.
216.5	Hovey	Indiana	Posey	392.0
218.0	Hartlein	Indiana	Posey	392.0
220.0	Griffin	Indiana	Posey	392.0
222.5	Barrett	Indiana	Posey	396.0
225.5	Stewartsville	Indiana	Posey	477.0
228.5	Poseyville	Indiana	Posey	430.0
233.0	Wendel	Indiana	Posey	450.0
235.0	Martin	Indiana	Vanderburgh	437.0
237.0	Armstrong	Indiana	Vanderburgh	479.0
239.0	Wilcox	Indiana	Vanderburgh	537.0
241.8		Indiana	Vanderburgh	418.0
244.5	Harwood	Indiana	Vanderburgh	391.0
247.0	Evansville	Indiana	Vanderburgh	374.0

New Harmony Branch.

225.5	Stewartsville	Indiana	Posey	473.0
228.4	Rogers	Indiana	Posey	4[illegible]6.0
231.5	New Harmony	Indiana	Posey	384.0

Branch Between Illinois State Line and West Lebanon.

66.4	Thomas	Indiana	Warren	703.0
68.5	Hedrick	Indiana	Warren	709.0
69.5	Sloan	Indiana	Warren	713.0
74.6	West Lebanon	Indiana	Warren	689.0

INDIANAPOLIS SOUTHERN RAILROAD.

Indianapolis Division.

Distances from Indianapolis.	Stations.	State.	County.	Elevation.
0.0	Indianapolis	Indiana	Marion	707.0
1.0		Indiana	Marion	713.0
2.0		Indiana	Marion	692.0
3.0		Indiana	Marion	696.0
4.3	Lenore	Indiana	Marion	692.0
6.5	Gravel Pit	Indiana	Marion	708.0
8.3	Glenn Valley	Indiana	Marion	711.0
11.7	Frances	Indiana	Johnson	768.0
15.0		Indiana	Johnson	803.0
17.5	Bargersville	Indiana	Johnson	827.0
19.5		Indiana	Johnson	854.0
24.3	Anita	Indiana	Johnson	821.0
26.0		Indiana	Johnson	800.0
28.0		Indiana	Johnson	747.0
30.0	Morgantown	Indiana	Morgan	692.0
33.0		Indiana	Brown	797.0
35.5		Indiana	Brown	726.0
38.5		Indiana	Brown	676.0
41.3	Trevlac	Indiana	Brown	654.0
46.0		Indiana	Monroe	740.0
49.6		Indiana	Monroe	865.0
51.0		Indiana	Monroe	871.0
54.0		Indiana	Monroe	845.0
55.6	Bloomington	Indiana	Monroe	826.0
59.0		Indiana	Monroe	858.0
61.0	Kirby	Indiana	Monroe	841.0

INDIANAPOLIS SOUTHERN RAILROAD—Continued.

Distances from Indianapolis.	Stations.	State.	County.	Elevation.
65.0	Elwren	Indiana	Monroe	845.0
68.0		Indiana	Greene	812.0
70.0		Indiana	Greene	792.0
70.2	Solsberry	Indiana	Greene	785.0
74.0		Indiana	Greene	712.0
77.5	Tulip	Indiana	Greene	652.0
82.0		Indiana	Greene	557.0
83.0	Bloomfield	Indiana	Greene	542.0
87.0		Indiana	Greene	524.0
89.5	Switz City	Indiana	Greene	527.0
91.0		Indiana	Greene	839.0
93.0		Indiana	Greene	517.0
95.0	Linton	Indiana	Greene	517.0
97.3	Summit	Indiana	Greene	526.0
98.0		Indiana	Greene	501.0
100.0		Indiana	Greene	582.0
101.2	Dugger	Indiana	Sullivan	606.0
103.0	Cass	Indiana	Sullivan	575.0
106.3	Caledonia	Indiana	Sullivan	500.0
109.0		Indiana	Sullivan	594.0
110.0	Sullivan	Indiana	Sullivan	502.0
112.0	Van Dusen Spur	Indiana	Sullivan	508.0
114.3	New Lebanon	Indiana	Sullivan	535.0
116.0		Indiana	Sullivan	510.0
118.5	Merom	Indiana	Sullivan	445.0
120.5	Riverton	Indiana	Sullivan	452.0

TOLEDO, ST. LOUIS AND WESTERN RAILROAD.

Distances from Toledo, O.	Stations.	State.	County.	Elevation.
100.0	Indiana-Ohio Line			800.7
101.0		Indiana		795.9
102.0		Indiana		802.7
103.0	Pleasant Mills	Indiana	Adams	799.4
104.0		Indiana	Adams	797.0
105.0		Indiana	Adams	800.1
106.0		Indiana	Adams	804.0
107.0		Indiana	Adams	802.2
108.0		Indiana	Adams	795.6
108.3	Decatur	Indiana	Adams	800.3
109.0		Indiana	Adams	804.9
110.0		Indiana	Adams	809.0
111.0		Indiana	Adams	815.0
112.0		Indiana	Adams	815.6
113.0		Indiana	Adams	822.0
113.3	Peterson	Indiana	Adams	817.0
114.0		Indiana	Adams	823.8
115.0		Indiana	Adams	829.0
116.0		Indiana	Adams	835.6
117.0		Indiana	Adams	846.3
118.0		Indiana	Adams	851.0
119.0		Indiana	Adams	859.5
120.0		Indiana	Adams	855.2
121.0		Indiana	Adams	830.3
122.0		Indiana	Adams	824.0
123.0		Indiana	Adams	814.5
123.5	Bluffton	Indiana	Wells	829.0
124.0		Indiana	Wells	833.0
125.0		Indiana	Wells	836.6
126.0		Indiana	Wells	843.0
127.0		Indiana	Wells	846.6
128.0		Indiana	Wells	850.0
129.0		Indiana	Wells	836.5
129.5	Liberty Centre	Indiana	Wells	845.5
130.0		Indiana	Wells	847.7
131.0		Indiana	Wells	851.8
132.0		Indiana	Wells	858.8

TOLEDO, ST. LOUIS AND WESTERN RAILROAD—Continued.

Distances from Toledo, O.	STATIONS.	State.	County.	Elevation.
133.0		Indiana	Wells	859.0
133.5	Buckeye	Indiana	Huntington	859.0
134.0		Indiana	Huntington	864.0
135.0		Indiana	Huntington	865.3
136.0		Indiana	Huntington	866.0
137.0		Indiana	Huntington	836.3
137.4	Warren	Indiana	Huntington	832.3
138.0		Indiana	Huntington	828.2
139.0		Indiana	Huntington	845.0
140.0		Indiana	Huntington	848.3
141.0		Indiana	Huntington	841.0
142.0		Indiana	Huntington	842.7
143.0		Indiana	Huntington	854.1
144.0	Van Buren	Indiana	Grant	845.4
145.0		Indiana	Grant	856.4
146.0		Indiana	Grant	858.0
146.7	Landess	Indiana	Grant	866.2
147.0		Indiana	Grant	869.0
148.0		Indiana	Grant	875.0
149.0		Indiana	Grant	874.8
150.0		Indiana	Grant	854.6
151.0		Indiana	Grant	837.6
152.0		Indiana	Grant	817.1
153.0		Indiana	Grant	804.8
153.6	Marion	Indiana	Grant	802.0
154.0		Indiana	Grant	814.1
155.0		Indiana	Grant	823.8
156.0		Indiana	Grant	848.4
156.4	Kiley	Indiana	Grant	849.3
157.0		Indiana	Grant	847.8
158.0		Indiana	Grant	846.3
159.0		Indiana	Grant	848.8
159.1	Roseburgh	Indiana	Grant	847.6
160.0		Indiana	Grant	852.8
161.0		Indiana	Grant	854.0
162.0		Indiana	Grant	856.3
162.2	Herbst	Indiana	Grant	856.0
163.0		Indiana	Grant	855.9
164.0		Indiana	Grant	861.2
164.3	Swayzee	Indiana	Grant	862.3
165.0		Indiana	Grant	863.5
166.0		Indiana	Grant	860.0
166.1	Sims	Indiana	Grant	859.8
167.0		Indiana	Grant	858.2
168.0		Indiana	Grant	856.0
169.0		Indiana	Grant	850.2
169.4	Sycamore	Indiana	Howard	851.5
170.0		Indiana	Howard	852.8
171.0		Indiana	Howard	852.0
172.0	Greentown	Indiana	Howard	840.6
173.0		Indiana	Howard	830.0
174.0		Indiana	Howard	827.0
175.0		Indiana	Howard	828.6
175.8	Vermont	Indiana	Howard	828.2
176.0		Indiana	Howard	826.2
177.0		Indiana	Howard	820.4
178.0		Indiana	Howard	817.7
179.0		Indiana	Howard	821.8
180.0		Indiana	Howard	817.2
181.0		Indiana	Howard	816.6
181.3	Kokomo	Indiana	Howard	813.8
182.0		Indiana	Howard	812.2
183.0		Indiana	Howard	795.0
184.0		Indiana	Howard	808.7
185.0		Indiana	Howard	825.8
186.0		Indiana	Howard	822.6
187.0		Indiana	Howard	821.8
187.1	Middletons	Indiana	Howard	822.2
188.0		Indiana	Howard	831.0
189.0		Indiana	Howard	843.3
190.0		Indiana	Howard	844.9
190.6	Russiaville	Indiana	Howard	848.0
191.0		Indiana	Howard	852.6
192.0		Indiana	Howard	863.1
193.0		Indiana	Howard	877.7
194.0		Indiana	Howard	881.0

TOLEDO, ST. LOUIS AND WESTERN RAILROAD—Continued.

Distances from Toledo, O.	STATIONS.	State.	County.	Elevation.
194.8	Forrest	Indiana	Clinton	878.8
195.0		Indiana	Clinton	877.8
196.0		Indiana	Clinton	870.0
197.0		Indiana	Clinton	866.2
198.0		Indiana	Clinton	861.5
199.0		Indiana	Clinton	866.0
199.2	Michigantown	Indiana	Clinton	866.6
200.0		Indiana	Clinton	862.0
201.0		Indiana	Clinton	875.1
202.0		Indiana	Clinton	873.0
202.1	Avery's	Indiana	Clinton	872.0
203.0		Indiana	Clinton	883.1
204.0		Indiana	Clinton	862.7
205.0		Indiana	Clinton	845.5
206.0		Indiana	Clinton	850.1
206.4	Frankfort	Indiana	Clinton	846.7
207.0		Indiana	Clinton	856.0
208.0		Indiana	Clinton	849.9
209.0		Indiana	Clinton	853.7
210.0		Indiana	Clinton	846.7
210.5	Jefferson	Indiana	Clinton	859.3
211.0		Indiana	Clinton	850.0
212.0		Indiana	Clinton	849.5
213.0		Indiana	Clinton	833.2
214.0		Indiana	Clinton	837.0
215.0		Indiana	Clinton	830.2
215.4	Fickle	Indiana	Clinton	827.3
216.0		Indiana	Clinton	829.1
217.0		Indiana	Clinton	822.4
218.0		Indiana	Clinton	812.5
218.1	Clark's Hill	Indiana	Tippecanoe	818.6
219.0		Indiana	Tippecanoe	813.5
220.0		Indiana	Tippecanoe	805.1
221.0		Indiana	Tippecanoe	800.0
222.0		Indiana	Tippecanoe	791.0
223.0		Indiana	Tippecanoe	786.7
223.9	Kirkpatrick	Indiana	Montgomery	792.0
224.0		Indiana	Montgomery	793.1
225.0		Indiana	Montgomery	798.4
226.0		Indiana	Montgomery	798.7
227.0		Indiana	Montgomery	800.3
228.0		Indiana	Montgomery	791.4
228.6	Linden	Indiana	Montgomery	783.4
229.0		Indiana	Montgomery	779.8
230.0		Indiana	Montgomery	774.7
231.0		Indiana	Montgomery	781.6
232.0		Indiana	Montgomery	782.2
232.6	New Richmond	Indiana	Montgomery	777.9
233.0		Indiana	Montgomery	767.8
234.0		Indiana	Montgomery	759.5
235.0		Indiana	Montgomery	772.8
236.0		Indiana	Montgomery	768.2
237.0		Indiana	Montgomery	764.5
237.9	Wingate	Indiana	Montgomery	771.3
238.0		Indiana	Montgomery	768.2
239.0		Indiana	Montgomery	740.0
240.0		Indiana	Montgomery	720.3
241.0		Indiana	Montgomery	705.7
241.9	Mellott	Indiana	Fountain	699.0
242.0		Indiana	Fountain	698.5
243.0		Indiana	Fountain	686.3
244.0		Indiana	Fountain	675.6
245.0		Indiana	Fountain	675.4
246.0		Indiana	Fountain	662.0
247.0		Indiana	Fountain	631.0
248.0		Indiana	Fountain	696.4
249.0		Indiana	Fountain	588.9
249.4	Veedersburg	Indiana	Fountain	604.3
250.0		Indiana	Fountain	594.9
251.0		Indiana	Fountain	598.6
252.0		Indiana	Fountain	632.8
253.0		Indiana	Fountain	648.4
254.0		Indiana	Fountain	642.1
255.0		Indiana	Fountain	638.7
256.0		Indiana	Fountain	640.2
257.0		Indiana	Fountain	646.8

TOLEDO, ST. LOUIS AND WESTERN RAILROAD—Continued.

Distances from Toledo, O.	Stations.	State.	County.	Elevation.
258.0	....	Indiana........	Fountain......	641.3
258.7	Cates....................................	Indiana........	Fountain......	644.7
259.0	....	Indiana........	Fountain......	637.1
260.0	....	Indiana........	Fountain......	621.7
261.0	....	Indiana........	Fountain......	598.7
262.0	....	Indiana........	Fountain......	563.0
263.0	....	Indiana........	Fountain......	532.5
263.4	Silverwood............................	Indiana........	Fountain......	516.0
264.0	....	Indiana........	Fountain......	499.9
265.0	....	Indiana........	Fountain......	491.3
266.0	....	Indiana........	Fountain......	491.4
266.7	Cayuga..................................	Indiana........	Vermillion.....	504.2
267.0	....	Indiana........	Vermillion.....	522.0
268.0	....	Indiana........	Vermillion.....	572.4
269.0	....	Indiana........	Vermillion.....	610.7
270.0	....	Indiana........	Vermillion.....	628.9
271.0	....	Indiana........	Vermillion.....	616.3
271.2	Indiana-Illinois......................	....	....	626.0

NEW YORK, CHICAGO AND ST. LOUIS RAILROAD.

Distances from Erie Station, Buffalo.	Stations.	State.	County.	Elevation.
353.0	State Line..............................	Indiana........	Allen..........	757.8
353.5	Edgarton................................	Indiana........	Allen..........	758.3
355.0	....	Indiana........	Allen..........	760.3
358.0	Dawkins.................................	Indiana........	Allen..........	769.1
360.0	....	Indiana........	Allen..........	767.9
362.4	....	Indiana........	Allen..........	771.6
364.4	New Haven.............................	Indiana........	Allen..........	758.6
364.6	Wabash Crossing.....................	Indiana........	Allen..........	757.8
365.0	....	Indiana........	Allen..........	759.1
367.0	....	Indiana........	Allen..........	758.1
370.0	....	Indiana........	Allen..........	763.7
371.0	Ft. Wayne..............................	Indiana........	Allen..........	765.1
372.0	L. S. & M. S. Crossing..............	Indiana........	Allen..........	767.6
372.7	G. R. & I. Crossing..................	Indiana........	Allen..........	781.8
376.5	Hadley...................................	Indiana........	Allen..........	840.1
378.0	....	Indiana........	Allen..........	837.1
381.5	Dunfee..................................	Indiana........	Whitley.......	857.1
385.0	....	Indiana........	Whtiley.......	862.1
386.5	Raber....................................	Indiana........	Whitley.......	848.1
389.0	Peabody.................................	Indiana........	Whitley.......	835.1
390.0	....	Indiana........	Whitley.......	839.1
392.4	Arnolds.................................	Indiana........	Whitley.......	806.1
396.5	South Whitley........................	Indiana........	Whitley.......	811.3
396.8	Vandalia R. R. Crossing...........	Indiana........	Whitley.......	811.9
398.0	....	Indiana........	Whitley.......	832.5
401.0	Kinzie...................................	Indiana........	Kosciusko.....	881.0
403.0	Sidney	Indiana........	Kosciusko.....	913.3
405.0	....	Indiana........	Kosciusko.....	921.1
406.0	Packertown............................	Indiana........	Kosciusko.....	918.2
409.0	....	Indiana........	Kosciusko.....	917.1
410.0	Claypool...............................	Indiana........	Kosciusko.....	887.8
411.0	C. C. C. & St. R. R. Crossing	Indiana........	Kosciusko.....	891.5
413.0	....	Indiana........	Kosciusko.....	886.1
415.0	Burkett..................................	Indiana........	Kosciusko.....	867.7
418.0	....	Indiana........	Kosciusko.....	859.1
419.0	Mentone................................	Indiana........	Kosciusko.....	837.1
421.0	....	Indiana........	Marshall......	807.1
424.0	Tippecanoe............................	Indiana........	Marshall......	783.1
425.0	....	Indiana........	Marshall......	783.1
428.0	....	Indiana........	Marshall......	817.1
430.0	L. E. & W. Crossing	Indiana........	Marshall......	823.6
431.0	Argos....................................	Indiana........	Marshall......	820.3
433.0	....	Indiana........	Marshall......	790.8
435.0	....	Indiana........	Marshall......	798.8
437.0	Rutland.................................	Indiana........	Marshall......	796.4

NEW YORK, CHICAGO AND ST. LOUIS RAILROAD—Continued.

Distances from Erie Station, Buffalo.	Stations.	State.	County.	Elevation.
438.0	Hibbard	Indiana	Marshall	782.1
440.0		Indiana	Marshall	777.8
443.0		Indiana	Marshall	758.1
446.0	Ober	Indiana	Starke	740.6
448.0		Indiana	Starke	719.1
451.0	Knox	Indiana	Starke	715.3
454.0		Indiana	Starke	692.1
456.0	Brems	Indiana	Starke	686.1
458.0	Willvale	Indiana	Starke	684.1
460.0		Indiana	Starke	684.6
463.0	Thomaston	Indiana	Starke	687.0
465.0		Indiana	Starke	712.7
468.0	South Wanatah	Indiana	Starke	727.4
470.0		Indiana	Porter	728.1
474.0	Nickel	Indiana	Porter	759.5
477.0	Valparaiso	Indiana	Porter	735.1
479.0		Indiana	Porter	701.1
481.0	Spriggsboro	Indiana	Porter	698.1
484.0	Wheeler	Indiana	Porter	654.6
488.0	Hobart	Indiana	Lake	628.3
490.0		Indiana	Lake	656.1
493.0	Glen Park	Indiana	Lake	636.8
495.0		Indiana	Lake	605.1
498.0	Vanloon	Indiana	Lake	610.3
500.0	Hessville	Indiana	Lake	618.7
503.0	Hammond	Indiana	Lake	597.5
504.0	Erie R. R. Crossing	Indiana	Lake	597.1

EVANSVILLE AND TERRE HAUTE RAILROAD.

Frisco Lines.

Distances from Evansville.	Stations.	State.	County.	Elevation.
0.0	Evansville	Indiana	Vanderburgh	383.0
4.0	State Line Junction	Indiana	Vanderburgh	382.0
5.0	Erskine	Indiana	Vanderburgh	381.0
8.0		Indiana	Vanderburgh	416.0
10.0	Ingle	Indiana	Vanderburgh	470.0
13.0	Staser	Indiana	Vanderburgh	444.0
15.0	St. James	Indiana	Gibson	458.0
17.0	Haubstadt	Indiana	Gibson	473.0
20.0	Ft. Branch	Indiana	Gibson	454.0
21.0	Mt. Vernon Junction	Indiana	Gibson	458.0
24.0	King	Indiana	Gibson	468.0
26.0	Southern Junction	Indiana	Gibson	499.0
27.0	Princeton	Indiana	Gibson	483.0
28.0	Princeton Junction	Indiana	Gibson	459.0
31.0	Patoka	Indiana	Gibson	427.0
33.0	Miller	Indiana	Gibson	494.0
36.0		Indiana	Gibson	429.0
38.0	Hazleton	Indiana	Gibson	424.0
40.0	Decker	Indiana	Knox	435.0
43.0	Bald Hill	Indiana	Knox	420.0
45.0	Purcell	Indiana	Knox	427.0
47.0	Duncan	Indiana	Knox	443.0
49.0		Indiana	Knox	424.0
51.0	Vincennes	Indiana	Knox	422.0
55.0	Ft. Knox	Indiana	Knox	430.0
56.0	Stony Point	Indiana	Knox	525.0
59.0		Indiana	Knox	455.0
61.0	Emison	Indiana	Knox	470.0
64.0	Busseron	Indiana	Knox	465.0
66.0	Oaktown	Indiana	Knox	478.0
69.0	Bellevue Mine	Indiana	Sullivan	464.0
73.0	Carlisle	Indiana	Sullivan	482.0
77.0	Paxton	Indiana	Sullivan	489.0
80.0		Indiana	Sullivan	461.0

EVANSVILLE AND TERRE HAUTE RAILROAD—Continued.

Frisco Lines—Continued.

Distances from Evansville.	Stations.	State.	County.	Elevation
82.0	Sullivan	Indiana	Sullivan	539.0
84.0	Union Mine	Indiana	Sullivan	512.0
86.0	Mildred Mine	Indiana	Sullivan	516.0
88.0	Shelburn	Indiana	Sullivan	541.0
89.0	Standard	Indiana	Sullivan	559.0
94.0	Seifert	Indiana	Vigo	581.0
97.0	Pimento	Indiana	Vigo	603.0
100.0	Young	Indiana	Vigo	578 0
104.0	Spring Hill	Indiana	Vigo	514.0
106.0		Indiana	Vigo	504.0
108.0	Terre Haute	Indiana	Vigo	491.0

EVANSVILLE AND INDIANAPOLIS RAILROAD.

Distances from Evansville.	Stations.	State.	County.	Elevation.
0.0	Evansville	Indiana	Vanderburgh	382.0
2.3	Belt Yard	Indiana	Vanderburgh	388.0
3.5		Indiana	Vanderburgh	383.0
4.5	St. George	Indiana	Vanderburgh	385.0
6.2	McCutchan	Indiana	Vanderburgh	410.0
7.3	Iglehart	Indiana	Vanderburgh	396.0
9.3	Green River Road	Indiana	Vanderburgh	397.0
11.8	Elliott	Indiana	Vanderburgh	411.0
14.7	Elberfeld	Indiana	Warrick	455.0
17.3	Lynn	Indiana	Warrick	399.0
19.7	Buckskin	Indiana	Gibson	424.0
21.8	Mackey	Indiana	Gibson	440.0
23.7	Somerville	Indiana	Gibson	480.0
25.7	Gudgel	Indiana	Gibson	442.0
28.3	Oakland City	Indiana	Gibson	460.0
31.2	Massey	Indiana	Gibson	418.0
33.3	Little	Indiana	Pike	427.0
34.3	Hosmer	Indiana	Pike	435.0
36.6	Clark	Indiana	Pike	464.0
40.2	Petersburg	Indiana	Pike	437.0
43.3	Blackburn	Indiana	Pike	448.0
45.1	Rogers	Indiana	Pike	448.0
47.6	Sandy Hook	Indiana	Daviess	448.0
48.2	Veale	Indiana	Daviess	450.0
49.3	Jacobs	Indiana	Daviess	450.0
51.9	Thomas	Indiana	Daviess	450.0
54.7	Maysville	Indiana	Daviess	450.0
57.6	Washington	Indiana	Daviess	453.0
59.6	Hawkins	Indiana	Daviess	453.0
60.9	Jordan	Indiana	Daviess	455.0
63.2	Graham	Indiana	Daviess	455.0
65.0	Hyatt	Indiana	Daviess	455.0
66.0	Albright	Indiana	Daviess	455.0
69.7	Plainville	Indiana	Daviess	460.0
76.2	Elnora	Indiana	Daviess	465.0
79.2	Slinkard	Indiana	Greene	465.0
81.6	Newberry	Indiana	Greene	473.0
84.7	Lester	Indiana	Greene	473.0
86.3	Plummer	Indiana	Greene	473.0
89.6	Elliston	Indiana	Greene	473.0
93.0	Welsh	Indiana	Greene	473.0
96.2	I. & V. Crossing	Indiana	Greene	473.0
97.7	Worthington	Indiana	Greene	517.0
101.6	Johnstown	Indiana	Greene	517.0
102.7	Hubbell	Indiana	Owen	520.0
105.3	Daggett	Indiana	Owen	630.0
106.5	Coal City	Indiana	Owen	647.0
109.4	Lancaster	Indiana	Clay	593.0
111.5	Clay City	Indiana	Clay	577.0
112.5	Briar Hill	Indiana	Clay	574.0
114.7	Eel River	Indiana	Clay	552.0
117.6	Saline City	Indiana	Clay	556.0

EVANSVILLE AND INDIANAPOLIS RAILROAD—*Continued.*

Distances from Evansville.	STATIONS.	State.	County.	Elevation.
121.9	Cory	Indiana	Clay	619.0
124.0	County Line	Indiana	Clay-Vigo	604.0
127.2	Riley	Indiana	Vigo	562.0
132.4	Spring Hill	Indiana	Vigo	510.0
137.3	Terre Haute	Indiana	Vigo	485.0

CHICAGO AND EASTERN ILLINOIS RAILROAD.

Brazil Branch.

Distances from Chicago.	STATIONS.	State.	County.	Elevation.
62.7	Elmer	Indiana	Newton	670.0
64.3	Pogue	Indiana	Newton	664.0
68.6	Morocco	Indiana	Newton	685.0
71.9	Beaver City	Indiana	Newton	689.0
75.8	Brook	Indiana	Newton	653.0
81.6	Percy Junction	Indiana	Newton	676.0
84.1	Goodland	Indiana	Newton	720.0
89.3	Wadena	Indiana	Benton	800.0
91.3	Lochiel	Indiana	Benton	795.0
94.3	Barce	Indiana	Benton	808.0
96.9	Swanington	Indiana	Benton	796.0
101.8	Oxford	Indiana	Benton	736.0
106.8	Pine Village	Indiana	Warren	702.0
110.1	Chatterton	Indiana	Warren	714.0
112.2	Winthrop	Indiana	Warren	677.0
115.6	Kickapoo	Indiana	Warren	546.0
116.6	Independence	Indiana	Warren	521.0
118.7	Attica	Indiana	Fountain	543.0
122.6	Rob Roy	Indiana	Fountain	634.0
124.9	Aylesworth	Indiana	Fountain	635.0
127.2	Stone Bluff	Indiana	Fountain	622.0
131.3	Veedersburg	Indiana	Fountain	618.0
136.2	Poydras	Indiana	Fountain	654.0
138.4	Yeddo	Indiana	Fountain	689.0
141.6	Kingman	Indiana	Fountain	696.0
145.7	Tangier	Indiana	Parke	615.0
151.8	West Union	Indiana	Parke	523.0
155.3	West Melcher	Indiana	Parke	532.0
159.7	Mecca	Indiana	Parke	494.0
165.8	Coxville	Indiana	Parke	515.0
167.3	Rosedale	Indiana	Parke	530.0
172.2	Coal Bluff	Indiana	Vigo	549.0
180.0	Brazil	Indiana	Clay	640.0

EVANSVILLE AND TERRE HAUTE RAILROAD.

Mt. Vernon Branch.

Distances from Mt. Vernon.	STATIONS.	State.	County.	Elevation.
0.0	Mt. Vernon	Indiana	Posey	380.0
11.0	Oliver	Indiana	Posey	402.6
13.0	Hepburn	Indiana	Posey	401.0
16.0	Wadesville	Indiana	Posey	467.4
19.0	Wilson	Indiana	Posey	419.3
20.0	Poseyville	Indiana	Posey	434.5
25.0	Cynthiana	Indiana	Posey	444.4
26.0	Knowles	Indiana	Gibson	431.2
28.0	Mounts	Indiana	Gibson	446.9
31.0	Owensville	Indiana	Gibson	508.7
38.0	Ft. Branch	Indiana	Gibson	454.0

CHICAGO AND EASTERN ILLINOIS RAILROAD.

Terre Haute Division.

Distances from Chicago.	STATIONS.	State.	County.	Elevation.
129.2	Rileysburg	Indiana	Vermillion	646.0
131.3	Gessie	Indiana	Vermillion	616.0
134.7	Perrysville	Indiana	Vermillion	582.0
137.1	Dickason	Indiana	Vermillion	555.0
139.8	Malone	Indiana	Vermillion	526.0
141.4	Cayuga	Indiana	Vermillion	507.0
144.4	Walnut Grove	Indiana	Vermillion	528.0
147.1	Newport	Indiana	Vermillion	496.0
149.7	Dorner	Indiana	Vermillion	510.0
151.0	Worthy	Indiana	Vermillion	489.0
152.4	Mt. Silica	Indiana	Vermillion	492.0
153.7	West Montezuma	Indiana	Vermillion	488.0
154.7	Hillsdale	Indiana	Vermillion	488.0
155.7	Logan	Indiana	Vermillion	496.0
158.6	Summit Grove	Indiana	Vermillion	520.0
160.6	Norton Crossing	Indiana	Vermillion	493.0
162.5	Jackson	Indiana	Vermillion	495.0
163.1	Clinton	Indiana	Vermillion	494.0
164.4	Lyford	Indiana	Parke	492.0
167.7	Atherton	Indiana	Vigo	520.0
170.1	Evans Line	Indiana	Vigo	520.0
172.0	Otter Creek Junction	Indiana	Vigo	504.0
173.4	Ellsworth	Indiana	Vigo	488.0
174.5	Dewey Yard	Indiana	Vigo	494.0
177.5	Terre Haute	Indiana	Vigo	490 0

Brazil Branch.

172.0	Otter Creek Junction	Indiana	Vigo	504.0
174.9	Burnett	Indiana	Vigo	513.0
177.6	Ehrmanndale	Indiana	Vigo	535.0
180.7	Collins Mine	Indiana	Clay	558.0
184.5	Brazil	Indiana	Clay	641.0

BRANCHES OF CHICAGO AND EASTERN ILLINOIS RAILROAD.

LaCrosse Branch.

Distances from Brazil.	STATIONS.	State.	County.	Elevation.
98.4	Percy Junction	Indiana	Newton	676.0
103.0	Foresman	Indiana	Newton	655.0
105.0	Julian	Indiana	Newton	662.0
108.9	Mount Ayr	Indiana	Newton	704.0
117.9	Fair Oaks	Indiana	Jasper	697.0
121.1	Moffitts	Indiana	Jasper	693.0
122.9	Virgie	Indiana	Jasper	695.0
125.7	Kniman	Indiana	Jasper	696.0
131.5	Wheatfield	Indiana	Jasper	667.0
134.5	Dunns	Indiana	Jasper	668.0
136.3	Burks	Indiana	Porter	671.0
141.0	Wilders	Indiana	LaPorte	673.0
144.4	LaCrosse	Indiana	LaPorte	678.0

Milford Branch.

Distances from Milford.	STATIONS.	State.	County.	Elevation.
10.3	State Line	Indiana	Benton	706.0
12.0	Freeland	Indiana	Benton	720.0

BRANCHES OF CHICAGO AND EASTERN ILLINOIS RAILROAD—Continued.

Rossville & Eastern Branch.

Distances from Rossville Junction.	STATIONS.	State.	County.	Elevation.
6.1	State Line	Indiana	Warren	694.0
7.1	Pence	Indiana	Warren	700.0
10.8	Finney	Indiana	Warren	719.0
13.1	Judyville	Indiana	Warren	771.0

Coal Bluff Branch.

Distances from Coal Bluff.	STATIONS.	State.	County.	Elevation.
0.0	Coal Bluff	Indiana	Vigo	549.0
4.2	Diamond	Indiana	Vigo	625.0

VANDALIA RAILROAD.

St. Louis Division—Indianapolis to East St. Louis.

Distances from Indianapolis.	STATIONS.	State.	County.	Elevation.
0.0	Indianapolis	Indiana	Marion	706.2
1.58	Indianapolis	Indiana	Marion	695.1
8.82	Bridgeport	Indiana	Marion	751.0
10.62	Hobbs	Indiana	Hendricks	794.2
13.56	Plainfield	Indiana	Hendricks	747.5
15.16	Gibson	Indiana	Hendricks	775.7
16.89	Cartersburg	Indiana	Hendricks	775.3
20.15	Clayton	Indiana	Hendricks	865.1
20.81	Summit	Indiana	Hendricks	886.0
22.83	Pecksburg	Indiana	Hendricks	818.7
24.94	Amo	Indiana	Hendricks	817.2
27.97	Coatsville	Indiana	Hendricks	875.9
32.54	Fillmore	Indiana	Putnam	841.2
36.31	Almeda	Indiana	Putnam	839.8
38.89	Greencastle	Indiana	Putnam	819.5
40.29	Limedale	Indiana	Putnam	764.1
43.80	Hamrick	Indiana	Putnam	699.9
47.29	Reelsville	Indiana	Putnam	635.4
50.43	Eagles	Indiana	Clay	674.7
53.63	Harmony	Indiana	Clay	669.6
54.81	Knightsville	Indiana	Clay	675.1
56.96	Brazil	Indiana	Clay	639.6
59.02	Turner	Indiana	Clay	671.9
60.95	Staunton	Indiana	Clay	639.9
64.50	Seelyville	Indiana	Vigo	583.3
71.96	Terre Haute	Indiana	Vigo	488.5
74.35	Macksville	Indiana	Vigo	473.3
76.94	Liggett	Indiana	Vigo	510.8
78.35	Nelson	Indiana	Vigo	507.9

VANDALIA RAILROAD.

Michigan Division—Terre Haute to South Bend.

Distances from Terre Haute.	Stations.	State.	County.	Elevation.
0.0	Terre Haute	Indiana	Vigo	488.5
3.69	Dewey	Indiana	Vigo	492.7
4.35	Ellsworth	Indiana	Vigo	486.7
5.88	Otter Creek Junction	Indiana	Vigo	501.7
8.25	Heckland	Indiana	Vigo	522.7
12.17	Rosedale	Indiana	Parke	535.7
	Rosedale	Indiana	Parke	528.7
14.87	Jessups	Indiana	Parke	528.7
17.77	Catlin	Indiana	Parke	543.7
22.90	Rockville	Indiana	Parke	677.7
26.59	Sand Creek	Indiana	Parke	587.7
29.88	Judson	Indiana	Parke	604.7
32.29	Guion	Indiana	Parke	629.7
	Guion	Indiana	Parke	651.7
36.09	Waveland Junction	Indiana	Montgomery	693.7
37.24	Waveland	Indiana	Montgomery	732.7
40.42	Browns Valley	Indiana	Montgomery	806.7
45.57	New Market	Indiana	Montgomery	802.7
52.47	Crawfordsville	Indiana	Montgomery	767.7
51.96	Crawfordsville Junction	Indiana	Montgomery	784.7
	Crawfordsville Junction	Indiana	Montgomery	785.7
57.18	Garfield	Indiana	Montgomery	788.7
60.12	Darlington	Indiana	Montgomery	760.7
64.57	Bowers	Indiana	Montgomery	811.7
68.59	Colfax	Indiana	Clinton	840.7
73.66	Manson	Indiana	Clinton	857.7
78.37	Frankfort	Indiana	Clinton	858.7
78.34	Frankfort	Indiana	Clinton	858.7
78.51	Frankfort	Indiana	Clinton	860.7
	Frankfort	Indiana	Clinton	860.7
83.14	Kilmore	Indiana	Clinton	829.7
85.93	Moran	Indiana	Clinton	796.7
87.85	Sedalia	Indiana	Clinton	776.7
92.17	Cutler	Indiana	Carroll	722.7
95.56	Bringhurst	Indiana	Carroll	718.7
97.01	Flora	Indiana	Carroll	699.7
101.25	Camden	Indiana	Carroll	659.7
105.35	Woodville	Indiana	Carroll	692.7
109.24	Clymers	Indiana	Cass	715.7
113.31	Long Cliff	Indiana	Cass	623.7
115.53	Logansport	Indiana	Cass	600.7
	Logansport	Indiana	Cass	595.7
120.40	Verona	Indiana	Cass	747.7
124.17	Lucerne	Indiana	Cass	796.7
129.77	Grass Creek	Indiana	Fulton	766.7
134.69	Kewanna	Indiana	Fulton	777.7
	Kewanna	Indiana	Fulton	767.7
138.30	Bruce Lake	Indiana	Fulton	771.7
143.00	DeLong	Indiana	Fulton	742.7
147.35	Arlington	Indiana	Marshall	740.7
148.77	Culver	Indiana	Marshall	748.7
151.64	Hibbard	Indiana	Marshall	775.7
154.78	Twin Lakes	Indiana	Marshall	805.7
159.22	Plymouth	Indiana	Marshall	794.7
158.90	Plymouth	Indiana	Marshall	790.7
158.91	Plymouth	Indiana	Marshall	790.7
164.15	Harris	Indiana	Marshall	832.7
167.30	La Paz Junction	Indiana	Marshall	847.7
172.12	Lakeville	Indiana	St. Joseph	838.7
176.73	Nutwood	Indiana	St. Joseph	839.7
182.24	South Bend	Indiana	St. Joseph	721.7

VANDALIA RAILROAD.

Vincennes Division—Indianapolis to Vincennes.

Distances from Indianapolis.	STATIONS.	State.	County.	Elevation.
0.0	Indianapolis	Indiana	Marion	706.2
1.58	Indianapolis	Indiana	Marion	695.1
5.65	Maywood	Indiana	Marion	686.0
9.13	Valley Mills	Indiana	Marion	7[illegible]6.4
11.91	Camby	Indiana	Marion	775.6
13.35	Friendswood	Indiana	Hendricks	736.3
16.74	Mooresville	Indiana	Morgan	683.4
21.53	Brooklyn	Indiana	Morgan	657.8
22.13	Bethany Park	Indiana	Morgan	642.9
23.75	Centerton	Indiana	Morgan	627.6
25.65	Campbells	Indiana	Morgan	609.1
30.60	Martinsville	Indiana	Morgan	596.5
33.99	Hynds	Indiana	Morgan	596.5
38.43	Paragon	Indiana	Morgan	577.3
41.03	Whitaker	Indiana	Morgan	569.6
44.17	Gosport Junction	Indiana	Owen	568.1
44.96	Gosport	Indiana	Owen	594.5
47.11	Keystone	Indiana	Owen	556.2
49.68	Romona	Indiana	Owen	577.2
53.53	Spencer	Indiana	Owen	559.7
62.73	Freedom	Indiana	Owen	534.9
65.80	Farmers	Indiana	Owen	524.3
72.30	Worthington	Indiana	Greene	519.7
73.78	Rincon Junction	Indiana	Greene	507.3
79.55	Switz City	Indiana	Greene	522.6
79.77	Switz City	Indiana	Greene	522.7
	Switz City	Indiana	Greene	537.2
83.14	Lyons	Indiana	Greene	515.9
85.06	Bushrod	Indiana	Greene	477.8
86.27	Bee Hunter	Indiana	Greene	481.8
88.01	Marco	Indiana	Greene	478.7
91.68	Sandborn	Indiana	Knox	469.0
94.73	Westphalia	Indiana	Knox	460.5
98.49	Edwardsport	Indiana	Knox	455.7
102.89	Bicknell	Indiana	Knox	488.7
109.28	Bruceville	Indiana	Knox	504.1
117.72	Vincennes	Indiana	Knox	412.1
116.98	Vincennes	Indiana	Knox	416.5

PITTSBURGH, CINCINNATI, CHICAGO AND ST. LOUIS RAILROAD.

Louisville Division.

Distances from Louisville Ky.	STATIONS.	State.	County.	Elevation.
0.0	Main Street	Kentucky		453.8
2.2	Jeffersonville	Indiana	Clark	437.0
11.3	Speeds	Indiana	Clark	478.8
16.7	Memphis	Indiana	Clark	489.7
20.8	Henryville	Indiana	Clark	485.0
25.3	Underwood	Indiana	Clark	616.0
28.3	Vienna	Indiana	Scott	563.8
30.9	Scottsburg	Indiana	Scott	568.4
35.0	Austin	Indiana	Scott	537.5
39.5	Crothersville	Indiana	Jackson	557.9
51.0	Seymour	Indiana	Jackson	603.5
53.1	Rockford	Indiana	Jackson	577.9
62.1	Waynesville	Indiana	Bartholomew	601.7
69.0	Columbus	Indiana	Bartholomew	628.4
79.5	Edinburg	Indiana	Johnson	674.2
89.7	Franklin	Indiana	Johnson	733.9
94.1	Whiteland	Indiana	Johnson	800.5
99.3	Greenwood	Indiana	Johnson	814.0
102.9	Southport	Indiana	Marion	756.7
107.6	Garfield	Indiana	Marion	715.0
110.0	Indianapolis	Indiana	Marion	707.0

PITTSBURGH, CINCINNATI, CHICAGO AND ST. LOUIS RAILROAD—Continued.

Louisville Division—Continued.

Distances from Louisville, Ky.	STATIONS.	State.	County.	Elevation.
111.9	Massachusetts Ave	Indiana	Marion	733.0
124.2	County Line	Indiana	Marion-Hamilton	820.0
126.2	Fishers	Indiana	Hamilton	821.0
132.3	Noblesville	Indiana	Hamilton	766.0
138.6	Cicero	Indiana	Hamilton	837.0
141.7	Arcadia	Indiana	Hamilton	868.0
144.6	Atlanta	Indiana	Hamilton	852.0
149.7	Tipton	Indiana	Tipton	871.0
152.6	Jacksons	Indiana	Tipton	884.0
156.3	Sharpsville	Indiana	Tipton	883.0
159.2	Fairfield	Indiana	Howard	848.0
164.4	Kokomo	Indiana	Howard	804.0
171.0	Galveston	Indiana	Cass	821.9
173.9	Lincoln	Indiana	Cass	794.0
177.3	Walton	Indiana	Cass	754.0
187.3	Logansport	Indiana	Cass	589.0

PITTSBURGH, CINCINNATI, CHICAGO AND ST. LOUIS RAILROAD.

Logansport Division.

Distances from Columbus, Ohio.	STATIONS.	State.	County.	Elevation.
104.0	Union City	Indiana	Randolph	1,106.3
121.4	Powers	Indiana	Jay	993.3
125.1	Redkey	Indiana	Jay	965.9
128.7	Dunkirk	Indiana	Jay	953.7
138.7	Hartford City	Indiana	Blackford	910.4
145.4	Upland	Indiana	Grant	936.0
152.6	Gas City	Indiana	Grant	847.1
157.7	Marion	Indiana	Grant	808.5
163.6	Sweetser	Indiana	Grant	846.6
174.4	North Grove	Indiana	Miami	816.3
177.2	McGrawsville	Indiana	Miami	792.4
179.7	Loree	Indiana	Miami	811.9
182.3	Bunker Hill	Indiana	Miami	803.6
193.0	Anoka Junction	Indiana	Cass	722.0
197.8	Logansport	Indiana	Cass	589.0
201.8	Gebhardt	Indiana	Cass	758.8
204.1	Fords Crossing	Indiana	Cass	736.1
207.7	Boone	Indiana	Cass	760.0
213.6	Thornhope	Indiana	Pulaski	725.1
217.1	Star City	Indiana	Pulaski	710.8
220.0		Indiana	Pulaski	697.7
223.0	Winamac	Indiana	Pulaski	700.3
237.0	North Judson	Indiana	Starke	702.4
254.0	Kouts	Indiana	Porter	671.6
263.2	Hebron	Indiana	Porter	708.4
274.1	Crown Point	Indiana	Lake	701.6
277.3	Rush	Indiana	Lake	701.4
282.4	Hartsdale	Indiana	Lake	626.8

PITTSBURGH, CINCINNATI, CHICAGO AND ST. LOUIS RAILROAD.

Indianapolis Division.

Distances from Columbus, Ohio.	STATIONS.	State.	County.	Elevation.
119.6	Richmond	Indiana	Wayne	957.5
121.7	East Haven	Indiana	Wayne	1,007.5
123.6		Indiana	Wayne	1,050.6
125.6	Centreville	Indiana	Wayne	969.0
127.8	Jackson Hill	Indiana	Wayne	1,066.3
130.0	Harveys	Indiana	Wayne	960.3
132.0		Indiana	Wayne	988.5
135.1	Cambridge City	Indiana	Wayne	930.0
137.1	Dublin	Indiana	Wayne	1,030.5
141.4	Strawns	Indiana	Henry	1,077.1
144.7	Lewisville	Indiana	Henry	1,041.8
145.0		Indiana	Henry	1,070.6
149.1	Dunreith	Indiana	Henry	1,035.9
154.1	Knightstown	Indiana	Henry	898.2
157.0		Indiana	Henry	974.5
158.8	Charlottsville	Indiana	Hancock	933.5
160.0	Cleveland	Indiana	Hancock	972.2
165.0	Scott Crossing	Indiana	Hancock	902.3
167.3	Greenfield	Indiana	Hancock	866.0
168.0		Indiana	Hancock	891.6
171.1		Indiana	Hancock	853.0
172.0		Indiana	Hancock	830.7
176.0		Indiana	Hancock	852.9
177.0	Cumberland	Indiana	Marion	852.5
180.0		Indiana	Marion	859.3
181.0	McVays	Indiana	Marion	842.0
183.2	Irvington	Indiana	Marion	823.3
186.0	Belt R. R	Indiana	Marion	771.4
188.0	Indianapolis, Union Station	Indiana	Marion	705.8

PITTSBURGH, CINCINNATI, CHICAGO AND ST. LOUIS RAILROAD.

Richmond Division.

Distances from Cincinnati.	STATIONS.	State.	County.	Elevation.
74.6	Richmond	Indiana	Wayne	986.0
81.5		Indiana	Wayne	1,081.5
88.7		Indiana	Wayne	1,066.4
90.3	Hagerstown	Indiana	Wayne	946.0
95.6	Millville	Indiana	Henry	1,159.5
98.3	Ashland	Indiana	Henry	1,085.8
101.7	New Castle	Indiana	Henry	1,058.9
104.1	Fayne	Indiana	Henry	1,077.0
106.3		Indaina	Henry	1,093.2
113.4		Indiana	Henry	941.7
115.3	Middletown	Indiana	Henry	974.1
121.2	Gridley	Indiana	Madison	889.0
123.0	Anderson	Indiana	Madison	846.0
152.4	Hemlock	Indiana	Howard	853.0
153.9	Center	Indiana	Howard	832.0
159.5	Kokomo	Indiana	Howard	838.8
168.8	Lincoln	Indiana	Cass	794.0
172.2	Walton	Indiana	Cass	754.0
182.2	Logansport	Indiana	Cass	589.0

VANDALIA RAILROAD.

Butler Branch.—Logansport to Butler.

Distances from Logansport.	STATIONS.	State.	County.	Elevation.
0.0	Logansport	Indiana	Cass	600.7
5.70	Adamsboro	Indiana	Cass	662.7
10.05	Hoover	Indiana	Cass	685.7
14.26	Mexico	Indiana	Miami	695.7
18.27	Denver	Indiana	Miami	702.7
21.04	Chili	Indiana	Miami	722.7
23.59	Pettysville	Indiana	Miami	737.7
27.19	Roann	Indiana	Wabash	749.7
33.20	Laketon	Indiana	Wabash	759.7
33.88	Newton	Indiana	Wabash	751.7
37.10	North Manchester	Indiana	Wabash	773.7
36.91	North Manchester	Indiana	Wabash	766.7
40.48	Liberty Mills	Indiana	Wabash	770.7
47.69	South Whitley	Indiana	Whitley	807.7
51.44	Wynkoop	Indiana	Whitley	862.7
55.92	Columbia City	Indiana	Whitley	836.7
62.06	Collins	Indiana	Whitley	867.7
66.10	Churubusco	Indiana	Whitley	890.7
70.34	Ari	Indiana	Allen	879.7
73.69	LaOtto	Indiana	Dekalb	873.7
76.27	Cedar	Indiana	Dekalb	858.7
81.36	Auburn Junction	Indiana	Dekalb	865.7
	Auburn Junction	Indiana	Dekalb	865.7
82.40	Auburn	Indiana	Dekalb	862.7
88.45	Moore	Indiana	Dekalb	877.7
93.03	Butler	Indiana	Dekalb	868.7

PITTSBURGH, CINCINNATI, CHICAGO & ST. LOUIS RAILROAD.

Logansport Division.—Muncie Branch.

Distances from Converse.	STATIONS.	State.	County.	Elevation.
0.0	Converse	Indiana	Grant	825.5
2.5	Rich	Indiana	Grant	826.6
5.9	Swayzee	Indiana	Grant	863.2
8.7	Cole	Indiana	Grant	860.0
10.0		Indiana	Grant	877.6
17.9	Fairmount	Indiana	Grant	861.8
20.0		Indiana	Grant	869.8
22.1	Fowlerton	Indiana	Grant	877.5
26.4	Matthews	Indiana	Grant	882.7
28.6	Wheeling	Indiana	Delaware	884.8
31.6	Stockport	Indiana	Delaware	880.8
35.0	Anthony	Indiana	Delaware	898.0
37.0		Indiana	Delaware	925.8
40.0		Indiana	Delaware	957.3
41.0	Muncie	Indiana	Delaware	938.0

Effner Branch.

Distances from Peoria Jct.	STATIONS.	State.	County.	Elevation.
0.0	Peoria Junction	Indiana	Cass	589.6
4.3	Kenneth	Indiana	Cass	583.2
4.9	Trimmer	Indiana	Cass	607.2
5.8	Curveton	Indiana	Cass	664.0
11.3	Burnettsville	Indiana	White	711.2
14.3	Idaville	Indiana	White	709.7
20.4	Monticello	Indiana	White	677.9
26.1	Reynolds	Indiana	White	691.2
31.9	Seafield	Indiana	White	697.7
35.0	Wolcott	Indiana	White	714.1
40.6	Remington	Indiana	Jasper	730.6
48.1	Goodland	Indiana	Newton	716.6
56.1	Kentland	Indiana	Newton	679.7
60.3	Effner	Indiana	Newton	676.5

PITTSBURGH, CINCINNATI, CHICAGO AND ST. LOUIS RAILROAD.

Columbus Division.—Cambridge City Branch.

Distances from Cambridge City.	STATIONS.	State.	County.	Elevation.
0.0	Cambridge City	Indiana	Wayne	937.2
5.9	Bentonville	Indiana	Fayette	1,045.0
14.8	Gings	Indiana	Rush	1,000.2
21.0	Rushville	Indiana	Rush	988.0
25.0		Indiana	Rush	946.3
29.0		Indiana	Rush	909.8
33.3	Rays Crossing	Indiana	Shelby	879.1
39.9	Shelbyville	Indiana	Shelby	765.5
44.0	Fenns	Indiana	Shelby	751.5
48.1	Lewis Creek	Indiana	Shelby	708.6
50.8	Flat Rock	Indiana	Shelby	694.1
54.0	St. Louis Crossing	Indiana	Bartholomew	679.5
56.8	Clifford	Indiana	Bartholomew	668.3
63.2	Columbus	Indiana	Bartholomew	627.3

Madison Branch.

Distances from Columbus.	STATIONS.	State.	County.	Elevation.
0.0	Columbus	Indiana	Bartholomew	615.9
4.6	Wiggs	Indiana	Bartholomew	646.6
7.6	Elizabethtown	Indiana	Bartholomew	615.8
11.4	Hege	Indiana	Jennings	657.5
14.1	Scipio	Indiana	Jennings	657.9
17.0	Queensville	Indiana	Jennings	701.2
21.2	North Vernon	Indiana	Jennings	750.6
22.7	Vernon	Indiana	Jennings	665.1
25.9	Grayford	Indiana	Jennings	777.5
31.7	Dupont	Indiana	Jefferson	797.9
35.0	Middlefork	Indiana	Jefferson	784.8
38.6	Wirt	Indiana	Jefferson	837.4
42.7	North Madison	Indiana	Jefferson	876.9

GRAND RAPIDS AND INDIANA RAILROAD.

LOCATION.	County.	Elevation.
Richmond Union Station	Wayne	964.1
M. P. 1		984.1
Parry	Wayne	1,018.5
M. P. 3		1,065.5
M. P. 4		1,102.7
Chester	Wayne	1,107.6
M. P. 5		1,108.9
M. P. 6		1,119.2
M. P. 7		1,121.8
M. P. 9		1,113.5
M. P. 10		1,155.7
M. P. 11		1,189.8
M. P. 12		1,216.3
M. P. 13		1,179.1
M. P. 14		1,136.1
M. P. 15		1,152.5
Lynn	Randolph	1,159.3
M. P. 16		1,169.2
M. P. 17		1,156.3
M. P. 18		1,174.6
Snow Hill	Randolph	1,186.7
M. P. 19		1,185.1

GRAND RAPIDS AND INDIANA RAILROAD—Continued.

Location.	County.	Elevation.
Woods	Randolph	1,176.6
M. P. 20		1,173.2
M. P. 21		1,153.3
M. P. 22		1,121.7
M. P. 23		1,096.2
Winchester	Randolph	1,087.0
M. P. 25		1.072,3
M. P. 26		1,088.6
M. P. 27		1,057.7
M. P. 28		1,036.7
M. P. 29		1,036.4
M. P. 30		1,013.9
M. P. 31		993.7
M. P. 32		980.3
Ridgeville	Randolph	986.5
M. P. 34		1,017.9
M. P. 35		994.1
M. P. 36		1,027.1
M. P. 37		1,009.4
M. P. 38		961.5
M. P. 39		960.9
M. P. 40		933.0
M. P. 41		937.3
M. P. 43		905.4
Portland	Jay	904.7
M. P. 44		918.4
M. P. 45		927.5
M. P. 46		944.3
M. P. 47		905.8
Jay	Jay	888.1
M. P. 48		886.9
M. P. 49		878.1
M. P. 50		866.8
Bryant	Jay	870.6
M. P. 51		864.8
M. P. 52		851.4
M. P. 53		831.2
M. P. 54		852.8
Geneva	Adams	840.5
M. P. 55		849.7
M. P. 56		832.2
M. P. 57		845.2
M. P. 58		847.4
M. P. 59		838.7
M. P. 60		841.3
M. P. 61		840.3
M. P. 62		836.2
M. P. 63		839.2
M. P. 64		825.3
Monroe	Adams	823.8
M. P. 65		823.2
M. P. 66		817.2
M. P. 67		812.6
M. P. 68		808.7
M. P. 69		803.5
M. P. 70		801.8
Decatur	Adams	799.2
M. P. 71		797.7
M. P. 72		786.4
M. P. 73		794.0
Monmouth	Adams	789.7
M. P. 74		798.0
M. P. 75		810.0
M. P. 76		817.5
M. P. 77		816.1
Williams	Adams	826.2
M. P. 78		835.4
M. P. 79		831.1
Hoagland	Allen	826.7
M. P. 80		829.9
M. P. 81		828.0
M. P. 82		814.3
Gorham	Allen	817.8
M. P. 83		821.1
M. P. 84		808.0
M. P. 85		795.9
M. P. 86		797.3

GRAND RAPIDS AND INDIANA RAILROAD—Continued.

Location.	County.	Elevation.
Adams	Allen	790.9
East Yard	Allen	802.3
Ft. Wayne	Allen	779.0
Junction	Allen	764.4
M. P. 94		775.9
M. P. 95		806.8
M. P. 96		808.0
Washington	Allen	811.9
M. P. 97		813.3
M. P. 98		825.9
M. P. 99		843.1
Wallen	Allen	854.6
M. P. 100		857.2
M. P. 101		867.9
M. P. 102		854.8
M. P. 103		845.0
Huntertown	Allen	841.6
M. P. 105		858.5
M. P. 106		851.8
M. P. 107		861.3
M. P. 108		868.4
La Otto	Noble	872.9
M. P. 109		865.1
M. P. 110		872.0
Swan	Noble	872.0
M. P. 111		888.3
M. P. 112		908.1
M. P. 113		911.0
M. P. 114		956.2
Avilla	Noble	962.9
M. P. 115		988.2
M. P. 116		986.8
M. P. 117		1,053.2
M. P. 118		1,014.2
M. P. 119		990.0
M. P. 120		975.4
Kendallville	Noble	974.7
M. P. 121		967.5
M. P. 122		960.3
M. P. 123		957.5
M. P. 124		956.0
M. P. 125		971.8
M. P. 126		950.9
M. P. 127		930.1
Rome City	Noble	920.3
M. P. 128		939.2
M. P. 129		945.8
Wolcottville	Lagrange	933.6
M. P. 130		939.1
M. P. 131		941.9
M. P. 132		955.8
M. P. 133		957.7
M. P. 134		951.9
Valentine	Lagrange	958.3
M. P. 135		957.1
M. P. 136		959.0
M. P. 137		957.9
M. P. 138		928.9
LaGrange	Lagrange	913.0
M. P. 139		902.9
M. P. 140		900.4
M. P. 141		884.7
M. P. 142		874.9
M. P. 143		870.0
Lima	Lagrange	879.8
M. P. 144		881.1
M. P. 145		880.8
M. P. 146		873.9
Michigan-Indiana Line		871.9

CHESAPEAKE AND OHIO RAILWAY.

Distances from Cincinnati, 8th St. Sta.	Stations.	State.	County.	Elevation.
33.14	Peoria	Indiana	Franklin	999.00
36.15	Raymond	Indiana	Franklin	1,008.00
38.98	Bath	Indiana	Franklin	1,012.00
45.04	Cottage Grove	Indiana	Union	1,039.40
50.98	Kitchell	Indiana	Union	1,096.00
52.96	Witts	Indiana	Union	1,119.00
54.92	Boston	Indiana	Wayne	1,114.00
55.94	Druley	Indiana	Wayne	1,101.00
61.92	South Richmond	Indiana	Wayne	965.00
63.04	Richmond	Indiana	Wayne	943.13
73.92	Williamsburg	Indiana	Wayne	1,059.00
79.61	Economy	Indiana	Wayne	1,093.00
82.32	Thornburg	Indiana	Wayne	1,063.00
86.50	Losantville	Indiana	Randolph	1,132.00
90.47	Blountsville	Indiana	Henry	1,066.50
96.78	Medford	Indiana	Delaware	1,002.00
103.11	Muncie	Indiana	Delaware	935.00
110.29	Benadum	Indiana	Delaware	897.00
113.62	Gaston	Indiana	Delaware	888.00
117.78	Janney	Indiana	Delaware	874.00
121.06	Fowlerton	Indiana	Grant	886.00
127.39	Jonesboro	Indiana	Grant	817.00
132.47	Marion	Indiana	Grant	852.00
138.02	Sweetser	Indiana	Grant	846.50
141.04	Mier	Indiana	Grant	808.00
143.74	Converse	Indiana	Miami	822.00
146.86	Amboy	Indiana	Miami	809.00
152.71	Santa Fe	Indiana	Miami	786.00
160.46	Peru	Indiana	Miami	638.00
161.33	Peru Shops	Indiana	Miami	639.00
170.07	Hoovers	Indiana	Cass	696.00
174.51	Twelve Mile	Indiana	Cass	795.00
180.43	Fulton	Indiana	Fulton	786.00
189.82	Kewanna	Indiana	Fulton	751.00
194.19	Wynn	Indiana	Fulton	732.00
197.98	Lawton	Indiana	Pulaski	713.00
202.72	Beardstown	Indiana	Pulaski	713.00
213.37	North Judson	Indiana	Starke	688.00
217.59	English Lake	Indiana	Starke	670.50
220.35	Runnymede	Indiana	Starke	670.00
222.50	Lacrosse	Indiana	Starke	677.00
230.91	Malden	Indiana	Porter	710.00
240.09	Beatrice	Indiana	Porter	755.50
284.73	Merrillville	Indiana	Lake	645.00
254.03	Griffith	Indiana	Lake	633.00

SOUTHERN INDIANA RAILWAY.

Distances from Terre Haute.	Stations.	State.	County.	Elevation.
0.0	Terre Haute	Indiana	Vigo	495.0
4.7	Springhill	Indiana	Vigo	512.0
9.6	Keller	Indiana	Vigo	582.0
13.3	Blackhawk	Indiana	Vigo	595.0
17.4	Lewis	Indiana	Vigo	600.0
22.3	Coalmont	Indiana	Clay	632.0
25.0	Jasonville	Indiana	Greene	638.0
27.9	Midland	Indiana	Greene	670.0
34.4	Linton	Indiana	Greene	530.0
46.1	Elnora	Indiana	Daviess	493.0
52.0	Odon	Indiana	Daviess	545.0
58.0	Burns City	Indiana	Martin	690.0
61.8	Blankenship	Indiana	Martin	525.0
84.4	Bedford	Indiana	Lawrence	665.0
98.5	Norman	Indiana	Jackson	895.0
102.7	Kurtz	Indiana	Jackson	600.0
120.5	Seymour Junction	Indiana	Jackson	620.0
147.9	Westport	Indiana	Decatur	822.0

SOUTHERN INDIANA RAILWAY—Continued.

Distances from McKeen.	Stations.	State.	County.	Elevation.
0.0	McKeen	Indiana	Vigo	495.0
7.3	Dewey	Indiana	Vigo	498.0
18.5	Libertyville	Indiana	Vermillion	640.0
26.0	St. Bernice	Indiana	Vermillion	605.0
32.1	Dana	Indiana	Vermillion	630.0
35.5	State Line	Indiana	Vermillion	637.0

Distances from Terre Haute.	Stations.	State.	County.	Elevation.
0.0	Terre Haute	Indiana	Vigo	495.0
14.0	Blackhawk	Indiana	Vigo	595.0
16.0	Shady Grove	Indiana	Vigo	586.0
18.0	Martz	Indiana	Sullivan	564.0
23.0	Hymera	Indiana	Sullivan	496.0
27.0	Hawton	Indiana	Sullivan	474.0
29.0	Glendora	Indiana	Sullivan	502.0
32.0	Sullivan	Indiana	Sullivan	532.0

BEDFORD STONE RAILWAY.

Distances from Rivervale.	Stations.	State.	County.	Elevation.
0.0	Rivervale	Indiana	Lawrence	499.0
1.3	Lawrenceport	Indiana	Lawrence	501.0
2.8	Stonington	Indiana	Lawrence	544.0

GRAND TRUNK WESTERN RAILROAD.

Distances from Port Huron, Michigan.	Stations.	State.	County.	Elevation.
225.0	Granger	Indiana	St. Joseph	806.0
229.0		Indiana	St. Joseph	754.0
231.8	Mishawaka	Indiana	St. Joseph	742.5
234.6	Studebaker	Indiana	St. Joseph	712.0
236.0	Olivers	Indiana	St. Joseph	722.0
238.0		Indiana	St. Joseph	720.0
240.0		Indiana	St. Joseph	721.5
242.0		Indiana	St. Joseph	718.0
244.0	Crumstown	Indiana	St. Joseph	710.7
246.0		Indiana	St. Joseph	706.0
248.0		Indiana	St. Joseph	705.0
251.0	Mill Creek	Indiana	Laporte	698.2
253.0		Indiana	Laporte	708.0
255.8	Stillwell	Indiana	Laporte	741.0
258.0		Indiana	Laporte	749.8
260.8	Kingsbury	Indiana	Laporte	740.0
264.6	Wellsboro	Indiana	Laporte	745.9
265.6	Union Mills	Indiana	Laporte	747.0
268.0		Indiana	Laporte	766.0
271.8	Haskels	Indiana	Laporte	766.1
274.0		Indiana	Porter	748.8
278.0		Indiana	Porter	811.0
280.0	Valparaiso	Indiana	Porter	805.0
285.4	Sedley	Indiana	Porter	693.3
290.6	Ainsworth	Indiana	Lake	657.5
293.0		Indiana	Lake	636.5
296.0	Lottaville	Indiana	Lake	627.1
299.6	Griffith	Indiana	Lake	632.5
302.0		Indiana	Lake	621.3
304.0	Maynard	Indiana	Lake	619.0

PERE MARQUETTE RAILROAD.

LaCrosse Division.

Distances from LaCrosse.	Stations.	State.	County.	Elevation.
0.0	LaCrosse	Indiana	Laporte	676.8
2.0	Machlers	Indiana	Laporte	678.6
6.5	Thomaston	Indiana	Laporte	680.6
9.0	Hanna	Indiana	Laporte	705.6
13.0		Indiana	Laporte	727.6
15.5	Wellsboro	Indiana	Laporte	750.9
17.5	Magee	Indiana	Laporte	774.6
22.0	Poorhouse	Indiana	Laporte	818.9
23.5	Laporte	Indiana	Laporte	811.4
24.5	Hilt	Indiana	Laporte	815.2
26.5	Belfast	Indiana	Laporte	863.9

Chicago Division.

Distances from Alfred, Mich.	Stations.	State.	County.	Elevation.
4.0	Merrick	Indiana	Laporte	626.6
7.0		Indiana	Laporte	628.9
9.5	Michigan City	Indiana	Laporte	621.6
15.5	Doran	Indiana	Porter	667.4
20.5	Porter	Indiana	Porter	642.2

CHICAGO AND ERIE RAILROAD.

Distances from Marion, Ohio.	Stations.	State.	County.	Elevation.
92.0	Bridge No. 49	Indiana	Adams	799.0
96.0	*Decatur*	Indiana	Adams	799.0
97.5	Bridge No. 53	Indiana	Adams	800.0
100.6	Bridge No. 56	Indiana	Adams	809.0
103.0	Magley	Indiana	Adams	830.0
106.0	Tocsin	Indiana	Wells	830.0
109.5	Kingsland	Indiana	Wells	841.5
112.5	Uniondale	Indiana	Wells	808.0
118.0	Markle	Indiana	Huntington	804.0
119.0	Bridge No. 61	Indiana	Huntington	802.0
121.0	Bridge No. 62	Indiana	Huntington	801.0
125.6	Bridge No. 64	Indiana	Huntington	734.0
131.0	Bridge No. 73	Indiana	Huntington	792.0
132.6	Warren-Clear Creek Twp. Line	Indiana	Huntington	820.0
137.0	County Line	Indiana	Wabash-Huntington	832.0
140.0	Bridge No. 77	Indiana	Wabash	838.0
142.0	Servia	Indiana	Wabash	792.0
144.0	C., C., C. & St. L. R. R.	Indiana	Wabash	788.0
146.0	T. H. & L. R. R.	Indiana	Wabash	747.0
149.5	Midway	Indiana	Wabash	768.0
153.0	Disco	Indiana	Wabash	837.0
158.0	Akron	Indiana	Fulton	851.0
161.5	Bridge No. 87	Indiana	Fulton	802.0
163.0	Athens	Indiana	Fulton	802.0
167.5	Rochester	*Indiana*	*Fulton*	770.0
174.0	Germany	Indiana	Fulton	742.0
177.5	Leiters	Indiana	Fulton	735.0
180.0	DeLong	Indiana	Fulton	734.0
185.0	County Line	Indiana	Fulton-Pulaski	712.0
184.0	Monterey	Indiana	Pulaski	714.0
187.5	Ora	Indiana	Starke	718.0
190.5	Bass Lake Junction	Indiana	Starke	711.0
194.0	Aldine	Indiana	Starke	715.0
197.5	Bridge No. 101	Indiana	Starke	690.0

CHICAGO AND ERIE RAILROAD—Continued.

Distances from Marion, Ohio.	Stations.	State.	County.	Elevation.
199.0	North Judson	Indiana	Starke	681.6
205.5	County Line	Indiana	Starke-Laporte	655.5
208.0	Bridge No. 106	Indiana	Laporte	655.5
211.5	Bridge No. 108	Indiana	Porter	662.0
214.0	P., C., C. & St. L. R. R	Indiana	Porter	669.4
216.5	Bridge No. 111	Indiana	Porter	657.0
219.6	Boone Grove	Indiana	Porter	707.0
222.0		Indiana	Porter	704.0
226.0	Stone Arch	Indiana	Lake	727.0
228.5	Winfield	Indiana	Lake	674.0
230.0	Bridge No. 120	Indiana	Lake	682.0
233.0	Crown Point	Indiana	Lake	677.0
237.0	Bridge No. 127	Indiana	Lake	642.0
240.0	Griffith	Indiana	Lake	623.0
243.0	Bridge No. 130	Indiana	Lake	608.0
245.0	Downeys	Indiana	Lake	591.0
248.0	Hammond	Indiana	Lake	576.7

BALTIMORE AND OHIO RAILROAD.

Indiana Division.—Bench Marks from Data of U. S. C. & G. Survey.

Distances East from Seymour.	Stations.	Designation.	Description.	Elevation.
15 0	North Vernon	LXIX	Cut on the east abutment of Ohio & Mississippi R. R. bridge over north fork of Vernon River about ¾ mile east of North Vernon, marked B O M	684.9
39.8	Delaware	LXVIII	Cut on east abutment of Ohio & Mississippi R. R. bridge over Greasy Run, a short distance east of Delaware, marked B O M	928.0
59.9	Cochran	LXVII	Cut on the east abutment of Ohio & Mississippi R. R. bridge No. 11, over South Hogan Creek, about 3½ miles west of Cochran Station. It is marked B O M	493.5
65.1	Lawrenceburg	U	Cut on the water table of the court house at Lawrenceburg, Ind., on the front, under center of second window from the east corner. It is marked thus: 1879 U. S. C. & G. S. B O M U	485.9
Distances West from Seymour.				
8.2	Medora	V	Cut on west abutment of Ohio & Mississippi R. R. bridge over east fork of White River, about 2 miles east of Medora. It is marked thus: V U. S. C. & G. S. B O M (Year)	534.1
26.5	Fort Ritner	LXX	Cut on coping stone of arch, O. & M. R. R. over wagon road, about 656 ft. east of Fort Ritner Station. It is marked thus: B O M	521.8
59.8	West Shoals	Y	The center of a cross, cut on face of stone cap of basement window, on N. E. side of court house at West Shoals, marked Y B+M	522.3

BALTIMORE AND OHIO RAILROAD—Continued.

Indiana Division.—Bench Marks from Data of U. S. C. & G. Survey—Continued.

Distances West from Seymour.	Stations.	Designation.	Description.	Elevation.
82.4	Washington....	Z............	Cut on sill of basement window at S. E. corner of court house at Washington, Ind. It is marked thus: Z / U. S. C. & G. S. / B O M / (Year) or Z / B O M / U. S. C. & G. S. / (Year)	509.4
101.3	Vincennes.....	A_3............	Cut on stone ledge on N. W. front of court house at Vincennes, Ind. It is marked thus: A_3 / U. S. C. & G. S. / B O M / (Year) or A_3 / B O M / U. S. C. & G. S. / (Year)	434.1

CHICAGO AND WABASH VALLEY RAILROAD.

Distances from McCoysburg.	Stations.	State.	County.	Elevation.
1.22	Randle	Indiana	Jasper	695.6
2.98	Della	Indiana	Jasper	675.4
5.23	Pleasant Grove	Indiana	Jasper	697.4
7.27	Lewiston	Indiana	Jasper	688.8
9.17	Newland	Indiana	Jasper	688.2
11.10	Gifford	Indiana	Jasper	689.1
13.14	Laura	Indiana	Jasper	689.2
18.18	Zadoc	Indiana	Jasper	684.2
21.73	Kersey	Indiana	Jasper	652.5
26.74	Beech Ridge	Indiana	Jasper	644.5
29.80	Range Line	Indiana	Lake	645.6
31.98	Dinwiddie	Indiana	Lake	666.5

NEW JERSEY, INDIANA AND ILLINOIS RAILROAD.

Distances from South Bend.	Stations.	State.	County.	Elevation.
0.0	South Bend	Indiana	St. Joseph	721.7
6.6	Wharton's	Indiana	St. Joseph	821.7
8.6	Sweeney's	Indiana	St. Joseph	821.7
11.6	Pine	Indiana	St. Joseph	671.7

PITTSBURGH, FT. WAYNE AND CHICAGO RAILROAD.

Distances from Pittsburgh, Pa.	Stations.	State.	County.	Elevation.
300.8	Dixon	Indiana	Allen	793.5
304.8	Monroeville	Indiana	Allen	789.6
310.5	Naples	Indiana	Allen	790.5
315.0	Adams	Indiana	Allen	791.9
320.3	Ft. Wayne	Indiana	Allen	780.3
325.6	Hadley	Indiana	Allen	839.9
328.8	Arcola	Indiana	Allen	843.0
334.5	Coesse	Indiana	Whitley	853.0
339.3	Columbia City	Indiana	Whitley	838.5
346.9	Larwill	Indiana	Whitley	950.8
351.3	Pierceton	Indiana	Kosciusko	926.0
353.3	Kosciusko	Indiana	Kosciusko	883.5
357.8	Winona Lake	Indiana	Kosciusko	835.4
359.7	Warsaw	Indiana	Kosciusko	824.3
361.6	Selby	Indiana	Kosciusko	812.1
366.1	Atwood	Indiana	Kosciusko	823.0

PITTSBURGH, FT. WAYNE AND CHICAGO RAILROAD—Continued.

Distances from Pittsburgh, Pa.	STATIONS.	State.	County.	Elevation.
370.0	Etna Green	Indiana	Kosciusko	813.0
373.8	Bourbon	Indiana	Marshall	840.2
378.5	Inwood	Indiana	Marshall	842.3
384.5	Plymouth	Indiana	Marshall	791.3
388.4	Seiders	Indiana	Marshall	840.0
394.8	Grovertown	Indiana	Starke	719.8
398.9	Hamlet	Indiana	Starke	696.9
404.7	Davis	Indiana	Starke	681.7
406.7	Bee Grove	Indiana	Laporte	682.3
409.3	Hanna	Indiana	Laporte	702.8
411.	Schnells	Indiana	Laporte	715.8
412.6	Morgans	Indiana	Laporte	729.2
415.5	Wanatah	Indiana	Laporte	727.5
417.2	Osborns	Indiana	Laporte	736.5
421.1	Montdale	Indiana	Porter	754.5
422.9	Cemetary	Indiana	Porter	755.9
424.7	Valparaiso	Indiana	Porter	736.2
428.2	Loucks Crossing	Indiana	Porter	698.4
431.3	Wheeler	Indiana	Porter	664.3
435.2	Hobart	Indiana	Lake	620.7
438.2	Liverpool	Indiana	Lake	622.5
440.9	Gary	Indiana	Lake	609.5
442.4	Tolleston	Indiana	Lake	599.8
444.4	Clarke	Indiana	Lake	590.7
446.2	Clarke Junction	Indiana	Lake	589.8
448.5	Indiana Harbor	Indiana	Lake	589.0
451.6	Whiting	Indiana	Lake	588.9
468.4	Chicago	Illinois		585.6

INDIANAPOLIS UNION RAILWAY.

Belt Railroad Profile.

LOCATION.	Elevation.
W. Washington Street	710.0
Harding Street	703.5
P., C., C. & St. L., Louisville Division Tracks	733.5
Singleton Street	730.0
Cypress Street	766.0
Prospect Street	768.5
English Avenue	779.5
E. Washington Street	790.0
Clifford Avenue	791.0
Gale Street	802.5
C., C., C. & St. L., Cleveland Division Tracks	818.5
Columbia Avenue	741.5
C., I. & L., L. E. & W. Tracks	742.0
New York Street	718.5
Vermont Street	717.5
Michigan Street	713.0
Tenth Street	712.0
Crawfordsville Road	716.7
Indiana Avenue	713.0
North Indianapolis	728.1

INDIANAPOLIS UNION RAILWAY TRACKS.

LOCATION.	Elevation.
Capitol Avenue	722.9
Illinois Street	722.9
Meridian Street	721.5
Pennsylvania Street	720.2
Delaware Street	721.7
Alabama Street	722.8
New Jersey Street	722.9
C., H. & D. Tracks	724.2
East Street	724.8
Liberty Street	725.5
E. Washington Street	726.5

PEORIA AND EASTERN RAILROAD.

New York Central.

Distances from Springfield, Ohio.	Stations.	State.	County.	Elevation.
66.0	Crete	Indiana	Randolph	1,196.0
71.0	Lynn	Indiana	Randolph	1,162.0
76.0	Carlos City	Indiana	Randolph	1,204.0
81.0	Modoc	Indiana	Randolph	1,186.0
86.0	Losantville	Indiana	Randolph	1,180.0
91.0	Messick	Indiana	Henry	1,107.0
96.0	New Castle	Indiana	Henry	980.0
101.0		Indiana	Henry	1,068.0
106.0	Kennard	Indiana	Henry	1,048.0
111.0	Wilkinson	Indiana	Hancock	1,000.0
116.0		Indiana	Hancock	929.0
121.0	Mohawk	Indiana	Hancock	870.0
126.0	Mt. Comfort	Indiana	Hancock	873.0
131.0		Indiana	Marion	869.0
136.0		Indiana	Marion	825.0
142.0	Indianapolis	Indiana	Marion	707.6
146.0	Moorefield	Indiana	Marion	729.0
151.0		Indiana	Marion	852.0
156.0	Brownsburg	Indiana	Hendricks	896.0
161.0	Pittsboro	Indiana	Hendricks	956.0
166.0		Indiana	Hendricks	948.0
171.0		Indiana	Boone	936.0
176.0		Indiana	Montgomery	863.5
181.0	Crawfordsville Junction	Indiana	Montgomery	835.0
184.0	Crawfordsville Junction	Indiana	Montgomery	789.0
186.0		Indiana	Montgomery	739.0
191.0		Indiana	Montgomery	751.0
196.0	Waynetown	Indiana	Montgomery	760.5
201.0	Hillsboro	Indiana	Fountain	706.5
206.0	Veedersburg	Indiana	Fountain	622.0
211.0		Indiana	Fountain	621.5
214.0	Covington	Indiana	Fountain	506.0
216.0	Mound City	Indiana	Warren	628.0
221.0		Indiana	Warren	649.0

CHICAGO, INDIANA AND SOUTHERN.

Kankakee Division.—New York Central.

Distances from South Bend.	Stations.	State.	County.	Elevation.
0.0	South Bend	Indiana	St. Joseph	723.0
4.0		Indiana	St. Joseph	718.0
8.0	Ginger Hill	Indiana	St. Joseph	720.0
10.0		Indiana	St. Joseph	743.0
13.5	North Liberty	Indiana	St. Joseph	732.0
17.0		Indiana	St. Joseph	731.0
20.0	Walkerton	Indiana	St. Joseph	720.0
25.0		Indiana	Starke	694.0
27.5	Hamlet	Indiana	Starke	702.0
31.0		Indiana	Starke	706.0
34.0	Knox	Indiana	Starke	702.0
38.0	Toto	Indiana	Starke	703.0
43.0	North Judson	Indiana	Starke	697.0
45.0		Indiana	Starke	710.0
49.0	San Pierre	Indiana	Starke	704.0
53.5	Dunnville	Indiana	Jasper	679.0
57.5	Wheatfield	Indiana	Jasper	666.0
61.0	Stoutsburg	Indiana	Jasper	670.0
63.5	Kersey	Indiana	Jasper	665.0
65.5	DeMotte	Indiana	Jasper	667.0
70.0		Indiana	Newton	643.0
73.0	Shelby	Indiana	Newton	641.0
78 5	Schneider	Indiana	Newton	636.0
82.0	State Line	Indiana	Newton	632.0

INDIANA HARBOR BELT RAILROAD.

Location.	Elevation.
Terminus, north of Whiting	594.9
Curve Southeast of Whiting	593.8
Point North End Lake George	591.6
Point Middle East Side Lake Wolf	591.6
Point Southeast Corner Lake Wolf	590.6
Point Illinois Indiana State Line	592.8
Terminus Hammond	594.1
Point Southeast Corner Hammond	591.2
Point South Edge East Chicago	590.9
Crossing C., I. & S.	594.5
Point East Edge East Chicago	592.6
Terminus Northeast Corner East Chicago	591.3

MICHIGAN CENTRAL RAILROAD.

Main Line.—New York Central.

Distances from Chicago.	Stations.	State.	County.	Elevation.
20	Hammond	Indiana	Lake	592.1
	Gibson (C., I. & E. Crossing)	Indiana	Lake	596.2
	Ivanhoe (E., J. & E. Crossing)	Indiana	Lake	599.4
28	Tolleston (Penna. Crossing)	Indiana	Lake	601.9
30	Gary	Indiana	Lake	603.3
35	East Gary	Indiana	Lake	614.2
	Willow Creek (B. & O. Crossing)	Indiana	Porter	634.3
39	Crisman	Indiana	Porter	643.8
44	Porter (L. S. & M. S. Crossing)	Indiana	Porter	644.1
48	Furnessville	Indiana	Porter	667.2
56	Michigan City	Indiana	Laporte	598.6

Joliet Division.

Distances from East Gary.	Stations.	State.	County.	Elevation.
0	East Gary	Indiana	Lake	614.2
3	Liverpool (Penna. Crossing)	Indiana	Lake	624.8
[illegible]	Glen Park (Nickel Plate Crossing)	Indiana	Lake	632.3
8	Ross	Indiana	Lake	635.4
10	Griffith	Indiana	Lake	637.8
13	Hartsdale	Indiana	Lake	629.2
15	Dyer	Indiana	Lake	634.8
	Indiana and Illinois State Line			634.7

South Bend Division.

Distances from Niles, Mich.	Stations.	State.	County.	Elevation.
	Webster	Indiana	St. Joseph	716.0
10	Notre Dame	Indiana	St. Joseph	714.0
12	South Bend	Indiana	St. Joseph	686.0

Benton Harbor Division.

Distances from South Bend.	Stations.	State.	County.	Elevation.
2	S. S. & S. Junction	Indiana	St. Joseph	719.0
8	Lydick	Indiana	St. Joseph	753.0
13	Warwick	Indiana	St. Joseph	744.0

THE LAKE SHORE AND MICHIGAN SOUTHERN RAILWAY.

Air Line Division.—Elkhart to Ohio-Indiana State Line.

NOTE.—Elevations given are of top of rail opposite middle of passenger station unless otherwise indicated. L. S. & M. S. datum is 572.34 above sea level.
(P) Indicates center of platform.
(H) Indicates center of highway.
(RX) Indicates center of railroad crossing.
(S) Indicates center of siding.
(TT) Indicates center of track trough.

Distances from Elkhart.	Stations.	State.	County.	Elevation.
0.00	Elkhart	Indiana	Elkhart	753.0
5.28	Dunlap	Indiana	Elkhart	784.5
10.23	Goshen	Indiana	Elkhart	797.6
18.03	Millersburg	Indiana	Elkhart	879.7
21.69	Grismore (TT)	Indiana	Noble	868.2
25.08	Ligonier	Indiana	Noble	893.8
30.47	Wawaka	Indiana	Noble	904.2
34.91	Brimfield	Indiana	Noble	952.1
41.64	Kendallville	Indiana	Noble	975.7
48.01	Corunna	Indiana	Dekalb	967.1
54.35	Waterloo	Indiana	Dekalb	916.3
62.26	Butler	Indiana	Dekalb	870.8
66.01	Ohio-Indiana State Line			850.4

Western Division.—Elkhart to Indiana-Illinois State Line.

Distances from Elkhart.	Stations.	State.	County.	Elevation.
0.00	Elkhart	Indiana	Elkhart	753.0
5.51	Osceola	Indiana	St. Joseph	740.0
11.11	Mishawaka	Indiana	St. Joseph	723.5
15.09	South Bend	Indiana	St. Joseph	721.9
22.05	Lydick	Indiana	St. Joseph	734.0
26.84	Terre Coupee	Indiana	St. Joseph	753.4
28.48	New Carlisle	Indiana	St. Joseph	778.2
30.15	Hudson Lake	Indiana	Laporte	804.6
34.77	Rolling Prairie	Indiana	Laporte	815.5
41.80	Laporte	Indiana	Laporte	813.2
45.79	Pinola	Indiana	Laporte	835.3
48.20	Durham	Indiana	Laporte	835.6
51.75	Otis	Indiana	Laporte	746.5
55.20	Burdick	Indiana	Porter	685.5
59.47	Chesterton	Indiana	Porter	644.6
60.57	Porter (RX)	Indiana	Porter	643.6
65.12	Dune Park	Indiana	Porter	610.1
70.83	Millers	Indiana	Lake	621.7
74.43	Gary	Indiana	Lake	613.3
77.65	Pine	Indiana	Lake	592.6
79.55	Buffington	Indiana	Lake	590.9
81.20	Indiana Harbor	Indiana	Lake	590.2
83.77	Whiting	Indiana	Lake	589.7
85.06	Robertsdale	Indiana	Lake	588.6
85.58	Robey	Indiana	Lake	588.6
86.56	Indiana-Illinois State Line			588.5

Old Road Division.—Elkhart to Indiana-Michigan Line.

Distances from Elkhart.	Stations.	State.	County.	Elevation.
0.00	Elkhart	Indiana	Elkhart	753.0
4.21	Morehouse (S)	Indiana	Elkhart	761.4
8.35	Bristol	Indiana	Elkhart	771.8
13.43	Vistula	Indiana	Elkhart	794.2
14.75	Indiana-Michigan State Line			794.3

LAKE SHORE AND MICHIGAN SOUTHERN RAILWAY—Continued.

Ft. Wayne Branch.—Ft. Wayne to Indiana-Michigan State Line.

Distances from Ft. Wayne.	Stations.	State.	County.	Elevation.
0.00	Fort Wayne	Indiana	Allen	757.3
5.50	Academie (P)	Indiana	Allen	829.9
7.85	Carroll's Crossing (H)	Indiana	Allen	852.6
9.85	Huntertown (H)	Indiana	Allen	871.1
11.48	Stoners (H)	Indiana	Allen	837.7
14.61	New Era	Indiana	Dekalb	857.7
16.12	St. Johns (H)	Indiana	Dekalb	861.3
19.63	Auburn Junction (P)	Indiana	Dekalb	867.0
20.79	Auburn	Indiana	Dekalb	869.1
25.81	Waterloo	Indiana	Dekalb	916.3
31.57	Summit	Indiana	Dekalb	1,001.1
32.79	Steubenville	Indiana	Steuben	991.0
35.78	Pleasant Lake	Indiana	Steuben	976.1
40.03	Angola	Indiana	Steuben	1,055.3
47.38	Fremont	Indiana	Steuben	1,058.1
51.45	Ray	Indiana	Steuben	1,077.8
51.55	Indiana-Michigan State Line			1,077.3

Goshen and Michigan Branch.—Goshen to Indiana-Michigan Line.

Distances from Goshen.	Stations.	State.	County.	Elevation.
0.00	Goshen	Indiana	Elkhart	797.6
4.18	Williams	Indiana	Elkhart	845.5
6.48	Burns (H)	Indiana	Elkhart	894.6
9.26	Middlebury	Indiana	Elkhart	852.1
12.74	Oak (H)	Indiana	Lagrange	852.5
14.25	Pashan (H)	Indiana	Lagrange	869.3
16.44	Shipshewana	Indiana	Lagrange	903.2
20.42	Seyberts	Indiana	Lagrange	855.3
23.24	Twin Lake	Indiana	Lagrange	859.1
25.60	Indiana-Michigan State Line			863.0

Elkhart and Western Branch.—Elkhart to Mishawaka.

Distances from Elkhart.	Stations.	State.	County.	Elevation.
0.00	Elkhart (E. & W. Depot)	Indiana	Elkhart	738.1
4.99	Pleasant Valley (S)	Indiana	Elkhart	749.9
8.97	Willow Creek (H)	Indiana	St. Joseph	738.3
12.10	Mishawaka (Freight House)	Indiana	St. Joseph	696.5

CLEVELAND, CINCINNATI, CHICAGO AND ST. LOUIS RAILROAD.

Indianapolis Division.

Distances from Galion, O	Stations.	State.	County.	Elevation.
119.0	Union City	Indiana	Randolph	1,111.4
124.0	Harrisville	Indiana	Randolph	1,104.7
129.0	Winchester	Indiana	Randolph	1,091.2
138.0	Farmland	Indiana	Randolph	1,040.2
141.0	Parker City	Indiana	Randolph	1,025.7
145.0	Selma	Indiana	Delaware	984.7
151.0	Muncie	Indiana	Delaware	947.5
156.0	Yorktown	Indiana	Delaware	925.0
161.0	Daleville	Indiana	Delaware	916.0
166.0		Indiana	Madison	914.0
168.0	Anderson	Indiana	Madison	885.0
171.0		Indiana	Madison	876.5
177.0	Pendleton	Indiana	Madison	875.0
181.0		Indiana	Madison	870.0
186.0	Fortville	Indiana	Hancock	863.0
192.0	Oaklandon	Indiana	Marion	831.9
196.0	Lawrence	Indiana	Marion	871.5
199.0	Brightwood	Indiana	Marion	793.7
204.0	Indianapolis	Indiana	Marion	707.6

St. Louis Division.

Distances from Indianapolis	Stations.	State.	County.	Elevation.
0.0	Indianapolis	Indiana	Marion	707.6
4.0		Indiana	Marion	711.0
6.0		Indiana	Marion	748.3
11.0		Indiana	Hendricks	826.5
16.0		Indiana	Hendricks	844.5
20.0	Danville	Indiana	Hendricks	922.7
24.0	Hadley	Indiana	Hendricks	936.3
26.0		Indiana	Hendricks	896.9
31.0		Indiana	Putnam	880.4
36.0		Indiana	Putnam	805.1
39.0	Greencastle	Indiana	Putnam	721.2
46.0		Indiana	Putnam	718.9
49.0	Lena	Indiana	Clay	773.4
56.0	Perth	Indiana	Clay	638.2
61.0	Fontanet	Indiana	Vigo	543.0
73.0	Terre Haute	Indiana	Vigo	476.0
76.0		Indiana	Vigo	547.5
81.0	Sanford	Indiana	Vigo	631.0

CLEVELAND, CINCINNATI, CHICAGO AND ST. LOUIS RAILROAD.

Chicago Division.

Distances from Cincinnati, Ohio.	Stations.	State.	County.	Elevation.
23.0	Lawrenceburg Junction	Indiana	Dearborn	498.0
26.0		Indiana	Dearborn	491.5
31.0	Manchester	Indiana	Dearborn	588.0
36.0		Indiana	Dearborn	826.0
41.0	Sunman	Indiana	Ripley	1,018.6
46.0	Morris	Indiana	Ripley	997.5
51.0		Indiana	Franklin	946.5
56.0	New Point	Indiana	Decatur	986.0
59.0	McCoy	Indiana	Decatur	1,003.0
66.0		Indiana	Decatur	930.0
71.0		Indiana	Decatur	887.5
76.0	Waldron	Indiana	Shelby	854.5
80.0		Indiana	Shelby	830.0
86.0		Indiana	Shelby	771.5
91.0	Fairland	Indiana	Shelby	769.5
96.0	London	Indiana	Shelby	773.0

CLEVELAND, CINCINNATI, CHICAGO AND ST. LOUIS RAILROAD—Continued.

Chicago Division—Continued.

Distances from Cincinnati, Ohio.	STATIONS.	State.	County.	Elevation.
101.0		Indiana	Marion	816.5
106.0	Beech Grove	Indiana	Marion	841.5
112 0	Indianapolis	Indiana	Marion	707.6
121.0	Augusta	Indiana	Marion	822.0
126.0	Zionsville	Indiana	Boone	842.0
131 0	Whitestown	Indiana	Boone	928.0
136.0		Indiana	Boone	955.0
141.0		Indiana	Boone	928.0
146 0	Hazelrigg	Indiana	Boone	904.0
151 0		Indiana	Boone	830.0
156 0		Indiana	Clinton	824.0
161 0	Stockwell	Indiana	Tippecanoe	810.0
166.0	Crane	Indiana	Tippecanoe	736.0
171.0	Altamount	Indiana	Tippecanoe	645.0
176.0	Lafayette	Indiana	Tippecanoe	542.0
181.0		Indiana	Tippecanoe	700.0
186 0		Indiana	Tippecanoe	691.0
191 0		Indiana	Benton	707.0
196.0	Atkinson	Indiana	Benton	712.0
201 0	Swanington	Indiana	Benton	800.0
206 0	Gravel Hill	Indiana	Benton	811.0
211 0	Sheff	Indiana	Benton	780.0
216.0		Indiana	Benton	727.0
221 0	Sheldon	Indiana	Benton	680.0
224.0	Iroquois	Indiana	Benton	649.0

CLEVELAND, CINCINNATI, CHICAGO AND ST. LOUIS RAILROAD.

Michigan Division.

Distances from St. Joseph, Mich.	STATIONS.	State.	County.	Elevation.
36.0	Granger	Indiana	St. Joseph	806.0
41.0		Indiana	Elkhart	761.0
46.0	Elkhart	Indiana	Elkhart	753.0
51.0	Dunlap	Indiana	Elkhart	778.5
56.0	Goshen	Indiana	Elkhart	791.0
61.0	New Paris	Indiana	Elkhart	809.0
66.0	Milford Junction	Indiana	Kosciusko	818.0
71.0		Indiana	Kosciusko	842.0
76.0		Indiana	Kosciusko	832.0
81.0	Warsaw	Indiana	Kosciusko	808.0
86.0	Claypool	Indiana	Kosciusko	853.5
91.0	Silver Lake	Indiana	Kosciusko	884.5
96.0		Indiana	Wabash	829.0
101.0	Bolivar	Indiana	Wabash	757.0
106.0	Urbana	Indiana	Wabash	786.5
111.0		Indiana	Wabash	810.0
116.0		Indiana	Wabash	752.0
121.0		Indiana	Wabash	793.0
126 0	Fox's	Indiana	Grant	804.0
131.0	Marion	Indiana	Grant	810.0
136.0	Jonesboro	Indiana	Grant	834.0
141.0	Fairmount	Indiana	Grant	852.0
146.0		Indiana	Madison	872.0
151.0		Indiana	Madison	872.5
156.0		Indiana	Madison	861.5
161.0		Indiana	Madison	870.0
166.0	Anderson	Indiana	Madison	864.0
171.0	Alliance	Indiana	Madison	893.0
177.0		Indiana	Madison	937.0
181.0	Shirley	Indiana	Hancock	997.0
186.0	Knightstown	Indiana	Henry	978.0
191.0	Carthage	Indiana	Rush	890.0
196.0	Farmers	Indiana	Rush	951.5
201.0		Indiana	Rush	935.0
206.0	Rushville	Indiana	Rush	946.0
211.0	Milroy	Indiana	Rush	970.0

CLEVELAND, CINCINNATI, CHICAGO AND ST. LOUIS RAILROAD—Continued.

Michigan Division—Continued.

Distances from St. Joseph, Mich.	STATIONS.	State.	County.	Elevation.
216.0	Sandusky	Indiana	Decatur	940.0
221.0		Indiana	Decatur	933.0
226.0		Indiana	Decatur	914.0
231.0	Horace	Indiana	Decatur	875.0
236.0	Westport	Indiana	Decatur	855.0
241.0		Indiana	Jennings	775.5
246.0		Indiana	Jennings	734.0
250.0	North Vernon	Indiana	Jennings	725.0

F. F. & M. Branch.

Distances from Fairland.	STATIONS.	State.	County.	Elevation.
0.0	Fairland	Indiana	Shelby	769.5
12.0	Franklin	Indiana	Johnson	733.9
26.0	Morgantown	Indiana	Morgan	692.0
38.0	Martinsville	Indiana	Morgan	596.5

LAKE ERIE AND WESTERN RAILROAD.

Main Line.

Distances from Sandusky, Ohio.	STATIONS.	State.	County.	Elevation.
141.1	Brice	Indiana	Jay	923.5
145.7	Portland	Indiana	Jay	908.5
150.3	Blaine	Indiana	Jay	929.5
152.3	Como	Indiana	Jay	949.0
156.6	Redkey	Indiana	Jay	965.6
162.4	Albany	Indiana	Delaware	938.8
167.2	DeSoto	Indiana	Delaware	955.6
173.6	Muncie	Indiana	Delaware	947.7
179.5	Cammack	Indiana	Delaware	930.5
181.0	Reeds	Indiana	Delaware	929.1
184.3	Gilman	Indiana	Madison	901.4
189.9	Alexandria	Indiana	Madison	854.8
192.6	Orestes	Indiana	Madison	870.8
194.1	Dundee	Indiana	Madison	874.5
198.6	Elwood	Indiana	Madison	862.3
204.0	Hobbs	Indiana	Tipton	869.0
210.2	Tipton	Indiana	Tipton	871.7
215.0	Goldsmith	Indiana	Tipton	908.8
219.1	Kempton	Indiana	Tipton	927.7
222.8	Circleville	Indiana	Clinton	929.3
225.0	Hillisburg	Indiana	Clinton	919.7
227.9	Boylston	Indiana	Clinton	903.0
234.1	Frankfort	Indiana	Clinton	848.8
238.7	Deniston	Indiana	Clinton	844.1
243.5	Mulberry	Indiana	Clinton	772.6
249.4	Dayton	Indiana	Tippecanoe	672.7
255.6	Altamont	Indiana	Tippecanoe	647.1
258.6	Lafayette	Indiana	Tippecanoe	539.9
260.4	Summit	Indiana	Tippecanoe	608.0
263.2	Balls	Indiana	Tippecanoe	697.0
267.5	Montmorenci	Indiana	Tippecanoe	692.0
271.2	Otterbein	Indiana	Benton	705.3
272.0	Vilas	Indiana	Benton	707.0
277.2	Templeton	Indiana	Benton	669.0
279.3	Oxford	Indiana	Benton	727.8
280.9	Fargo	Indiana	Benton	771.0
284.3	Chase	Indiana	Benton	738.3
286.5	Boswell	Indiana	Benton	756.3
290.3	Talbot	Indiana	Benton	763.8
291.4	Handy	Indiana	Benton	743.0
293.6	Ambia	Indiana	Benton	730.6

LAKE ERIE AND WESTERN RAILROAD.

Indianapolis and Michigan City Division.

Distances from Indianapolis.	Stations.	State.	County.	Elevation.
0.0	Indianapolis	Indiana	Marion	707.0
1.8	Massachusetts Ave	Indiana	Marion	732.0
3.0	Belt Junction	Indiana	Marion	726.0
3.9	Moon	Indiana	Marion	726.0
7.1	Malott Park	Indiana	Marion	752.8
12.1	Castleton	Indiana	Marion	809.4
16.1	Fishers	Indiana	Hamilton	815.6
22.2	Noblesville	Indiana	Hamilton	772.2
28.5	Cicero	Indiana	Hamilton	837.2
31.6	Arcadia	Indiana	Hamilton	859.7
34.5	Atlanta	Indiana	Hamilton	862.1
39.6	Tipton	Indiana	Tipton	871.6
42.5	Jacksons	Indiana	Tipton	882.9
46.2	Sharpsville	Indiana	Tipton	877.1
49.1	Fairfield	Indiana	Howard	858.5
52.6	Marshall	Indiana	Howard	828.0
54.3	Kokomo	Indiana	Howard	816.7
54.7	Kokomo Junction	Indiana	Howard	817.5
59.2	Cassville	Indiana	Howard	811.2
60.9	Bennetts	Indiana	Miami	815.8
63.0	Miami	Indiana	Miami	789.0
66.2	Bunker Hill	Indiana	Miami	804.1
73.8	Peru	Indiana	Miami	648.8
77.8	Doyle	Indiana	Miami	790.0
79.8	Courter	Indiana	Miami	742.6
81.9	Denver	Indiana	Miami	703.9
85.4	Deeds	Indiana	Miami	831.7
88.9	Macy	Indiana	Miami	848.0
91.4	Wagoners	Indiana	Miami	843.8
97.7	Rochester	Indiana	Fulton	779.6
104.0	Tiosa	Indiana	Fulton	825.9
105.5	Walnut	Indiana	Fulton	850.0
107.7	Railsback	Indiana	Marshall	886.0
110.1	Argos	Indiana	Marshall	828.4
118.3	Plymouth	Indiana	Marshall	790.3
125.0	Tyner	Indiana	Marshall	790.7
130.6	Walkerton	Indiana	St. Joseph	724.6
135.3	Kankakee	Indiana	Laporte	691.6
139.6	Stillwell	Indiana	Laporte	730.8
147.1	Laporte	Indiana	Laporte	815.3
149.4	Belfast	Indiana	Laporte	863.4
152.3	Oakwood	Indiana	Laporte	727.0
156.0	Roeskes	Indiana	Laporte	628.0
159.3	Michigan City	Indiana	Laporte	597.0

LAKE ERIE AND WESTERN RAILROAD.

Connersville to Ft. Wayne.

Distances from Connersville.	Stations.	State.	County.	Elevation.
0.0	Connersville	Indiana	Fayette	828.0
5.3	Beesons	Indiana	Wayne	876.0
10.1	Milton	Indiana	Wayne	935.5
11.9	Cambridge City	Indiana	Wayne	940.5
17.9	New Lisbon	Indiana	Henry	1,100.0
25.2	New Castle	Indiana	Henry	1,039.8
27.7	Fayne	Indiana	Henry	1,058.0
28.2	Rhein	Indiana	Henry	1,077.0
30.3	Mount Summit	Indiana	Henry	1,088.7
33.4	Springport	Indiana	Henry	1,017.0
35.5	Oakville	Indiana	Delaware	1,007.5
37.3	Cowan	Indiana	Delaware	991.4
43.3	Muncie	Indiana	Delaware	949.5
48.7	Royerton	Indiana	Delaware	928.4
51.6	Shidelers	Indiana	Delaware	910.8
54.0	Eaton	Indiana	Delaware	909.5
61.6	Hartford City	Indiana	Blackford	887.6
69.7	Montpelier	Indiana	Blackford	867.0
72.8	Keystone	Indiana	Wells	862.0
77.5	Poneto	Indiana	Wells	849.0
83.6	Bluffton	Indiana	Wells	827.2
90.0	Kingsland	Indiana	Wells	853.8
93.4	Ossian	Indiana	Wells	825.2

LAKE ERIE AND WESTERN RAILROAD—Continued.
Connersville to Ft. Wayne—Continued.

Distances from Connersville.	STATIONS.	State.	County.	Elevation.
96.8	Yoder	Indiana	Allen	813.0
100.7	Fergusons	Indiana	Allen	794.5
105.1	Hugo	Indiana	Allen	787.9
108.5	Ft. Wayne	Indiana	Allen	788.0

LAKE ERIE AND WESTERN RAILROAD.
Rushville Branch.

Distances from Ft. Wayne.	STATIONS.	State.	County.	Elevation.
83.3	New Castle	Indiana	Henry	1,039.8
91.2	Spiceland	Indiana	Henry	1,062.5
93.5	Dunreith	Indiana	Henry	1,036.2
97.7	Mays	Indiana	Rush	1,006.8
100.7	Sexton	Indiana	Rush	1,000.9
107.3	Rushville	Indiana	Rush	956.2

CINCINNATI, HAMILTON AND DAYTON RAILROAD.

Distances from Cincinnati, Ohio.	STATIONS.	State.	County.	Elevation
45.00	College Corner—State Line			988.0
48.21	Cottage Grove	Indiana	Union	1,042.0
50.25	Lotus	Indiana	Union	1,039.0
53.01	Liberty	Indiana	Union	980.0
59.15	Brownsville	Indiana	Union	793.0
62.88	Lyons	Indiana	Fayette	884.0
67.29	Connersville	Indiana	Fayette	832.0
72.00	Longwood—Summit	Indiana	Fayette	1,027.0
75.71	Hurricane—The Summit	Indiana	Fayette	1,104.0
76.97	Glenwood	Indiana	Rush	1,080.0
78.99	Griffin	Indiana	Rush	1,050.0
80.26	Farmington	Indiana	Rush	1,032.0
85.06	Rushville	Indiana	Rush	968.0
89.40	Brandon	Indiana	Rush	942.0
92.13	Arlington	Indiana	Rush	920.0
96.23	Gwynnville	Indiana	Shelby	911.0
99.03	Morristown	Indiana	Shelby	847.0
101.56	Lardona	Indiana	Shelby	852.0
103.65	Fountaintown	Indiana	Shelby	844.0
105.99	Reedville	Indiana	Hancock	834.0
109.72	New Palestine	Indiana	Hancock	831.0
113.46	Julietta	Indiana	Marion	830.0
116.96	Fenton	Indiana	Marion	857.0
119.74	Irvington	Indiana	Marion	819.0
124.06	Indianapolis—Virginia Ave	Indiana	Marion	709.0
126.60	Moorefield	Indiana	Marion	704.5
138.40	Tyrone	Indiana	Hendricks	870.5
139.80	Tilden	Indiana	Hendricks	897.0
143.50	Maplewood	Indiana	Hendricks	941.0
147.10	Montclair	Indiana	Hendricks	957.0
151.50	North Salem	Indiana	Hendricks	886.0
154.30	Barnard	Indiana	Putnam	902.0
156.75	Wheaton	Indiana	Putnam	885.5
159.80	Roachdale	Indiana	Putnam	837.5
164.50	Raccoon	Indiana	Putnam	738.5
169.50	Russellville	Indiana	Putnam	825.0
172.90	Milligan	Indiana	Parke	791.0
176.40	Guion	Indiana	Parke	653.5
178.60	Bethany	Indiana	Parke	742.0
180.90	Marshall	Indiana	Parke	699.0
184.40	Bloomingdale	Indiana	Parke	641.6
187.10	Leatherwood	Indiana	Parke	572.0
190.10	West Melcher	Indiana	Parke	526.0
191 90	Montezuma	Indiana	Parke	495.0
192.70	Hillsdale	Indiana	Vermillion	489.0
199.30	Dana	Indiana	Vermillion	644.0
201.40	State Line	Indiana	Vermillion	629.0

CHICAGO, INDIANAPOLIS AND LOUISVILLE RAILROAD.

State Line to New Albany.

Distances from Chicago, Ill.	Stations.	State.	County.	Elevation.
19.8	State Line			587.3
20.0		Indiana		588.8
20.7	Hammond	Indiana	Lake	590.0
21.0		Indiana		591.0
22.0		Indiana		603.2
23.0		Indiana		601.0
23.2	South Hammond	Indiana	Lake	600.0
24.0		Indiana		602.0
24.6	Munster	Indiana	Lake	615.7
25.0		Indiana		615.7
25.5	Maynard	Indiana	Lake	615.7
25.8	Grand Trunk Crossing	Indiana	Lake	615.7
26.0		Indiana		616.2
27.0		Indiana		619.6
28.0		Indiana		625.0
29.0	Dyer	Indiana	Lake	632.5
30.0		Indiana		641.5
31.0		Indiana		666.0
32.0		Indiana		690.1
33.0		Indiana		700.6
33.5	St. John	Indiana	Lake	702.0
34.0		Indiana		696.0
35.0		Indiana		707.7
36.0		Indiana		723.3
37.0		Indiana		741.1
38.0		Indiana		721.5
38.4	Armour	Indiana	Lake	711.5
39.0		Indiana		697.4
39.5	Cedar Lake	Indiana	Lake	695.0
40.0		Indiana		695.0
41.0		Indiana		697.8
41.5	Creston	Indiana	Lake	708.8
42.0		Indiana		710.2
43.0		Indiana		694.5
44.0		Indiana		682.9
44.8	Lowell	Indiana	Lake	666.8
45.0		Indiana		667.8
46.0		Indiana		676.8
47.0		Indiana		663.6
48.0		Indiana		641.5
49.0		Indiana		641.0
50.0		Indiana		641.0
50.2	Grassmere	Indiana	Lake	641.0
51.0		Indiana		641.2
52.0		Indiana		640.2
52.6	Shelby	Indiana	Lake	640.2
53.0		Indiana		641.0
53.2	Water Valley	Indiana	Newton	642.1
54.0		Indiana		643.6
54.1	Thayer	Indiana	Newton	643.7
55.0		Indiana		649.3
56.0		Indiana		677.1
56.5	Rose Lawn	Indiana	Newton	688.7
57.0		Indiana		688.2
58.0		Indiana		685.3
59.0		Indiana		685.2
60.0		Indiana		685.4
60.4	Pembroke	Indiana	Jasper	687.0
61.0		Indiana		688.0
62.0		Indiana		696.7
62.2	Fair Oaks	Indiana	Jasper	695.3
63.0		Indiana		691.2
64.0		Indiana		690.4
65.0		Indiana		686.1
65.8	Parr	Indiana	Jasper	690.0
66.0		Indiana		693.7
67.0		Indiana		694.2
68.0		Indiana		696.1
68.1	Surrey	Indiana	Jasper	697.0
69.0		Indiana		704.8
70.0		Indiana		717.3
71.0		Indiana		690.6
72.0		Indiana		665.5
72.8	Rensselaer	Indiana	Jasper	664.0

CHICAGO, INDIANAPOLIS AND LOUISVILLE RAILROAD—Continued.

State Line to New Albany—Continued.

Distances from Chicago, Ill.	Stations.	State.	County.	Elevation.
73.0		Indiana		662.5
74.0		Indiana		662.8
75.0		Indiana		663.0
76.0		Indiana		668.0
76.9	Pleasant Ridge	Indiana	Jasper	696.0
77.0		Indiana		695.0
78.0		Indiana		682.1
79.0		Indiana		684.4
80.0	McCoysburg	Indiana	Jasper	672.3
81.0		Indiana		669.1
82.0		Indiana		669.8
83.0		Indiana		670.9
83.1	Lee	Indiana	White	671.0
84.0		Indiana		679.3
85.0		Indiana		680.5
86.0		Indiana		684.3
87.0		Indiana		687.0
88.0		Indiana		679.8
88.4	Monon	Indiana	White	672.3
89.0		Indiana		677.0
90.0		Indiana		684.9
91.0		Indiana		686.9
92.0		Indiana		686.9
93.0		Indiana		685.5
94.0		Indiana		686.1
95.0		Indiana		686.5
95.8	Reynolds	Indiana	White	694.0
96.0		Indiana		698.0
97.0		Indiana		696.0
98.0		Indiana		690.7
98.2	Wheelers	Indiana	White	690.7
99.0		Indiana		689.4
100.0		Indiana		692.9
101.0		Indiana		703.1
102.0		Indiana		709.0
102.1	Chalmers	Indiana	White	708.9
103.0		Indiana		705.4
104.0		Indiana		695.0
105.0		Indiana		695.0
106.0		Indiana		683.5
106.2	Brookston	Indiana	White	680.5
107.0		Indiana		672.2
108.0		Indiana		686.8
109.0		Indiana		679.0
110.0		Indiana		663.3
110.2	Ash Grove	Indiana	Tippecanoe	666.0
111.0		Indiana		652.0
112.0		Indiana		610.0
112.9	Battle Ground	Indiana	Tippecanoe	584.3
113.0		Indiana		580.2
114.0		Indiana		550.6
115.0		Indiana		547.5
116.0		Indiana		537.8
117.0		Indiana		543.0
118.0		Indiana		549.0
119.0		Indiana		536.0
119.5	Lafayette	Indiana	Tippecanoe	539.0
120.0		Indiana		554.0
121.0	Lafayette Junction	Indiana	Tippecanoe	571.0
122.0		Indiana		559.0
122.5	Gravelotte	Indiana	Tippecanoe	588.2
123.0		Indiana		613.0
124.0		Indiana		582.0
125.0		Indiana		584.2
126.0		Indiana		623.7
126.5	Taylors	Indiana	Tippecanoe	651.0
127.0		Indiana		658.0
128.0		Indiana		706.7
129.0		Indiana		697.0
129.5	Raubs	Indiana	Tippecanoe	707.2
130.0		Indiana		733.0
131.0		Indiana		743.2
132.0		Indiana		741.0
132.9	Romney	Indiana	Tippecanoe	738.0

CHICAGO, INDIANAPOLIS AND LOUISVILLE RAILROAD—Continued.

State Line to New Albany—Continued.

Distances from Chicago, Ill.	Stations.	State.	County.	Elevation.
133.0		Indiana		739.7
134.0		Indiana		734.4
135.0		Indiana		755.0
136.0		Indiana		770.3
137.0	Linden	Indiana	Montgomery	787.0
138.0		Indiana		800.3
139.0		Indiana		824.3
140.0		Indiana		804.0
141.0	Cherry Grove	Indiana	Montgomery	797.5
142.0		Indiana		783.6
143.0		Indiana		765.0
144.0	Manchester	Indiana	Montgomery	753.4
145.0		Indiana	Montgomery	755.7
146.0		Indiana		719.0
147.0		Indiana		728.5
147.3	Crawfordsville	Indiana	Montgomery	738.7
148.0		Indiana		770.0
148.4	Crawfordsville Junction	Indiana	Montgomery	786.7
149.0		Indiana		781.0
150.0		Indiana		807.0
151.0		Indiana		835.9
152.0		Indiana		821.8
153.0		Indiana		862.0
153.9	Whitesville	Indiana	Montgomery	871.0
154.0		Indiana		873.0
155.0		Indiana		873.0
156.0		Indiana		840.5
157.0		Indiana		850.0
157.8	Ladoga	Indiana	Montgomery	822.5
158.0		Indiana		822.5
159.0		Indiana		825.3
160.0		Indiana		811.8
161.0		Indiana		820.4
162.0		Indiana		835.6
162.2	Roachdale	Indiana	Putnam	839.5
163.0		Indiana		851.4
164.0		Indiana		845.1
165.0		Indiana		857.6
165.5	Carpentersville	Indiana	Putnam	883.0
166.0		Indiana		909.6
167.0		Indiana		926.0
168.0		Indiana		950.5
168.7	Bainbridge	Indiana	Putnam	933.0
169.0		Indiana		915.0
170.0		Indiana		874.0
171.0		Indiana		847.7
172.0		Indiana		800.4
173.0		Indiana		756.7
174.0		Indiana		711.8
175.0		Indiana		697.5
176.0		Indiana		713.0
177.0		Indiana		713.5
177.8	Greencastle	Indiana	Putnam	768.0
178.0		Indiana		771.6
179.0		Indiana		808.8
180.0	Limedale	Indiana	Putnam	763.0
181.0		Indiana		725.0
182.0		Indiana		732.0
183.0	Putnamville	Indiana	Putnam	683.3
184.0		Indiana		662.0
185.0		Indiana		690.8
186.0		Indiana		727.0
187.0		Indiana		774.0
188.0		Indiana		809.5
189.0		Indiana		772.0
189.2	Cloverdale	Indiana	Putnam	776.5
190.0		Indiana		762.7
191.0		Indiana		789.0
192.0		Indiana		773.4
192.2	Oakland	Indiana	Putnam	769.0
193.0		Indiana		738.3
194.0	Wallace Junction	Indiana	Owen	774.4
195.0		Indiana		744.0
195.3	Quincy	Indiana	Owen	742.0

CHICAGO, INDIANAPOLIS AND LOUISVILLE RAILROAD—Continued.

State Line to New Albany—Continued.

Distances from Chicago, Ill.	Stations.	State.	County.	Elevation.
196.0		Indiana		768.5
197.0		Indiana		770.0
197.8	Spring Cave	Indiana	Owen	769.5
198.0		Indiana	Owen	769.3
199.0		Indiana		740.0
200.0		Indiana		692.6
201.0		Indiana		643.0
202.0		Indiana		593.0
203.0		Indiana		567.0
203.1	Gosport Junction	Indiana	Owen	567.7
203.9	Gosport	Indiana	Owen	565.0
204.0		Indiana		566.2
205.0		Indiana		568.4
206.0		Indiana		568.0
207.0		Indiana		565.3
207.8	Stinesville	Indiana	Monroe	586.0
208.0		Indiana		589.0
209.0		Indiana		606.7
210.0		Indiana		629.6
211.0		Indiana		649.0
212.0		Indiana		666.0
212.2	Breyfogle	Indiana	Monroe	672.5
213.0		Indiana		681.0
213.1	Ellettsville	Indiana	Monroe	685.0
214.0		Indiana		717.0
215.0		Indiana		735.0
215.5	Woods	Indiana	Monroe	751.0
216.0		Indiana		772.5
217.0		Indiana		832.0
217.9	Hunters	Indiana	Monroe	884.0
218.0		Indiana		886.0
219.0		Indiana		866.5
220.0		Indiana		787.0
220.5	Bloomington	Indiana	Monroe	752.5
221.0		Indiana		735.0
222.0	Livingston	Indiana	Monroe	695.0
223.0		Indiana		680.3
224.0		Indiana		656.0
224.2	Clear Creek	Indiana	Monroe	655.0
225.0		Indiana		668.0
226.0		Indiana		727.0
227.0	Saunders	Indiana	Monroe	743.4
228.0		Indiana		728.0
228.2	Smithville	Indiana	Monroe	708.0
229.0		Indiana		646.6
230.0		Indiana		568.0
231.0		Indiana		518.0
232.0		Indiana		509.5
232.4	Harrodsburg	Indiana	Monroe	516.0
233.0		Indiana		509.3
234.0		Indiana		510.5
235.0		Indiana		517.4
235.4	Guthrie	Indiana	Lawrence	511.0
236.0		Indiana		509.0
237.0		Indiana		507.0
238.0		Indiana		507.7
238.6	Logan	Indiana	Lawrence	512.0
239.0		Indiana		508.5
240.0		Indiana		511.0
240.2	Peerless	Indiana	Lawrence	513.5
240.9	Thornton	Indiana	Lawrence	506.3
241.0		Indiana		505.6
241.4	Horse Shoe Bend	Indiana	Lawrence	606.0
242.0		Indiana		530.0
243.0		Indiana		589.0
244.0		Indiana		639.0
245.0		Indiana		703.6
245.6	Bedford Junction	Indiana	Lawrence	703.0
246.0	Bedford	Indiana	Lawrence	687.0
247.0		Indiana		642.0
248.0		Indiana		566.0
249.0		Indiana		516.0
249.4	Sand Pit	Indiana	Lawrence	527.0
250.0		Indiana		513.0

CHICAGO, INDIANAPOLIS AND LOUISVILLE RAILROAD—Continued.

State Line to New Albany—Continued.

Distances from Chicago, Ill.	Stations.	State.	County.	Elevation.
251.0		Indiana		555.0
251.7	Yockey	Indiana	Lawrence	593.0
252.0		Indiana		613.0
253.0		Indiana		651.0
253.3	Becks	Indiana	Lawrence	640.0
254.0		Indiana		665.6
255.0		Indiana		681.0
256.0	Mitchell	Indiana	Lawrence	678.1
257.0		Indiana		705.6
258.0		Indiana		680.0
259.0		Indiana		660.0
260.0		Indiana		637.3
261.0		Indiana		636.0
261.1	Orleans	Indiana	Orange	638.5
262.0		Indiana		658.3
263.0		Indiana		680.0
264.0		Indiana		697.0
265.0		Indiana		721.0
265.7	Leipsic	Indiana	Orange	723.2
266.0		Indiana		731.0
267.0		Indiana		752.0
268.0		Indiana		766.7
269.0		Indiana		785.0
270.0		Indiana		797.2
270.1	Saltillo	Indiana	Washington	800.0
271.0		Indiana		810.0
271.9	Campbellsburg	Indiana	Washington	838.0
272.0		Indiana		839.0
273.0		Indiana		844.7
274.0		Indiana		867.0
274.6	Smedley	Indiana	Washington	878.4
275.0		Indiana		895.0
276.0		Indiana		893.0
277.0		Indiana		883.0
277.2	Hitchcock	Indiana	Washington	874.0
278.0		Indiana		848.5
279.0		Indiana		780.0
280.0		Indiana		731.6
281.0		Indiana		710.0
281.1	Salem Quarry	Indiana	Washington	725.1
282.0		Indiana		726.0
282.3	Salem	Indiana	Washington	723.0
283.0		Indiana		729.5
284.0		Indiana		742.0
285.0		Indiana		761.0
286.0		Indiana		816.9
286.9	Norris	Indiana	Washington	873.0
287.0		Indiana		879.6
288.0		Indiana		813.0
289.0		Indiana		752.0
290.0		Indiana		753.0
290.2	Farabee	Indiana	Washington	765.0
291.0		Indiana		812.0
292.0		Indiana		798.7
293.0		Indiana		738.8
294.0	Pekin	Indiana	Washington	714.5
295.0		Indiana		703.2
296.0		Indiana		697.0
297.0		Indiana		617.0
298.0		Indiana		584.0
299.0	Borden	Indiana	Clark	562.9
300.0		Indiana		548.6
301.0		Indiana		530.0
302.0		Indiana		523.4
303.0		Indiana		513.7
303.1	Broom Hill	Indiana	Clark	510.0
303.8	Bridgeport	Indiana		503.5
304.0		Indiana		500.0
305.0		Indiana		491.6
305.6	Wilsons	Indiana	Clark	496.0
306.0		Indiana		521.6
307.0		Indiana		548.5
307.3	Bennettsville	Indiana	Clark	549.0
308.0		Indiana		573.7

CHICAGO, INDIANAPOLIS AND LOUISVILLE RAILROAD—Continued.

State Line to New Albany—Continued.

Distances from Chicago, Ill.	Stations.	State.	County.	Elevation.
309.0		Indiana		553.4
309.4	St. Joseph	Indiana	Clark	550.2
310.0		Indiana		570.0
310.9	Smith	Indiana	Floyd	565.0
311.0		Indiana		572.5
312.0		Indiana		542.5
313.0		Indiana		536.0
314.0		Indiana		494.5
315.0		Indiana		475.0
316.0		Indiana		446.0
317.0		Indiana		457.0
317.6	New Albany	Indiana	Floyd	459.8

CHICAGO, INDIANAPOLIS AND LOUISVILLE RAILROAD.

Monon to Indianapolis.

Distances from Chicago, Ill.	Stations.	State.	County.	Elevation.
88.4	Monon	Indiana	White	673.0
89.0		Indiana		678.5
90.0		Indiana		677.9
91.0		Indiana		680.2
92.0		Indiana		687.7
93.0		Indiana		684.0
93.8	Guernsey	Indiana	White	687.0
94.0		Indiana		690.0
95.0		Indiana		680.6
96.0		Indiana		682.5
97.0		Indiana		685.0
98.0		Indiana		691.5
98.6	Monticello	Indiana	White	678.0
99.0		Indiana		676.0
100.0		Indiana		666.2
101.0		Indiana		681.0
101.7	Pattons	Indiana	Carroll	682.4
102.0		Indiana		677.7
103.0		Indiana		670.3
104.0		Indiana		665.2
104.4	Lennox	Indiana	Carroll	663.7
105.0		Indiana		661.5
105.8	Sleeths	Indiana	Carroll	657.8
106.0		Indiana		656.7
107.0		Indiana		658.5
107.9	Wabash River	Indiana	Carroll	647.0
108.0		Indiana		646.2
109.0		Indiana		605.0
110.0		Indiana		559.0
110.4	North Delphi	Indiana	Carroll	557.0
111.0	Delphi	Indiana	Carroll	555.0
112.0		Indiana		589.0
113.0		Indiana		611.4
114.0		Indiana		656.0
114.4	Deer Creek	Indiana	Carroll	672.0
115.0		Indiana		675.0
116.0		Indiana		686.2
117.0	Harleys	Indiana	Carroll	693.5
118.0		Indiana		694.5
118.6	Radnor	Indiana	Carroll	685.5
119.0		Indiana		692.0
120.0		Indiana		693.6
120.1	Ockley	Indiana	Carroll	695.0
121.0		Indiana		699.7
122.0		Indiana		694.7
122.2	Owasco	Indiana	Carroll	701.0
123.0		Indiana		710.5
124.0		Indiana		726.6

CHICAGO, INDIANAPOLIS AND LOUISVILLE RAILROAD.

Monon to Indianapolis—Continued.

Distances from Chicago, Ill.	Stations.	State.	County.	Elevation.
125.0		Indiana		711.0
125.6	Rossville	Indiana	Clinton	725.0
126.0		Indiana		725.6
127.0		Indiana		761.0
128.0		Indiana		790.7
129.0		Indiana		811.3
129.7	Cambria	Indiana	Clinton	825.0
130.0		Indiana		836.2
131.0		Indiana		824.0
132.0		Indiana		819.0
133.0		Indiana		836.0
134.0		Indiana		830.5
135.0		Indiana		849.0
136.0	Frankfort	Indiana	Clinton	861.5
137.0		Indiana		865.0
138.0		Indiana		870.0
139.0		Indiana		880.0
140.0		Indiana		900.0
141.0		Indiana		911.8
142.0		Indiana		924.4
142.2	Cyclone	Indiana	Clinton	928.5
143.0		Indiana		923.0
144.0		Indiana		914.0
145.0		Indiana		899.4
146.0		Indiana		898.6
146.9	Kirklin	Indiana	Clinton	918.0
148.0		Indiana		924.0
149.0		Indiana		936.4
150.0		Indiana		931.0
151.0		Indiana		936.5
151.5	Terhune	Indiana	Boone	940.8
152.0		Indiana		944.0
153.0		Indiana		954.2
154.0		Indiana		961.2
155.0		Indiana		947.5
155.4	Sheridan	Indiana	Hamilton	947.5
156.0		Indiana		954.5
157.0		Indiana		953.4
158.0		Indiana		948.4
159.0		Indiana		939.7
159.9	Horton	Indiana	Hamilton	936.0
160.0		Indiana		933.1
161.0		Indiana		919.1
162.0		Indiana		904.0
163.0		Indiana		902.5
163.4	Westfield	Indiana	Hamilton	901.5
164.0		Indiana		893.0
165.0		Indiana		881.6
166.0		Indiana		874.0
167.0		Indiana		831.4
167.8	Carmel	Indiana	Hamilton	830.0
168.0		Indiana		830.6
169.0		Indiana		830.0
170.0		Indiana		838.3
171.0		Indiana		813.6
172.0		Indiana		792.7
172.4	Nora	Indiana	Marion	788.6
173.0		Indiana		776.4
174.0		Indiana		739.0
175.0		Indiana		721.5
175.3	Broad Ripple	Indiana	Marion	721.0
176.0		Indiana		738.8
177.0		Indiana		745.5
178.0		Indiana		735.5
178.3	Fair Grounds	Indiana	Marion	735.6
179.0		Indiana		729.0
180.0		Indiana		727.3
180.4	Belt Junction (Indianapolis)	Indiana	Marion	728.0
181.0		Indiana		724.0
181.7	Massachusetts Ave (Indianapolis)	Indiana	Marion	721.0

CHICAGO, INDIANAPOLIS AND LOUISVILLE RAILROAD.

Bedford to Switz City.

Distances from Chicago.	Stations.	State.	County.	Elevation.
246.0	Bedford	Indiana	Lawrence	702.5
247.0		Indiana		677.1
248.0		Indiana		610.2
249.0		Indiana		540.0
249.9	Dark Hollow	Indiana	Lawrence	514.0
250.0		Indiana		504.0
251.0		Indiana		510.0
251.5	Reeds	Indiana	Lawrence	509.2
252.0		Indiana		532.3
252.5	Avoca	Indiana	Lawrence	543.0
253.0		Indiana		591.4
254.0		Indiana		684.0
255.0		Indiana		695.0
256.0		Indiana		710.0
256.4	Flatwood	Indiana	Lawrence	702.7
257.0		Indiana		661.5
257.9	Springville	Indiana	Lawrence	639.7
258.0		Indiana		616.4
259.0		Indiana		576.0
260.0		Indiana		552.9
260.6	Armstrong	Indiana	Lawrence	548.0
261.0		Indiana		560.0
262.0		Indiana		561.7
263.0		Indiana		567.1
264.0		Indiana		602.0
264.9	Owensburg	Indiana	Greene	640.8
265.0		Indiana		664.5
266.0		Indiana		712.6
267.0		Indiana		672.8
268.0		Indiana		569.7
268.3	Dresden	Indiana	Greene	559.8
269.0		Indiana		544.8
269.8	Robinson	Indiana	Greene	537.1
270.0		Indiana		535.0
271.0		Indiana		525.8
272.0		Indiana		517.6
272.3	Koleen	Indiana	Greene	518.1
273.0		Indiana		516.0
274.0	Rockwood	Indiana	Greene	513.5
275.0		Indiana		505.8
275.7	Mineral City	Indiana	Greene	506.4
276.0		Indiana		501.4
277.0		Indiana		500.1
278.0		Indiana		505.5
279.0		Indiana		498.1
280.0		Indiana		528.1
280.3	Bloomfield	Indiana	Greene	507.8
281.0		Indiana		502.6
282.0	Elliston	Indiana	Greene	527 4
283.0		Indiana		518.1
283.2	Fairchilds	Indiana	Greene	511.8
284.0		Indiana		506.1
285.0		Indiana		538.0
286.0		Indiana		226.0
286.5	Switz City	Indiana	Greene	525.2

CHICAGO, INDIANAPOLIS AND LOUISVILLE RAILROAD.

Wallace Junction to Shirley Hill.

Distances from Chicago.	Stations.	State.	County.	Elevation.
194.0	Wallace Junction	Indiana	Owen	769.8
195.0		Indiana		752.2
196.0		Indiana		760.0
197.0		Indiana		758.1
198.0		Indiana		756.0
199.0		Indiana		766.0
200.0		Indiana		766.0
200.4	Cataract	Indiana	Owen	771.0

CHICAGO, INDIANAPOLIS AND LOUISVILLE RAILROAD—Continued.

Wallace Junction to Shirley Hill—Continued.

Distances from Chicago.	Stations.	State.	County.	Elevation.
201.0		Indiana		793.0
202.0		Indiana		789.9
203.0		Indiana		760.0
204.0		Indiana		723.8
205.0		Indiana		685.5
206.0		Indiana		645.5
206.9	Jordan	Indiana	Owen	649.0
207.0		Indiana		653.0
208.0		Indiana		649.0
209.0		Indiana		630.5
210.0		Indiana		612.0
211.0		Indiana		651.0
212.0		Indiana		676.0
213.0		Indiana		696.0
213.1	Patricksburg	Indiana	Owen	697.0
214.0		Indiana		670.0
215.0		Indiana		688.0
216.0		Indiana		670.0
217.0		Indiana		638.0
218.0		Indiana		616.5
219.0		Indiana		611.2
220.0		Indiana		594.0
221.0		Indiana		590.0
221.7	Clay City	Indiana	Clay	569.8
222.0		Indiana		571.9
223.0		Indiana		575.5
224.0		Indiana		571.3
225.0		Indiana		536.7
226.0		Indiana		529.6
227.0		Indiana		528.0
228.0		Indiana		528.0
229.0		Indiana		528.0
229.8	Howesville	Indiana	Clay	535.3
230.0		Indiana		532.0
231.0		Indiana		539.0
232.0		Indiana		548.5
233.0		Indiana		573.0
234.0		Indiana		556.1
235.0		Indiana		605.4
236.0	Midland	Indiana	Greene	641.3
237.0		Indiana		595.9
237.1	Vicksburg	Indiana	Greene	586.0
238.0		Indiana		553.9
239.0		Indiana		521.6
240.0		Indiana		511.0
241.0		Indiana		494.3
241.1	Victoria	Indiana	Greene	489.3
242.0		Indiana		488.0
243.0		Indiana		491.0
244.0		Indiana		545.9
245.0	Little Giant	Indiana	Sullivan	586.0
246.0		Indiana		573.0
247.0		Indiana		557.0
248.0		Indiana		525.8
248.6	Shirley Hill	Indiana	Sullivan	510.0

CHICAGO, INDIANAPOLIS AND LOUISVILLE RAILROAD.

Orleans to French Lick.

Distances from Chicago.	Stations.	State.	County.	Elevation.
261.1	Orleans	Indiana	Orange	635.8
262.1		Indiana		654.0
263.1		Indiana		660.3
264.1		Indiana		635.0
265.1	Lost River	Indiana	Orange	628.4
266.1		Indiana		650 0

CHICAGO, INDIANAPOLIS AND LOUISVILLE RAILROAD—Continued.

Orleans to French Lick—Continued.

Distances from Chicago.	STATIONS.	State.	County.	Elevation.
267.1	....	Indiana........	....	737.0
268.1	....	Indiana........	....	688.3
268.7	Paoli........	Indiana........	Orange........	637.7
269.1	....	Indiana........	....	653.0
269.7	Braxtons........	Indiana........	Orange........	588.0
270.1	....	Indiana........	Orange........	577.0
271.1	....	Indiana........	....	555.5
272.1	....	Indiana........	....	537.0
272.3	Glass Rock........	Indiana........	Orange........	535.0
273.1	....	Indiana........	....	561.0
274.1	....	Indiana........	....	572.0
274.2	Abby Dell........	Indiana........	Orange........	562.4
275.1	....	Indiana........	....	539.9
276.1	....	Indiana........	....	486.0
277.1	....	Indiana........	....	485.5
277.7	West Baden........	Indiana........	Orange........	486.3
278.1	....	Indiana........	....	483.8
278.8	French Lick........	Indiana........	Orange........	483.4

CHICAGO, INDIANAPOLIS AND LOUISVILLE RAILROAD.

Monon to Michigan City.

Distances from Chicago.	STATIONS.	State.	County.	Elevation.
88.4	Monon........	Indiana........	White........	673.5
97.0	Francesville........	Indiana........	Pulaski........	680.0
103.6	Medaryville........	Indiana........	Pulaski........	688.1
107.5	Clarks........	Indiana........	Pulaski........	705.4
109.3	Anthonys........	Indiana........	Pulaski........	706.6
111.7	San Pierre........	Indiana........	Starke........	702.1
114.9	Farm Siding........	Indiana........	Starke........	670.2
116.0	Riverside........	Indiana........	LaPorte........	672.0
116.5	Wilders........	Indiana........	LaPorte........	670.3
119.0	Longs........	Indiana........	LaPorte........	670.8
120.0	La Crosse........	Indiana........	Laporte........	680.0
121.9	Schimmels........	Indiana........	Laporte........	687.0
126.1	South Wanatah........	Indiana........	Laporte........	717.5
127.8	Wanatah........	Indiana........	Laporte........	732.2
131.5	Haskells........	Indiana........	Laporte........	767.0
133.4	Alida........	Indiana........	Laporte........	781.4
135.5	Westville........	Indiana........	Laporte........	788.0
139.5	Otis........	Indiana........	Laporte........	747.3
148.0	Michigan City........	Indiana........	Laporte........	617.8

CHICAGO, INDIANAPOLIS AND LOUISVILLE RAILROAD.

Clear Creek to Harrodsburg.

Distances from Chicago.	STATIONS.	State.	County.	Elevation.
224.2	Clear Creek........	Indiana........	Monroe........	652.6
225.2	....	Indiana........	....	628.6
226.2	....	Indiana........	....	612.0
226.5	Diamond........	Indiana........	Monroe........	610.0
227.2	....	Indiana........	....	606.1
227.5	Ketchums........	Indiana........	Monroe........	594.0
228.2	....	Indiana........	....	580.5
229.2	....	Indiana........	....	565.3
230.2	....	Indiana........	....	550.2
231.2	....	Indiana........	....	520.0
232.2	....	Indiana........	....	513.4
232.4	Harrodsburg........	Indiana........	Monroe........	515.0

BALTIMORE AND OHIO RAILROAD.

Indiana Division.

Distances from Cincinnati, Ohio.	STATIONS.	State.	County.	Elevation.
22.0	Lawrenceburg	Indiana	Dearborn	480.0
26.0	Aurora	Indiana	Dearborn	499.0
28.0	Cochran	Indiana	Dearborn	502.0
31.0		Indiana	Dearborn	514.0
34.0	Dillsboro	Indiana	Dearborn	650.0
38.0		Indiana	Dearborn	850.0
40.0	Moores Hill	Indiana	Dearborn	917.0
43.0	Milan	Indiana	Ripley	1,007.0
45.0	Pierceville	Indiana	Ripley	1,007.0
48.0		Indiana	Ripley	925.0
52.0	Osgood	Indiana	Ripley	990.0
53.0		Indiana	Ripley	995.0
56.0	Dabney	Indiana	Ripley	966.0
58.0	Holton	Indiana	Ripley	923.0
62.0		Indiana	Ripley	845.0
66.0	Butlerville	Indiana	Jennings	801.0
69.0	Oakdale	Indiana	Jennings	783.0
72.0	North Vernon	Indiana	Jennings	685.0
73.0	Whitcomb	Indiana	Jennings	757.0
79.0	Hayden	Indiana	Jennings	610.0
83.0	Flemings	Indiana	Jackson	592.0
87.0	Seymour	Indiana	Jackson	614.0
92.0	Dunham	Indiana	Jackson	568.0
97.0	Brownstown	Indiana	Jackson	561.0
101.0	Vallonia	Indiana	Jackson	550.0
105.0	Medora	Indiana	Jackson	544.0
108.0		Indiana	Jackson	544.0
110.0	Sparksville	Indiana	Jackson	544.0
113.0	Ft. Ritner	Indiana	Lawrence	529.0
117.0	Tunnelton	Indiana	Lawrence	502.0
119.0	Little Tunnel	Indiana	Lawrence	499.0
121.0	Rivervale	Indiana	Lawrence	499.0
125.0	Hamer	Indiana	Lawrence	670.0
126.0	Mitchell	Indiana	Lawrence	685.0
129.0		Indiana	Lawrence	724.0
131.0	Georgia	Indiana	Lawrence	680.0
135.0		Indiana	Lawrence	582.0
138.0	Huron	Indiana	Lawrence	546.0
141.0	Willow Valley	Indiana	Martin	514.0
144.0		Indiana	Martin	496.0
147.0	Shoals	Indiana	Martin	490.0
151.0		Indiana	Martin	480.0
155.0	Loogootee	Indiana	Martin	546.0
158.0		Indiana	Martin	514.0
160.0	Cannelburg	Indiana	Daviess	521.0
162.0	Montgomery	Indiana	Daviess	537.0
165.0	Black Oak	Indiana	Daviess	512.0
169.0	Washington	Indiana	Daviess	490.0
174.0	Hyatt	Indiana	Daviess	441.0
176.0	Wheatland	Indiana	Knox	483.0
180.0		Indiana	Knox	467.0
183.0	Fritchton	Indiana	Knox	530.0
185.0		Indiana	Knox	530.0
188.0	Vincennes	Indiana	Knox	422.0

BALTIMORE AND OHIO RAILROAD.

Chicago Division.

Distances from Garrett, Ind.	STATIONS.	State.	County.	Elevation.
0.0	Garrett	Indiana	D kalb	893.7
5.2	Avilla	Indiana	Noble	950.0
9.8	Ripley	Indiana	Noble	987.5
15.4	Albion	Indiana	Noble	928.0
22.0	Kimmel	Indiana	Noble	920.0
25.4	Cromwell	Indiana	Noble	932.8
30.2	Wawasee	Indiana	Kosciusko	882.0

BALTIMORE AND OHIO RAILROAD—Continued.

Chicago Division—Continued.

Distances from Garrett, Ind.	STATIONS.	State.	County.	Elevation.
32.5	Syracuse	Indiana	Kosciusko	869.0
37.6	Milford Junction	Indiana	Kosciusko	840.0
41.4	Gravelton	Indiana	Kosciusko	850.0
45.8	Nappanee	Indiana	Elkhart	880.0
49.7	Ayr	Indiana	Marshall	850.0
53.2	Bremen	Indiana	Marshall	820.0
60.9	La Paz Junction	Indiana	Marshall	859.0
61.6	La Paz	Indiana	Marshall	859.0
65.3	Teegarden	Indiana	Marshall	800.0
71.0	Walkerton	Indiana	St. Joseph	716.0
	Quinns	Indiana	Laporte	700.0
79.0	Union Center	Indiana	Laporte	718.0
	Tracy	Indiana	Laporte	733.0
85.7	Wellsboro	Indiana	Laporte	757.0
92.8	Alida	Indiana	Laporte	789.0
95.2	Coburg	Indiana	Porter	795.0
98.5	Suman	Indiana	Porter	731.4
101.7	Woodville	Indiana	Porter	690.7
104.9	Babcock	Indiana	Porter	652.0
106.7	McCool	Indiana	Porter	640.0
108.8	Willow Creek	Indiana	Porter	640.0
111.7	Dock Siding	Indiana	Lake	621.0
113.3	Miller	Indiana	Lake	617.0
116.9	Gary	Indiana	Lake	606.0
121.6	Pine	Indiana	Lake	600.0
	Edgemoor	Indiana	Lake	596.0
123.3	Indiana Harbor	Indiana	Lake	600.0
126.1	Whiting	Indiana	Lake	595.0
	Hammond	Indiana	Lake	595.0

Chicago Division.

Distances from Chicago Junction, O.	STATIONS.	State.	County.	Elevation.
0.0	Chicago Junction	Ohio		924.0
115.1	St. Joe	Indiana	Dekalb	830.0
118.7	Concord	Indiana	Dekalb	851.9
124.8	Auburn Junction	Indiana	Dekalb	871.7
128.0	Garrett	Indiana	Dekalb	893.0

BALTIMORE AND OHIO RAILROAD.

Louisville Branch.

Distances from North Vernon.	STATIONS.	State.	County.	Elevation.
0.0	North Vernon	Indiana	Jennings	722.0
6.8	Lovett	Indiana	Jennings	698.0
10.4	Commiskey	Indiana	Jennings	692.6
12.6	Paris	Indiana	Jennings	623.0
15.0	Deputy	Indiana	Jefferson	623.0
20.2	Blocher	Indiana	Scott	677.0
25.2	Lexington	Indiana	Scott	620.0
28.7	Nabbs	Indiana	Clark	688.0
30.2	Marysville	Indiana	Clark	715.0
33.5	Otisco	Indiana	Clark	668.0
38.3	Clarke	Indiana	Clark	609.0
40.5	Charlestown	Indiana	Clark	590.0
46.7	Watson	Indiana	Clark	501.4
53.5	Floyd	Indiana	Floyd	445.8
54.1	New Albany	Indiana	Floyd	456.5

BALTIMORE AND OHIO RAILROAD—Continued.

Jeffersonville Branch.

Distances from North Vernon.	Stations.	State.	County.	Elevation.
46.7	Watson	Indiana	Clark	504.6
52.4	C. C. C. & St. L. Junction	Indiana	Clark	454.0
53.4	Jeffersonville	Indiana	Clark	454.0

Bedford Branch.

Distances from Rivervale.	Stations.	State.	County.	Elevation.
0.0	Rivervale	Indiana	Lawrence	499.0
6.2	Palestine	Indiana	Lawrence	600.0
7.3	Dodd	Indiana	Lawrence	681.0
10.8	Bedford	Indiana	Lawrence	640.0

WABASH RAILROAD.

Main Line.

Distances from Toledo, O.	Stations.	State.	County.	Elevation.
75.3	State between Ohio and Indiana and between Paulding County, Ohio and Allen County, Indiana			748.4
78.7	Woodburn Station	Indiana	Allen	758.4
83.2	Car Creek Station	Indiana	Allen	764.4
88.5	New Haven Station	Indiana	Allen	759.4
88.5	Crossing N. Y., St. L. & C. Ry. (Nickel Plate) New Haven	Indiana		758.0
88.6	Junction with New Haven & Butler line	Indiana		759.4
93.5	Sumit 1 mile east of Ft. Wayne grade and surface	Indiana		798.4
94.0	Crossing No. 1, P., Ft. W. & C. Ry., Ft. Wayne grade	Indiana		791.4
94.5	Ft. Wayne Station, Calhoun Street	Indiana	Allen	781.0
96.2	St. Mary's River Bridge, center bridge grade	Indiana		770.0
96.2	St. Mary's River Bridge, low water	Indiana		743.4
96.2	St. Mary's River Bridge, extreme bottom	Indiana		740.4
97.2	Ft. Wayne, Cincinnati & Louisville Ry. crossing	Indiana		790.0
101.6	Midway (Ellison Spur)	Indiana		768.0
102.7	Prairie Switch	Indiana	Allen	761.0
105.2	Aboite	Indiana	Allen	757.0
	Little River Bridge 169 near County line, grade	Indiana		757.0
	Little River Bridge 169 near County line, bottom	Indiana		748.4
106.2	Line between Allen and Huntington Counties	Indiana		757.0
109.6	Roanoke Station	Indiana	Huntington	757.0
	Bend of Little River 2 miles west of Roanoke, grade	Indiana		751.0
	Bend of Little River, low water	Indiana		739.0
	Bend of Little River, bottom of river	Indiana		734.4
	Bend of Little River, high water	Indiana		747.0
113.9	Mardenis	Indiana	Huntington	752.0
116.5	Lillie	Indiana	Huntington	752.0
117.5	Huntington crossing Chicago & Atlantic Ry., grade	Indiana		746.0
118.4	Huntington Station	Indiana	Huntington	736.0

WABASH RAILROAD—Continued.

Main Line—Continued.

Distances from Toledo, O.	Stations.	State.	County.	Elevation.
119.9	Huntington	Indiana	Huntington	
	Little River, grade	Indiana		724.0
	Little River, low water	Indiana		709.4
	Little River, extreme bottom	Indiana		706.4
120.2	Wabash River Bridge, west of Huntington, grade	Indiana		724.0
	Wabash River, bottom	Indiana		697.4
	Wabash River, low water	Indiana		705.0
	Loose Creek Bridge, grade	Indiana		718.0
	Loose Creek Bridge, bottom	Indiana		703.0
124.2	Andrews Station Central Yard	Indiana	Huntington	716.0
126.5	Line between Wabash and Huntington Counties	Indiana		701.4
126.6	Wabash River at Belden, grade	Indiana		701.4
	Wabash River, low water	Indiana		680.4
	Wabash River, extreme bottom	Indiana		676.0
128.4	Wabash & Erie Canal, east of Lagro, grade	Indiana		715.4
	Wabash & Erie Canal, extreme bottom	Indiana		695.4
131.0	Lagro Creek Bridge, grade	Indiana		701.4
	Lagro Creek Bridge, extreme bottom	Indiana		681.4
131.3	Lagro Station	Indiana	Wabash	704.4
136.1	Crossing C., W. & M. R. R., ¾ mile east Wabash, grade	Indiana		729.4
	Crossing C., W. & M. R. R., grade	Indiana		709.4
136.8	Wabash Station	Indiana	Wabash	744.4
137.7	Char ey Creek, grade	Indiana		721.4
	Charley Creek, extreme bottom	Indiana		692.4
138.6	Helm's Creek, grade	Indiana		717.4
	Helm's Creek, extreme bottom	Indiana		683.4
139.6	Paul's Spur	Indiana		
141.3	Kentner's Creek, grade	Indiana		693.4
	Kentner's Creek, extreme bottom	Indiana		666.4
141.3	Rich Valley	Indiana	Wabash	666.4
143.6	County Line, Miami and Wabash Counties	Indiana		684.4
146.1	Erie	Indiana	Miami	666.4
150.3	Peru, I. P. & C. Ry., crossing	Indiana		656.9
15[illegible].6	Peru Station	Indiana	Miami	658.4
156.0	County Line, Cass and Miami Counties	Indiana		695.4
157.3	New Waverly	Indiana	Cass	690.4
161.0	Cass Station or Canes	Indiana	Cass	641.4
165.2	Wabash & Erie Canal Bridge, east Logansport, grade	Indiana		633.1
	Wabash & Erie Canal, bottom	Indiana		614.4
166.4	Logansport Station	Indiana	Cass	607.4
166.5	Logansport Crossing of Panhandle Ry.	Indiana		608.4
167.0	Wabash River Bridge, Logansport, grade	Indiana		614.4
170.6	Summit, 1¾ miles east of Clymers	Indiana		746.9
172.4	Clymers Station	Indiana	Cass	736.9
172.4	Crossing of Vandalia Line, west of Clymers	Indiana		730.4
173.9	Carroll and Cass Counties, line	Indiana		729.4
175.9	Burrows	Indiana	Carroll	712.9
178.8	Rock Creek, grade	Indiana		685.4
	Rock Creek, extreme bottom	Indiana		637.4
180.2	Rockfield Station	Indiana	Carroll	708.4
186.6	Delphi crossing of Wabash and C., I. & L. Ry. (Monon)	Indiana		570.4
186.7	Delphi Station	Indiana	Carroll	568.4
187.2	Deer Creek, West Delphi, grade	Indiana		582.9
	Deer Creek, extreme bottom	Indiana		542.4
189.0	Carroll & Tippecanoe Counties, line	Indiana		616.5
191.8	Colburn Station	Indiana	Tippecanoe	668.4
191.9	Sugar Creek, grade	Indiana		667.4
	Sugar Creek, natural surface, average bottom	Indiana		645.4
195.4	Buck Creek Station	Indiana	Tippecanoe	676.4
200.1	Wild Cat Creek Bridge, grade	Indiana		593.4
	Wild Cat Creek, extreme bottom	Indiana		540.4
203.5	Lafayette Station and Main Street	Indiana	Tippecanoe	596.4
205.1	Lafayette Junction of Wabash, I., C. & S. and L. E. & W.	Indiana		597.4
205.5	Durkee's Run, Lafayette, grade	Indiana		592.4
	Durkee's Run, extreme bottom	Indiana		534.4

WABASH RAILROAD—Continued.

Main Line—Continued.

Distances from Toledo, O.	STATIONS.	State.	County.	Elevation.
206.5	C., I. & L. R. R. under crossing Wabash grade	Indiana		634.4
	C., I. & L. R. R.;L., N., A. & C., grade.	Indiana		616.0
207.5	Wea Creek Bridge, grade	Indiana		608.8
208.3	Shadeland	Indiana	Tippecanoe	629.3
210.8	Wea Station	Indiana	Tippecanoe	622.4
213.3	West Point	Indiana	Tippecanoe	626.4
215.2	Flint Creek, grade	Indiana		5[illegible]7.4
	Flint Creek, bottom	Indiana		559.4
216.1	County Line, Tippecanoe and Fountain Counties	Indiana		
217.6	Neubousk Creek, grade	Indiana		577.4
	Neubousk Creek, extreme bottom	Indiana		538.4
218.6	Turkey Run, 1½ miles east of Independence, grade	Indiana		586.4
	Turkey Run, bottom	Indiana		538.4
219.8	Opossum Creek, grade	Indiana		561.4
	Opossum Creek, extreme bottom	Indiana		537.4
220.3	River Side	Indiana	Fountain	561.4
224.8	Attica Station	Indiana	Fountain	550.4
224.9	Junction, A., C. & S., head block	Indiana		548.9
225 1	County Line, Fountain and Warren Counties	Indiana		
225.5	C. & G. S. Ry., under crossing	Indiana		530.4
225.3	Wabash River Bridge, Attica, west end grade	Indiana		549.4
225.5	Wabash River Bridge, east end grade	Indiana		547.4
	Wabash River and Flint Creek, extreme bottom	Indiana		501.4
227.7	Williamsport Station, grade	Indiana	Warren	668.9
	Williamsport Station, Ravine, extreme bottom	Indiana		547.4
230.9	Summit between Rock Creek and Williamsport, grade	Indiana		715.4
	Natural surface	Indiana		722.4
232.3	Rock Creek, 0.7 mile east of Lebanon, grade	Indiana		671.4
	Rock Creek, average bottom	Indiana		642.4
233.0	West Lebanon and connection with H., R. & R.	Indiana	Warren	700.9
233.7	Summit ¾ mile west of Lebanon grade.	Indiana		712.4
	Summit natural surface	Indiana		734.4
235.2	Foster Branch of Redwood Creek, grade	Indiana		673.4
	Foster Branch, extreme bottom	Indiana		651.4
236 9	Marshfield	Indiana	Warren	706.9
239.4	Johnsonville, Wabash, C. & E. I. R. R. connection and crossing of C. & E. I. R. R.	Indiana	Warren	694.4
	Johnsonville, Wabash, C. & E. I. R. R. connection and crossing of C. & E. I. R. R	Indiana	Warren	690 4
242.3	State Line Station	Indiana	Warren	720.4
242.5	State Line between Illinois and Indiana grade			726.4
	State Line, natural surface			730.4

WABASH RAILROAD.

Detroit Division.

Distances from Detroit, Mich.	STATIONS.	State.	County.	Elevation.
107.2	Line between Williams County, Ohio and Steuben Counties, Indiana			921.0
109.2	Fish Creek, grade, North Branch	Indiana	Steuben	929.0
	Fish Creek, extreme bottom, North Branch	Indiana		899.5
112.3	Fish Creek, grade, near Hamilton	Indiana		929.5
	Fish Creek, extreme bottom, near Hamilton	Indiana		899.0

WABASH RAILROAD—Continued.

Detroit Division—Continued.

Distances from Detroit, Mich.	STATIONS.	State.	County.	Elevation.
113.0	Dry Creek, grade	Indiana		924.0
	Dry Creek, extreme bottom	Indiana		903.0
113.1	Hamilton	Indiana	Steuben	926.9
115.7	Woods Ditch, grade	Indiana		967.0
	Woods Ditch, extreme bottom	Indiana		938.0
118.6	Steubenville—Crossing Ft. W. & J. Branch of L. S. & M. S. (top of rail)	Indiana	Steuben	1,004.6
120.8	Ashley	Indiana	Steuben	999.0
121.3	Hudson	Indiana	Steuben	
123.9	Frederick (Gravel Pit)	Indiana	Steuben	972.2
126.4	Helmer	Indiana	Steuben	986.0
127.6	Line between Steuben and Lagrange Counties	Indiana		1,007.0
128.1	Maumee Creek, grade	Indiana		1,007.0
	Maumee Creek, extreme bottom	Indiana		986.5
130.2	Summit at Station 1685, 1½ miles east of South Milford	Indiana	Lagrange	1,029.0
131.7	Broomcorn Creek, grade	Indiana		1,001.0
	Broomcorn Creek, extreme bottom	Indiana		977.0
131.7	South Milford	Indiana	Lagrange	998.0
135.4	Taylor Gravel Pit	Indiana		956.0
136.0	Elkhart River Bridge east of Wolcottville, grade	Indiana		956.9
	Elkhart River Bridge east of Wolcottville, extreme bottom	Indiana		940.4
136.0	Lagrange and Noble County Line (East)	Indiana		957.4
136.6	Wolcottville—Crossing of Grand Rapids and Indiana R. R	Indiana	Lagrange	956.8
136.7	Wolcottville Depot	Indiana	Lagrange	954.3
138.8	Lagrange and Noble County Line (West)	Indiana		965.4
140.7	Eddy	Indiana	Lagrange	931.3
141.7	Elkhart River 1 mile west of Eddy, grade	Indiana	Lagrange	918.6
	Elkhart River 1 mile west of Eddy, extreme bottom	Indiana		908.4
146.0	Topeka	Indiana	Lagrange	950.0
151.9	Line between Lagrange and Elkhart Counties	Indiana		899.3
152.7	Stony Creek, grade	Indiana		888.0
	Stony Creek, extreme bottom	Indiana		877.4
153.2	Stony Creek, siding	Indiana		888.0
153.8	West Branch Stony Creek, grade	Indiana		896.9
	West Branch Stony Creek, extreme bottom	Indiana		878.4
154.0	Millersburg passenger depot	Indiana	Elkhart	907.0
	Millersburg, overhead road crossing, 46 foot girder, grade	Indiana		912.2
	Millersburg, overhead road crossing, surface of public road	Indiana		897.7
154.2	Millersburg, L. S. & M. S. Ry. Crossing Wabash, grade	Indiana		913.0
	Millersburg, L. S. & M. S. Ry. Crossing L. S. & M. S., base of rail	Indiana		897.1
157.9	Benton Station	Indiana	Elkhart	845.6
160.0	Elkhart River, two 120 foot spans, grade	Indiana		828.4
	Elkhart River, two 120 foot spans, extreme bottom	Indiana		812.2
161.3	New Paris	Indiana	Elkhart	807.6
161.4	Crossing C. W. & M. Ry. (Big Four Ry.) grade	Indiana		807.3
162.1	Turkey Creek, grade	Indiana		822.0
	Turkey Creek, extreme bottom	Indiana		804.5
166.5	Foraker	Indiana	Elkhart	873.8
171.2	Wakarusa	Indiana	Elkhart	876.0
172.8	Bango Creek, grade	Indiana		837.7
	Bango Creek, bottom	Indiana		827.4
173.5	Line between Elkhart and St. Joseph Counties	Indiana		846.0
179.1	Wyatt	Indiana	St. Joseph	848.0
184.7	Lakeville Depot, sub-grade	Indiana	St. Joseph	856.2
184.8	Lakeville Crossing of T. H. & I. (Vandalia), base of rail	Indiana		856.9

WABASH RAILROAD—Continued.

Detroit Division—Continued.

Distances from Detroit, Mich.	STATIONS.	State.	County.	Elevation.
188.4	Little Potato Creek, grade	Indiana		817.3
	Little Potato Creek, extreme bottom	Indiana		796.5
190.0	Sycamore Creek, grade	Indiana		812.6
	Sycamore Creek, extreme bottom	Indiana		789.0
192.4	Potato Creek, grade	Indiana		792.9
	Potato Creek, extreme bottom	Indiana		780.0
192.8	North Liberty Depot	Indiana	St. Joseph	744.0
194.1	Potato Creek, west of Liberty, grade	Indiana		720.0
	Potato Creek, west of Liberty, extreme bottom	Indiana		710.0
196.3	Kankakee River and Line between St. Joseph and Laporte Counties, grade	Indiana		704.0
	Kankakee River and Line between St. Joseph and Laporte Counties, extreme bottom	Indiana		693.0
198.0	Little Kankakee River, grade	Indiana		704.0
	Little Kankakee River, extreme bottom	Indiana		693.0
200.3	Lake Erie and Western R. R. Crossing at Dillon	Indiana	Laporte	707.0
205.6	Crossing C. & G. T. Ry., east of Kingsbury, grade, Wabash track	Indiana		770.6
	Crossing C. & G. T. Ry., base of rail C. & G. T. Ry	Indiana		751.3
207.2	Kingsbury Depot	Indiana	Laporte	758.0
	Kingsbury Mill pond, grade	Indiana		758.0
	Kingsbury Mill pond, extreme bottom	Indiana		741.0
209.5	Magee Crossing, C. W. & M. Ry	Indiana	Laporte	786.8
211.4	Mill Creek at Station 5960, grade	Indiana		777.0
	Mill Creek, bottom	Indiana		762.7
217.1	Westville Depot	Indiana	Laporte	817.3
217.4	Westville Crossing L. N. A. & C. Ry, Wabash grade	Indiana		820.0
	Westville Crossing L. N. A. & C. Ry., base of rail, L. N. A. & C. Ry	Indiana		796.2
219.0	Line between Laporte and Porter Counties	Indiana		804.0
220.6	Overhead Wagon Bridge No. 1655, 1¾ miles west of east line of Porter County, Wabash grade	Indiana		796.6
	Surface of Wagon Road	Indiana		821.6
221.2	Overhead Highway Bridge No. 1659 at Station 111, 2⅛ miles west of County Line, grade	Indiana		779.1
	Surface of Road	Indiana		761.2
221.4	Page Creek Bridge No. 1660, Wabash grade	Indiana		773.4
	Page Creek Bridge No. 1660, extreme bottom	Indiana		747.2
223.4	Little Page Creek No. 1669, grade	Indiana		724.0
	Little Page Creek No. 1669, extreme bottom	Indiana		706.7
223.8	Spring Brook Creek No. 1670, grade	Indiana		712.8
	Spring Brook Creek No. 1670, extreme bottom	Indiana		698.7
226.1	Coffee Creek No. 1676, grade	Indiana		668.8
	Coffee Creek No. 1676, extreme bottom	Indiana		652.4
230.4	Crocker Crossing E., J. & E. Ry	Indiana	Porter	648.4
231.2	Salt Creek Bridge No. 1691, grade	Indiana		641.8
	Salt Creek Bridge No. 1691, extreme bottom	Indiana		614.2
231.8	Little Salt Creek Bridge No. 1692, grade	Indiana		641.4
	Little Salt Creek Bridge No. 1692, extreme bottom	Indiana		619.7
233.7	Willow Creek Station Crossing, B. & O. Ry. 233.68, base of rail	Indiana	Porter	645.1
233.7	Willow Creek Station Crossing, Michigan Central	Indiana	Porter	644.5
235.0	Willow Creek Bridge No. 1695, grade	Indiana		618.0
	Willow Creek Bridge No. 1695, extreme bottom	Indiana		607.7
236.7	Little Calumet River, grade	Indiana		615.7
	Little Calumet River, bottom	Indiana		601.7

WABASH RAILROAD—Continued.

Detroit Division—Continued.

Distances from Detroit, Mich.	Stations.	State.	County.	Elevation.
235.6	Line between Porter and Lake Counties	Indiana		615.7
236.3	Calumet Station	Indiana	Lake	619.8
	Overhead Crossing of Young's Sand Track and Bridge 1699, grade	Indiana		640.6
	Overhead Crossing of Young's Sand Track, top of rail of sand track	Indiana		623.5
	Overhead Crossing of Young's Sand Track, bottom	Indiana		618.2
237.9	Millers Station	Indiana	Lake	630.6
239.2	Aetna Station Platform	Indiana	Lake	618.7
241.5	Gary Station	Indiana	Lake	
242.0	Gibson's Run Creek Branch No. 1702, grade	Indiana		614.1
	Gibson's Run Creek Branch No. 1702, extreme bottom	Indiana		603.4
242.6	Tolleston	Indiana	Lake	614.1
244.6	Grand Calumet River, grade	Indiana		602.1
	Grand Calumet River, extreme bottom	Indiana		584.7
246.0	Clark Junction Siding	Indiana		602.1
246.5	Chicago and Calumet Junction Switch, end of Wabash track	Indiana		602.1
246.5	Crossing of P., Ft. W. & C. Ry., base of rail	Indiana		602.6

WABASH RAILROAD.

New Haven to Indiana-Ohio State Line.

Distances from Detroit, Mich.	Stations.	State.	County.	Elevation.
140.2	Junction of Main Line with Ft. W. and Detroit R. R. at New Haven	Indiana	Allen	759.4
138.7	Maumee River, grade	Indiana		756.8
	Maumee River, extreme bottom	Indiana		726.8
	Maumee River, low water	Indiana		721.8
136.4	Thurman Station	Indiana	Allen	768.8
130.0	Grabill	Indiana	Allen	824.8
127.0	St. Joe River, grade	Indiana		800.6
	St. Joe River, high water	Indiana		795.8
	St. Joe River, low water	Indiana		780.8
	St. Joe River, extreme bottom	Indiana		774.8
125.9	Line between Allen and Dekalb Counties	Indiana		801.8
124.8	Spencerville	Indiana	Dekalb	820.8
122.7	St. Joe	Indiana	Dekalb	837.8
122.2	Baltimore & Ohio Crossing	Indiana		840.0
121.7	Baer Creek, grade	Indiana		833.8
	Baer Creek, extreme bottom	Indiana		808.8
119.2	26 Mile Creek, grade	Indiana		840.8
	26 Mile Creek, extreme bottom	Indiana		828.8
117.0	Rose	Indiana	Dekalb	867.8
114.5	Butler New Wabash Depot	Indiana	Dekalb	876.8
113.9	Butler L. S. & M. S. Crossing	Indiana	Dekalb	870.8
110.7	Fish Creek, grade	Indiana		858.0
	Fish Creek, bottom	Indiana		845.0
109.9	Artic	Indiana	Dekalb	868.9
109.3	Indiana and Ohio State Line	Indiana		867.4

SOUTHERN RAILROAD.

St. Louis-Louisville Lines.

Distances from Louisville. Ky.	Stations.	State.	County.	Elevation.
6.0	New Albany	Indiana	Floyd	429.0
15.0	Georgetown	Indiana	Floyd	710.0
21.0	Crandall	Indiana	Harrison	650.0
	Mott	Indiana	Harrison	722.0
23.0	Corydon Junction	Indiana	Harrison	715.0
27.0	Ramsey	Indiana	Harrison	707.0
30.0	DePauw	Indiana	Harrison	642.0
34.0	Milltown	Indiana	Crawford	552.0
38.0	Marengo	Indiana	Crawford	574.0
43.0	Temple	Indiana	Crawford	621.0
46.0	English	Indiana	Crawford	503.0
52.0	Taswell	Indiana	Crawford	770.0
58.0	Riceville	Indiana	Crawford	791.0
60.0	Birdseye	Indiana	Dubois	711.0
61.0	Mentor	Indiana	Dubois	717.0
66.0	Kyana	Indiana	Dubois	503.0
68.0	St. Anthony	Indiana	Dubois	487.0
	Bretzville	Indiana	Dubois	529.0
75.0	Huntingburg	Indiana	Dubois	462.0
	Duff	Indiana	Dubois	467.0
84.0	Velpen	Indiana	Pike	475.0
91.0	Winslow	Indiana	Pike	433.0
92.0	Ayrshire	Indiana	Pike	423.0
105.0	Francisco	Indiana	Gibson	430.0
113.0	Princeton	Indiana	Gibson	461.0

Huntingburg, French Lick and West Baden.

Distances from Huntingburg.	Stations.	State.	County.	Elevation.
0.0	Huntingburg	Indiana	Dubois	462.0
7.0	Jasper	Indiana	Dubois	467.0
31.0	French Lick	Indiana	Orange	484.0

Evansville Division.

Distances from Louisville, Ky.	Stations.	State.	County.	Elevation.
74.0	Huntingburg	Indiana	Dubois	462.0
	Ferdinand	Indiana	Dubois	500.0
86.0	Dale	Indiana	Spencer	432.0
89.0	Lincoln City	Indiana	Spencer	459.0
91.0	Gentryville	Indiana	Spencer	413.0
93.0	Pigeon	Indiana	Spencer	403.0
96.0	Tennyson	Indiana	Warrick	417.0
101.0	DeGonia	Indiana	Warrick	411.0
105.0	Boonville	Indiana	Warrick	408.0
109.0	DeForest	Indiana	Warrick	425.0
112.0	Chandler	Indiana	Warrick	433.0
115.0	Stevenson	Indiana	Warrick	402.0
	Smythe	Indiana	Vanderburgh	401.0
122.0	Evansville	Indiana	Vanderburgh	383.0

SOUTHERN RAILROAD—Continued.

Cannelton Division.

Distances from Louisville, Ky.	STATIONS.	State.	County.	Elevation.
89.0	Lincoln City	Indiana	Spencer	459.0
92.0	Buffaloville	Indiana	Spencer	427.0
95.0	Lamars	Indiana	Spencer	411.0
100.0	Evanston	Indiana	Spencer	413.0
104.0	Troy	Indiana	Perry	550 0
109.0	Tell City	Indiana	Perry	395.0

Rockport Division.

Distances from Louisville, Ky.	STATIONS.	State.	County.	Elevation.
89.0	Lincoln City	Indiana	Spencer	459.0
93.0	Bradleys	Indiana	Spencer	460.0
97.0	Chrisney	Indiana	Spencer	447.0
	Millers	Indiana	Spencer	423.0
100.0	Ritchies	Indiana	Spencer	409.0
102.0	Rock Hill	Indiana	Spencer	400.0
106.0	Rockport	Indiana	Spencer	380.0

CENTRAL INDIANA RAILWAY.

Distances from Muncie.	STATIONS.	State.	County.	Elevation.
0.0	Muncie Station	Indiana	Delaware	950.0
0.7	Avondale Station	Indiana	Delaware	948.0
5.4	Sharps Station	Indiana	Delaware	937.0
9.8	Moreland Station	Indiana	Delaware	934.0
11.6	Daleville Station	Indiana	Delaware	919.0
13.7	Chesterfield Station	Indiana	Madison	906.0
17.2	Gridley Crossing with C., C., C. & St. L. Ry	Indiana	Madison	899.0
	Anderson Crossing, P., C., C. & St. L. Ry	Indiana	Madison	885.0
	Anderson Crossing, C., C., C. & St.L. Ry. (Michigan Division)	Indiana	Madison	881.0
18.8	Anderson Station	Indiana	Madison	880.0
	Anderson Crossing, C., C., C. & St. L. Ry. (Cleveland-Indianapolis Div.)	Indiana	Madison	883.0
23.7	Bloomer Station	Indiana	Madison	872.0
28.0	Lapel Station	Indiana	Madison	855.0
31.5	Durbin Station	Indiana	Hamilton	817.0
37.2	Noblesville Station	Indiana	Hamilton	801.0
	Noblesville Crossing, L. E. & W. R. R	Indiana	Hamilton	801.0
43.6	Westfield Station	Indiana	Hamilton	895.0
	Westfield Crossing, C., I. & L. Ry	Indiana	Hamilton	895.0
46.8	Eagletown Station	Indiana	Hamilton	896.0
48.7	Jolietville Station	Indiana	Hamilton	920.0
51.8	Roston Station	Indiana	Boone	930.0
54.8	Gadsden Station	Indiana	Boone	948.0
56.3	Heath Station	Indiana	Boone	950.0
61.4	Lebanon Station	Indiana	Boone	936.0
	Lebanon Crossing, C., C., C. & St. L. Ry	Indiana	Boone	936.0
67.9	Max Station	Indiana	Boone	922.0
70.1	Advance Station	Indiana	Boone	928.0
	New Ross Crossing, C., C., C. & St. L. Ry	Indiana	Montgomery	877.0
75.6	New Ross Station	Indiana	Montgomery	877.0
	Ladoga, Crossing, C., I. & L. Ry	Indiana	Montgomery	822.0

CENTRAL INDIANA RAILWAY—Continued.

Distances from Muncie.	Stations.	State.	County.	Elevation.
81.3	Ladoga Station	Indiana	Montgomery	822.0
85.6	Pawnee Station	Indiana	Montgomery	846.0
86.9	Lapland Station	Indiana	Montgomery	840.0
88.9	Penobscot Station	Indiana	Montgomery	859.0
94.8	Waveland Station	Indiana	Montgomery	744 0
95.9	Waveland, Junction with Vandalia R. R	Indiana	Montgomery	697.0
105.3	Sand Creek Station	Indiana	Montgomery	582.0
	Sand Creek, Junction with Vandalia R. R	Indiana	Montgomery	582.0
106.9	East Rockville Station	Indiana	Parke	577.0
113.3	Uncas Station	Indiana	Parke	632.0
114.4	Walton Station	Indiana	Parke	582.0
116.0	Bridgeton Station	Indiana	Parke	559.0
118.6	Superior Station	Indiana	Parke	654.0
121.2	Carbon Station	Indiana	Clay	678.0
	Carbon, Crossing, C., C., C. & St. L. Ry	Indiana	Clay	678.0
124.2	Cardonia Station	Indiana	Clay	613.0
124.6	Hall Station	Indiana	Clay	611.0
127.0	Brazil Station	Indiana	Clay	650.0
	Brazil, Connection with Vandalia R. R	Indiana	Clay	649.0

INDIANA.

BLOOMINGTON QUADRANGLE.

(United States Geological Survey.)

Greene, Monroe and Owen Counties.

The elevations in the following list are based upon an elevation at Cincinnati, Indiana, brought by an unadjusted line of precise leveling from Mitchell, Indiana, based upon the 1903 adjustment datum.

The leveling on this quadrangle and the precise leveling was done in 1906 by Mr. C. H. Semper, levelman, using prism level and yard rods.

BLOOMINGTON QUADRANGLE.

Cincinnati East Along Highways to Harrodsburg, Thence North Along Chicago, Indianapolis and Louisville Railroad to Clear Creek.

Feet.

Cincinnati, in front yard of J. H. Neals; iron post stamped "Prim. Trav. Sta. No. 7 880" 880.384

Cincinnati, 3.92 miles east of, southeast corner of schoolhouse, front face of, foundation stone; aluminum tablet stamped "815" 815.014

Cincinnati, 6.51 miles east of, at angle of road, 100 feet north of Gilmore's scale house, primary traverse station No. 8; iron post stamped "802" 801.565

Harrodsburg, brick schoolhouse, west wing, south face; aluminum tablet stamped "627" 627.100

Harrodsburg, in front of station; top of rail 520.7

Feet.

Smithville, 2.41 miles south of, railroad bridge over creek, south abutment east side of retaining wall, top of; aluminum tablet stamped "530" 532.960

Smithville, in front of station; top of rail 710.8

Saunders, 0.29 mile south of, 100 feet south of James Craig's house, 15 feet west of track, boulder, in top of; aluminum tablet stamped "737" 739.985

Saunders, in front of station; top of rail 749.0

Johnstons, in front of station; top of rail 730.8

Acme, in front of station; top of rail 692.6

Clear Creek, in front of station; top of rail 659.6

Clear Creek, 0.32 mile north of, railroad bridge over creek, south abutment, west side of top; aluminum tablet stamped "659"...662.502

Cincinnati North Along Highway, Thence East to Clear Creek.

Feet.

Cincinnati, 2.72 miles north of, west side of road, 584 feet nortn of O. N. Burges' barn, outcrop of rock; aluminum tablet stamped "853" 856.008

Cincinnati, 6.03 miles north of, Green County Chapel, northwest corner of, foundation of; aluminum tablet stamped "848"......851.419

Greene County Chapel, 5.24 miles east of (0.16 mile west of Bloomington pike), north side of road, Wm. Hemphill's house, southwest corner of, foundation; aluminum tablet stamped "843"....846.256

Greene County Chapel, 7.05 miles east of, at junction of road to Bloomington pike, Omer May's blacksmith, southwest corner; aluminum tablet stamped "833" 835.587

Clear Creek North Along Railroad to Bloomington.

Feet.

Bloomington, in front of station; top of rail 756.6

Bloomington, Indiana University, Student Building, south entrance to, top of east buttress; aluminum tablet stamped "785".......784.637

Bloomington, Indiana University, at east entrance to Library Hall, top of stone buttress (old elev.=792.89) 792.58

Bloomington, Indiana University, at Owen Hall, on top of west stone buttress (old elev. = 798.47)..........................798.20

Bloomington Northwest Along Highway to Hensonburg, Thence West to Freeman, Thence South Toward Cincinnati. (Three-foot Adjustment Is Thrown at End of This Line.)

Feet.

Hensonburg, road crossing with Vernal pike; top of rail...........795.5

Hensonburg, small highway bridge over Stout Creek, west abutment, south side of, top of; aluminum tablet stamped "787"....786.587

Hensonburg, 3.45 miles west of, north side of road, gate entrance to J. Reed, large stone gatepost, front face of; aluminum tablet stamped "741" 741.100

Feet.

Hensonburg, 6.30 miles west of, north side of road, 515 feet east of Horton farm house, north abutment of stone culvert; aluminum tablet stamped "740" 740.009

Hensonburg, 9.01 miles west of, at angle in road to west and north, on east margin of road, in top of outcrop; aluminum tablet stamped "716" 716.077

Freeman, 60 feet north of postoffice, west side of road, outcrop of rock, top of; aluminum tablet stamped "599"................602.147

Hendricksville, 660 feet north of, west side of road, Cove Springs, 20 feet north of spring, top of outcrop of rock; aluminum tablet stamped "636" 638.908

Cincinnati, 7.46 miles north of, railroad overhead bridge, southeast corner of floor; spike in plank 859.65

(The adjusted elevation of the above is 859.65.)

AVOCA, BEDFORD, BLOOMFIELD, BLOOMINGTON, JASONVILLE, KOLEEN, CLAY CITY AND TERRE HAUTE QUADRANGLES.

Clay, Greene, Lawrence, Owen and Vigo Counties.

PRECISE LEVELING.

The elevations in the following list are the unadjusted result of a line of precise levels run from Mitchell, Indiana to Illinois State line west of Terre Haute based upon 1903 adjustment datum. An extension of this line into Illinois is given in another list. A prism level, yard rods and the standard method were used. The total divergence between forward and backward lines by the main line was 0.228 feet in a distance of 101.23 miles to the State line, and for the spur to Cincinnati 0.037 foot in a distance of 6.53 miles.

The leveling Redmon to Bloomfield was done in 1906 by Mr. T. A. Green, levelman, and the remainder of the line was done by Mr. C. H. Semper in 1906, Mitchell to Cincinnati, and in 1907, Bloomfield, Indiana to Oakland, Illinois.

BEDFORD QUADRANGLE.

Mitchell Northwest Along Chicago, Indianapolis and Louisville Railroad to Robinson.

Feet.

Mitchell, cut on the sill of window near northwest corner of south face of M. N. Moore's store, thus

X
B □ M
U. S. C.
N..........................686.707

Mitchell, Bank of Mitchell, east face of, north corner; aluminum tablet stamped "688" 688.081

Feet.

Mitchell, in front of Monon station; top of rail 679.9
Yockey, highway crossing at station, 80 feet east of track, 15 feet north of highway, bed rock; aluminum tablet stamped "590"..590.383
Yockey, in front of signboard; top of rail 593.2
Yockey, 1.68 miles north of, Monon railroad bridge over White River, north abutment, west side, bridge seat; aluminum tablet stamped "508" 508.124
Bedford, city hall, front entrance to building, face of; aluminum tablet stamped "700" 699.604
Bedford, Monon railroad station, in front of; top of rail..........689.327

AVOCA QUADRANGLE.

Dark Hollow, in front of station signboard; top of rail............512.873
Dark Hollow, 0.29 mile west of Monon railroad bridge over Salt Creek, south abutment, east side; aluminum tablet stamped "503" 502.934
Reed, in front of station signboard; top of rail 510.6
Avoca, in front of station; top of rail 547.1
Avoca, A. H. Bridewell's residence, stone wall front of yard, 2 feet south of gate entrance, top of; aluminum tablet stamped "557" 556.789
Springville, in front of station; top of rail 639.4
Springville, schoolhouse, northwest corner of foundation; aluminum tablet stamped "644" 643.644
Springville, 1.58 miles west of, 15 feet east of private road crossing, about 400 feet southeast of small stone house, 4 feet south of track, large rock; aluminum tablet stamped "575"............575.355
Armstrong, in front of station sign; top of rail...................550.6
Armstrong, railroad water tank, front face stone foundation; aluminum tablet stamped "551" 550.544
Armstrong, 2.13 miles west of, 100 feet east of railroad bridge over Indian Creek, 10 feet north of track, in top of limestone bowlder; aluminum tablet stamped "565" 564.522
Owensburg, in front of station; top of rail 642.6
Owensburg, 343 feet west of station, railroad overhead bridge, coping stone, top of, south side of track; aluminum tablet stamped "641" 640.786

KOLEEN QUADRANGLE.

Dresden, in front of station; top of rail 570.9
Robison, highway bridge on south side of railroad track, east abutment, north wing wall, top of; aluminum tablet stamped "543".542.580
Robison, in front of station; top of rail 540.7

Robison Northeast Along Highways to Cincinnati.

Feet.

Robison, 2.86 miles north of, southwest corner of Latter Day Saints Church, front face; aluminum tablet stamped "755"...........754.716

BLOOMINGTON QUADRANGLE.

Feet.

Cincinnati, Ind., in front yard of J. H. Neal's; iron post stamped "Prim. Trav. Sta. No. 7 880" 880.384

Robison Northwest Along Chicago, Indianapolis and Louisville R. R. to Elliston, Thence Northwest Along Evansville and Indianapolis R. R. to Terre Haute, Thence Northwest Along Vandalia R. R. to State Line Near Nelson, Indiana.

KOLEEN QUADRANGLE.

Feet.

Koleen, in front of station; top of rail 521.8

Koleen, 378 feet north of station, 45 feet north of track, 45 feet northwest of milepost "C 26"; iron post stamped "519 1906"...519.460

Rockwood, at road crossing, top of rail 517.1

Mineral City, 0.38 mile east of station, 125 feet west of road crossing, 20 feet south of track, in northwest corner of lot owned by Chas. Hayward; iron post stamped "509 1906".............509.118

BLOOMFIELD QUADRANGLE.

Mineral City, in front of station; top of rail 508.4

Mineral City, 2.55 miles northwest of, 15 feet north of track, 15 feet east of private road at foot of hill; iron post stamped "509 1906" 508.577

Bloomfield, 120 feet north of Monon station; 50 feet west of wagon road, at southeast corner of Jones Planing Mill, on south side; iron post stamped "534 1906" 533.938

Bloomfield, in southwest corner of engine room at "Fawcett Mfg. Co." on south side; aluminum tablet stamped "541 1906"......540.835

Elliston, in front of station, E. & I. R. R., top of rail..............508.3

Elliston, 1.75 miles north of, south abutment, west side of county bridge 75 feet west of railroad, top of abutment; aluminum tablet stamped "503" 503.213

Elliston, 4.73 miles north of, at road crossing 780 feet north of milepost T H 43, 30 feet east of railroad, on north end of road culvert; aluminum tablet stamped "507"........................506.643

Worthington, southeast corner of Taylor Building, 338 feet south of E. & I. R. R. station; aluminum tablet stamped "526".........526.258

Worthington, in front of E. & I. station; top of rail 522.0

JASONVILLE QUADRANGLE.

Worthington, 3.29 miles north of, 12 feet west of track, 0.10 mile south of milepost T H 36, in bowlder; aluminum tablet stamped "521" 520.603

Hubbell, in front of station; top of rail 524.3

Worthington, 6.01 miles north of, 1,478 feet north of road crossing; 1,866 feet south of milepost T H 33, 20 feet east of track, large rock; in side of cut; aluminum tablet stamped "562"..........561.652

Feet.

Coal City, southwest front face of Red Men's Hall; aluminum tablet stamped "659" 659.431

Coal City, in front of station; top of rail 651.9

Coal City, 2.40 miles north of Barricks schoolhouse on crossroads 803 feet east of railroad, southwest corner; aluminum tablet stamped "596" 595.917

CLAY CITY QUADRANGLE.

Clay City, northeast corner of "Clay City Roller Mill," 50 feet west of railroad track; aluminum tablet stamped "588"...........587.843

Clay City, in front of station; top of rail 579.7

Clay City, 3.41 miles north of, south abutment of railroad bridge over Eel River, west side of track, in bridge seat; aluminum tablet stamped "558" 558.359

Saline City, in front of station; top of rail 560.7

Saline City, 60 feet south of southwest corner of Brown Hotel, at road crossing, south end of culvert under road; aluminum tablet stamped "569" 569.380

Cory, in front of station; top of rail 628.5

Cory, southwest of I. O. O. F. Building, front face; aluminum tablet stamped "634" 633.730

Cory, 1.94 miles west of, in brick chimney at rear of W. N. Brill's house, on county line road 300 feet south of railroad; aluminum tablet stamped "608" 607.598

TERRE HAUTE QUADRANGLE.

Riley, southeast corner of I. O. O. F. Building, in south wall; aluminum tablet stamped "669" 568.896

Riley, in front of station; top rail 569.5

Riley, 4.63 miles north of, 2.6 miles south of Spring Hill, railroad culvert under S. I. R. R., 60 feet north of highway, top of stone; aluminum tablet stamped "524" 523.809

Spring Hill, crossing of S. I. and E. & T. H. R. Rs., top of rail....515.7

Spring Hill, 1.04 miles north of, top of bridge seat of culvert under E. & T. H. R. R., 100 feet north of crossing of S. I. belt line; aluminum tablet stamped "493" 492.639

Terre Haute, Union Station, southwest corner, front face of; aluminum tablet stamped "495" 494.830

Terre Haute, northeast corner of postoffice; aluminum tablet stamped "513" 512.752

Terre Haute, 0.9 mile west of, south abutment east side of Vandalia R. R. bridge over Wabash River, top of bridge seat, U. S. Army Engineer B. M., chiseled square 482.271

West Terre Haute, Berry Block, northwest corner of Geo. L. Berry's Drug Store, in stone window sill; aluminum tablet stamped "477" 476.510

Macksville, in front of station; top of rail.......................477.2

Feet.

Liggett, in front of station; top of rail........................515.2
Liggett, 1.32 miles west of, top of bridge seat west abutment of railroad bridge; aluminum tablet stamped "508"..............507.602
Nelson, in front of signboard; top of rail 512.3

CLAY CITY QUADRANGLE.

Clay, Owen and Vigo Counties.

The elevations in the following list are based in an unadjusted precise level line from Mitchell, which traverses this section, based upon the 1903 adjustment value at that point.

The leveling was done by L. P. Jerrard in 1908 under the direction of C. L. Sadler.

CLAY CITY QUADRANGLE.

Clay City West, to Point About Three Miles Northeast of Lewis; Thence North to Point About Two Miles West of Cory.

Feet.

T. 10 N., R. 7 W., middle of east line of Section 27, 30 feet northwest of road crossing; iron post stamped "535"..............535.268
T. 10 N., R. 7 W., middle of north line of Section 20, 30 feet southwest of road intersection; iron post stamped "547"...........547.210
T. 10 N., R. 8 W., southwest corner of Section 1, 20 feet northwest of road intersection; iron post stamped "541"................541.408
T. 11 N., R. 7 W., southwest corner of Section 30, northeast of road crossing, on northeast abutment of bridge in concrete, chiseled cross; marked "563.7" 563.789
T. 11 N., R. 7 W., southeast corner of Section 19, 30 feet northeast of road crossing; iron post stamped "Prim. Trav. Sta. No. 13—609" 609.273
Cory, in southwest corner of I. O. O. F. Building in front face; aluminum tablet stamped "634"............................633.730

Saline City Northeast, to Center Point; Thence North to Asherville; Thence West to Staunton; Thence South to Point About Two Miles West of Cory.

Feet.

Saline City, 60 feet south of the southwest corner of Brown Hotel at road crossing, in south end of culvert; aluminum tablet stamped "569" 569.380
Ashboro, in front of station; top of rail........................570.5
T. 11 N., R. 6 W., middle of north line of Section 8, west of intersection of road and railroad track, on concrete on southeast abutment of bridge, chiseled cross; marked "573.7"..........573.72
Center Point, in front of station; top of rail 647.5
T. 11 N., R. 6 W., middle of north line of Section 3, 30 feet southeast of intersection of road and railroad track; iron post stamped "671" 671.286

Feet.

Asherville, in front of station; top of rail 662.0

T. 12 N., R. 6 W., southeast corner of Section 16, 30 feet northwest of road crossing; iron post stamped "660" 660.104

T. 12 N., R. 6 W., northwest corner of Section 19, southeast of road crossing, in capstone of culvert; aluminum tablet stamped "626" 625.927

T. 12 N., R. 7 W., southwest corner of section 15, 30 feet northeast of road intersection; iron post stamped "680" 680.284

T. 12 N., R. 7 W., middle of south line of section 19, 40 feet northwest of road intersection; iron post stamped "629" 628.758

T. 11 N., R. 8 W., southeast corner of Section 1, 30 feet northwest of road crossing; iron post stamped "610" 610.497

Clay City, to Point About Two Miles Northeast of Denmark; Thence North via Bowling Green to Point Just Northeast of Center Point.

Feet.

T. 10 N., R. 6 W., middle of east line of Section 21, 30 feet southwest of road crossing; iron post stamped "603" 603.175

T. 10 N., R. 5 W., middle of south line of northwest quarter of Section 18, 30 feet northwest of road intersection; iron post stamped "635" 635.449

T. 10 N., R. 5 W., middle of north line of northwest quarter of Section 6, 50 feet southeast of road intersection; iron post stamped "644" 643.858

T. 11 N., R. 5 W., middle of south line of Section 31, northwest of road intersection, on stone culvert, cross; marked "602.9" 602.90

T. 11 N., R. 5 W., center of Section 19, east of road corner, southeast of village of Bowling Green; iron post stamped "Prim. Trav. Sta. No. 17—665" 664.804

Bowling Green, northwest corner of, northwest of road crossing, on stone culvert, cross; marked "650.9" 650.856

T. 11 N., R. 6 W., 0.1 mile south of middle of north line of Section 13, 75 feet northwest of road intersection; iron post stamped "609" 609.178

TOLESTON QUADRANGLE.

Lake County.

The elevations in the following list are based upon a bronze tablet in the northeast corner of Todd Opera House Block, East Chicago, Indiana, stamped "588 CHGO," the elevation of which is now accepted as 589.104 feet above mean sea level. The descriptions of these bench marks were previously published in the appendix to the 19th Annual Report of the Director, pp 254, 255, but the elevations have been corrected to accord with the latest adjustment of the precise level net. The leveling was extended from a city bench mark in South Chicago and the elevation now used is that obtained by adding 579.938 feet to the elevations given above the Chicago City datum, the City Directrix or the zero of lake gage and low water of 1847.

The leveling was done in 1897 under the direction of Mr. R. C. McKinney, Topographer, by Mr. E. S. Smith, levelman.

The standard bench marks are stamped "CHGO" in addition to figures of elevation mostly one foot too low.

South Chicago, Southeast, via East Chicago to Hessville.

Feet.

East Chicago, northeast corner Todd Opera House Block, southwest corner Chicago avenue and Forsyth street, stone water table, bronze tablet stamped "CHGO 588" 589.104

Hessville, Southeast to Griffith, Thence East to Hobart, Thence Northwest to Toleston, Thence West to Hessville.

Feet.

T. 36 N., R. 9 W., Section 21, Highlands; southwest corner of front projection of public school building, south side of top course of stone foundation, bronze tablet stamped "CHGO 618"......... 618.819

T. 35 N., R. 9 W., Section 2, Griffith; frame schoolhouse south edge of town, brick foundation at northeast corner of, bronze tablet stamped "CHGO 630" 630.856

T. 35 N., R. 8 W., Section 4, near center of; large stone church, front face, northwest corner of, in stone work 20 inches from ground, bronze tablet stamped "CHGO 640"................. 640.870

T. 36 N., R. 7 W., Section 32, Hobart; wagon bridge over Deep River, top of stone southwest corner of west abutment, copper bolt stamped "CHGO 607" 607.574

*T. 35 N., R. 7 W., Section 5, in northwest quarter of; brick schoolhouse, south of entrance at east side of, top course of stone in foundation, bronze tablet stamped "633 CHGO".............. 633.721

T. 36 N., R. 8 W., Section 8, Toleston, frame schoolhouse, northwest corner of; top course stone foundation, bronze tablet stamped "CHGO 600" 600.575

*T. 36 N., R. 8 W., Section 31, Clark, water tank Pittsburgh, Fort Wayne and Chicago Railroad, 300 feet southeast of station, masonry foundation of northwest corner of, copper bolt stamped "CHGO 591" 591.814

* On single spur lines from Hobart and Toleston respectively.

[Preliminary Values Subject to Correction.]

BOONVILLE, DEGONIA, HUNTINGBURG, OWENSBORO, PETERSBURG, ST. MEINRAD, TELL CITY AND VELPEN QUADRANGLES.

Daviess, Dubois, Gibson, Pike, Spencer and Warrick Counties.

The elevations in the following list are based on Bench Mark A-3 at Vincennes of the Coast and Geodetic Survey transcontinental line of precise levels, a cut on the stone ledge on the northwest front of the courthouse. The elevation of this is now accepted as 433.445 feet above mean sea level. A double line of levels was first carried south from bench mark "Z" at Washington, via Petersburg to center of T. 1 S., which was the lone source of elevations published in Bulletin 185 for this group, but correction, the part closure of a similar line carried south from Vincennes plus corrections to Vincennes and Washington, by the last adjustment, modified by a slight readjustment of this group, have been applied in deriving the present values.

The leveling on the Boonville and the Petersburg quadrangles was done under the direction of Mr. R. C. McKinney, topographer, by L. E. Granke, levelman, in 1899; that on the Rockport and Tell City quadrangles was done under the direction of Chas. E. Cooke, by Dean Halford in 1900; and that on the Velpen, Huntingburg, Degonia, and St. Meinrad quadrangles was done under the direction of Mr. C. W. Goodlove, by C. E. Hewitt in 1900.

All standard bench marks of this work are stamped with the letters "VIN" in addition to the figures of elevations.

Evansville, East Along Railroad to Smith, and Return.

Feet.

Evansville, corner of Main and Water streets, an iron projection on iron door sill of brick building, 48.84 feet above zero of gauge. .378.374

Evansville, at Evansville and Terre Haute Railroad station; top of rail 383.2

T. 6 S., R. 10 W., southeast corner of Section 14, at intersection of roads, 4 feet west and 3 feet 7 inches north of fence corner; iron post stamped "378 VIN" 387.397

Smith, North Along Highway to Wheatonville; Thence South to Stevenson; Thence west to Smith.

Feet.

T. 5 S., R. 10 W., at southwest corner of Section 24, about 3 feet south of southwest corner of schoolhouse; iron post stamped "390 VIN" 390.894

T. 4 S., R. 10 W., at center of Section 25, northwest corner of crossroads; iron post stamped "429 VIN" 429.404

Feet.

T. 4 S., R. 9 W., northeast quarter of Section 21, 27 feet north and 29½ feet east of east end of bridge over canal; iron post stamped "392 VIN" 392.278

T. 5 S., R. 9 W., center Section 21, at southwest corner of crossroads, 13 feet south of fence corner; iron post stamped "411 VIN" 411.738

Stephenson, T. 6 S., R. 9 W., 2.5 feet south of southeast corner of schoolhouse, west side of road and 500 feet north of railroad; iron post stamped "389 VIN" 389.767

Stevenson, Northeast to Boonville; Thence North to Lynnville; Thence West to Wheatonville.

Feet.

T. 6 S., R. 8 W., 0.3 mile west of center Section 6, 4 feet north of fence at forks of road; iron post stamped "454 VIN"..........454.243

Boonville, 85 feet west and 95 feet north of amphitheater in fair grounds, in meridian stone; aluminum tablet stamped "395 VIN" 395.844

T. 4 S., R. 8 W., at center of Section 27, 6.67 feet west and 2.25 feet south of fence corner, at northwest corner of crossroads at cemetery; iron post stamped "487 VIN"....................457.701

Lynnville, North Along Highway Through R. 8 W., to Center of T. 1 S.; Thence West to Center of R. 9 W.; Thence South Through R. 9 W., to Wheatonville.

Feet.

T. 3 S., R. 8 W., at northeast corner of Section 28, 6.5 feet west and 2.83 feet north of fence corner, at southwest corner of crossroads; iron post stamped "501 VIN" 501.962

T. 2 S., R. 8 W., center Section 21, 15.5 feet west and 28.5 feet north of fence corner, the most westerly of two formed by intersection of roads; iron post stamped "458 VIN"............457.822

T. 1 S., R. 8 W., southwest corner of Section 16, 8.25 feet east and 1 foot south of fence corner, northeast corner of fence corner; iron post stamped "476 VIN" 476.278

T. 1 S., R. 9 W., Northeast corner of Section 21, 5.5 feet west and 8 feet south of fence corner, at southwest corner of crossroads; iron post stamped "489 VIN" 489.221

T. 2 S., R. 9 W., 0.3 mile west of northeast corner of Section 17, 3 feet south and 2 feet west of fence corner, at southeast corner of crossroads; iron post stamped "447 VIN"....................447.932

T. 3 S., R. 9 W., center of Section 16, 22.5 feet east and 2 feet north of fence corner, the most southerly of two corners formed by intersection of crossroads; iron post stamped "439 VIN"......439.266

T. 3 S., R. 10 W., quarter corner south side of Section 13, 12.5 feet north and 1.75 feet west of fence corner, the most easterly of two formed by intersection of roads; iron post stamped "432 VIN" 432.862

Boonville, East Along Highway, to Degonia; Thence South via Lake to Africa; Thence Northeast via Rockhill to Chrisney.

Feet.

Degonia, in stone post in front of Ash Iron Springs Hotel; aluminum tablet stamped "401 VIN" 401.725

Degonia Springs, about 0.3 mile south of northwest corner of Section 27, T. 5 S., R. 7 W., at railroad crossing; iron post stamped "401 VIN" 401.461

Pigeon Creek, in top pier at north end of west abutment of bridge; aluminum tablet stamped "383 VIN" 383.689

Richland (Lake postoffice), in cornerstone of I. O. O. F. Building; aluminum tablet stamped "393 VIN" 393.750

Richland, 8 miles south of, to Rockford, in foundation at northeast corner of Mr. Cramer's storehouse; aluminum tablet stamped "381 VIN" 381.744

Africa, at east entrance of Africa schoolhouse, in stone step; aluminum tablet stamped "388 VIN" 388.719

Rockport, in stone foundation on east wall and 6.5 feet south of north wall of court-house; aluminum tablet stamped "454 VIN" 454.927

Rock Hill, 330 feet north of a station; 14 feet west of Louisville, Evansville and St. Louis track, in face of rock; aluminum tablest stamped "398 VIN" 393.860

Chrisney, East Along Highway via Troy and Cannelton, to Hawesville, Ky.

Feet.

Grand View, T. 7 S., R. 5 W., Sections 4 and 5, under main street dividing; 270 rods north of Ohio River, in west face of culvert; aluminum tablet stamped "391 VIN" 391.620

Crooked Creek, in east end of north abutment top tier of bridge; aluminum tablet stamped "386 VIN" 386.713

Tell City, 300 feet west of Louisville, Evansville and St. Louis Railroad (side track), on Tell street, in northeast corner of top tier of foundation of Acme Distillery; aluminum tablet stamped "395 VIN" 395.190

Degonia, Southeast to Chrisney; Thence North to Lincoln City; Thence West to Degonia.

Feet.

T. 6 S., R. 7 W., near southwest corner of Section 11, at southeast corner of lot of Hale schoolhouse; iron post stamped "401 VIN" 401.230

Chrisney, T. 6 S., R. 6 W., in northwest quarter of Section 11, in southwest corner of hotel lot; iron post stamped "464 VIN"... 464.187

Gentryville, T. 5 S., R. 6 W., Section 1, at crossroads, 150 feet north of railroad track; iron post stamped "403 VIN"............. 403.704

Lincoln City, North Along Railroad, to Huntingburg.

Feet.

Huntingburg, in grounds of L. E. & S. L. R. R.; iron post stamped "472 VIN" 472.007

Lincoln City, Southeast to Troy.

Feet.

Buffaloville, T. 5 S., R. 5 W., Section 9, at northeast corner of station grounds; iron post stamped "427 VIN"..................427.063

Lamars, T. 5 S., R. 4 W., quarter mile south of northwest corner of Section 19, on east side of street at southwest corner of store lot; iron post stamped "411 VIN" 411.510

Evanston, T. 5 S., R. 4 W., Section 34, at southeast corner of store west of north-south road, 200 feet north of railroad crossing; iron post stamped "413 VIN" 413.264

Troy, West via Newtonville, to Chrisney.

Feet.

Troy, T. 6 S., R. 4 W., Section 13, in stone at southwest corner of Nester Hotel lot, northeast corner of Washington and Water streets; iron post stamped "391 VIN" 391.955

Newtonville, T. 6 S., R. 5 W., southeast corner of Section 11, at northeast corner of crossroads; iron post stamped "438 VIN"..438.463

Troy, North to St. Meinrad; Thence West to Dale.

Feet.

Troy, 3.5 miles east of, at fork of Tell City and Troy roads; iron post stamped "550 VIN" 550.730

T. 4 S., R. 3 W., near south side of Section 4, on north end of east-west road, opposite road south; iron post stamped "398 VIN"..398.480

Bristow, 0.25 mile northwest of, at northwest corner of intersection of road running west from road to Adyeville; iron post stamped "424 VIN" 424.465

St. Meinrad, T. 4 S., R. 4 W., 0.25 mile south of northeast corner of Section 14, at northeast corner of postoffice building at southwest corner of Main street and street south to Abbey; iron post stamped "456 VIN" 456.798

Heilman, T. 4 S., R. 6 W., 0.25 mile south of northeast corner of Section 20, at northeast corner of crossroads; iron post stamped "484 VIN" 484.900

Dale, T. 4 S., R. 5 W., Section 17, 6 feet west of the northwest corner of Heickelbech's store, at southeast corner of street crossing; iron post stamped "463 VIN" 463.390

St. Meinrad, Northwest to Ferdinand.

Feet.

Ferdinand, T. 2 S., R. 4 W., southwest quarter of Section 27, at northeast corner of lot 235, belonging to August Barth, at southwest corner of street crossing; iron post stamped "525 VIN" 525.101

Ferdinand station (Jonesboro postoffice), T. 2 S., R. 5 W., north side of Section 34, at northwest corner of Peter Schnell's store, south of road and east of railroad; iron post stamped "486 VIN" 486.385

Dale, West to Folsomville; Thence South to Degonia.

Feet.

Folsomville, T. 4 S., R. 7 W., 0.25 mile south of northeast corner of Section 34, at northeast corner of Odd Fellows' Hall; iron post stamped "464 VIN" 464.448

Folsomville, North to Stendall; Thence Northeast to Duff; Thence East to Huntingburg.

Feet.

Stendall, T. 3 S., R. 7 W., near quarter corner east side of Section 11, in front of Dr. Stork's office, at southwest corner of street crossing; iron post stamped "626 VIN" 626.952

T. 3 S., R. 6 W., near quarter corner east side of Section 9, at northwest corner of school lot on line between Dubois and Pike counties; iron post stamped "563 VIN" 563.545

Stendall, North to Winslow; Thence East to Duff.

Feet.

Augusta, T. 2 S., R. 7 W., Section 21, in northeast corner of hotel lot, at southwest corner of street crossing; iron post stamped "567 VIN" 567.627

Winslow, T. 1 S., R. 7 W., Section 32, in stone window sill of brick store, at southeast corner of street crossing; aluminum tablet stamped "463 VIN" 463.027

Velpen, T. 2 S., R. 6 W., Section 8, 200 feet east of station, 200 feet north of railroad, at southeast corner of G. W. Cockrel's Clothing store; iron post stamped "490 VIN"....................490.238

Huntingburg, Northwest to Otwell; Thence South to Velpen.

Feet.

Ireland, T. 1 S., R. 5 W., near east line of Section 19, at southeast corner of postoffice, northwest corner of street crossing; iron post stamped "479 VIN" 479.034

Otwell, T. 1 S., R. 6 W., 0.25 mile north of southeast corner of Section 5, at northeast corner of William McCormick's brick store, at southwest corner of crossroads; iron post stamped "496 VIN" 496.944

Otwell, West to Petersburg.

Feet.

Algiers, T. 1 N., R. 7 W., Section 27, at southwest corner of Dr. Harris' office, at northeast corner of street crossing; iron post stamped "527 VIN" 527.409

T. 1 N., R. 6 W., Section 30, at southwest corner of school lot, at northeast corner of junction with road between Otwell and Algiers; iron post stamped "502 VIN" 502.421

PROSPECT, NEW ALBANY AND KOSMOSDALE QUADRANGLES.

Clark, Floyd and Harrison Counties.

The elevations in the following list are based on the United States Corps of Engineers' bench marks at Louisville and West Point, Ky.

The leveling was done in 1910 by E. C. Bibee.

LOUISVILLE QUADRANGLE.

Bench Mark Established at Louisville.

Feet.

Louisville, northeast corner of Fifteenth and Main streets, iron post stamped "Primary Traverse Station No. 87; 458"............457.715

PROSPECT QUADRANGLE.

From Jeffersonville Along Highways to Howard Park Station.

Feet.

Jeffersonville, 250 feet west of penitentiary; chiseled square on north abutment west side of bridge 96 over Court avenue (Pennsylvania railroad), painted "461.2" 461.19

Howard Park Station, north side of railroad, at railroad crossing Interurban and Pittsburg, Chicago, Cincinnati and St. Louis; spike in base of telegraph anchor post, marked "450.7"........450.70

NEW ALBANY QUADRANGLE.

From Howard Park Station Southwest Along Highways to a Point Four Miles Southwest of New Albany.

Feet.

New Albany, 1.11 miles east of, 30 feet west of public road at railroad crossing; rail spike in base of telegraph pole, painted "440.9" 440.87

New Albany, chiseled square on north end of Monon and Pennsylvania passenger station platform; painted "459.2"............459.14

New Albany, at southwest corner of Main and Vincennes streets, opposite Monon and Pennsylvania passenger station; iron post stamped "464" 463.771

New Albany; chiseled square on west end, second step from bottom on approach to Pennsylvania State street station; painted "439.2" 439.17

New Albany; crossing of Elizabeth Pike and Southern Railroad, on east side of pike 20 feet south of railroad; rail spike in base of telephone pole, painted "445.8" 445.78

New Albany, 3.25 miles west of, on southwest side of road at Y road; iron post stamped "502" 501.567

New Albany, 3.89 miles west of; chiseled square on northwest corner of abutment of small iron bridge, painted "481.6"......481.58

New Albany, 4.2 miles west of, on south side of road; chiseled square on limestone ledge, painted "670.7" 670.64

KOMOSDALE QUADRANGLE.

From Four Miles Southwest of New Albany Southwest and South Along Highways via Lanesville, Elizabeth, Evans Landing to West Point, Ky.

Feet.

New Albany, 6.4 miles west of, at northwest corner of T road, 1,000 feet east of H. Hitchcock's residence; iron post stamped "467". 467.368

New Albany, 2.9 miles west of; bolt head in log foundation of foot bridge over creek, painted "482.1" 482.06

New Albany, 7.4 miles west of, on north side of road; chiseled square on sandstone ledge, painted "729.2" 729.09

Lanesville, 3.6 miles east of, on Elizabeth pike, at T road west, in front yard of W. M. Brown's residence; iron post stamped "931" 930.495

Lanesville, 2.2 miles east of; at private road north; chiseled square on west abutment north side of small bridge over creek, painted "772.4" 772.33

Lanesville, 1.5 miles east of, on Cardon pike, on north side of public road in front of residence of Joseph Stilger; chiseled square on ledge of rocks, painted "788.5" 788.40

Lanesville, northwest corner schoolhouse yard; iron post stamped "731" 730.888

Lanesville, on southwest corner of Main street and alley leading to Elizabeth pike, on corner in front of Jacob Tachinger's store; top of fire plug, painted "703.167" 703.06

Lanesville, 1 mile southeast of, at Y road; chiseled square on limestone ledge, painted "772.4" 772.27

Lanesville, 2.4 miles south of, 100 feet south of T road east; chiseled square on large stone in center of road, painted "859.8" 859.71

Lanesville, 468 miles south of, 15 feet northeast of northeast corner of No. 7 schoolhouse; iron post stamped "874" 873.976

Lanesville, 4.6 miles south of, east side of road, at terminus of mail route from Georgetown, said to be on line between Franklin and Posey townships; paint spot on top of white oak stump, painted "777.7" 777.61

Lanesville, 627 miles south of, at northeast corner of T road east; chiseled square on limestone rock, painted "693.6" 693.42

Lanesville, 6.96 miles south of, in southwest corner of schoolhouse yard, at T road north; iron post stamped "861" 860.872

Elizabeth, 2.7 miles north of; paint spot on north end of culvert leading to J. Morgan's barn, painted "784.7" 784.58

Elizabeth, 1.9 miles north of, on north side of road; chiseled square on rock, painted "793.8" 793.60

Elizabeth, 1.6 miles north of, in front of 7 Springs schoolhouse, No. 4 school; chiseled square on limestone ledge, painted "711.5" ... 711.30

Elizabeth, 0.6 mile north of, in northwest corner of T road north; chiseled square on stone, painted "813.4" 813.19

Elizabeth schoolhouse "Old," at southwest corner of, iron post stamped "Traverse Station No. 6; 744" 743.374

Feet.

Elizabeth, 1.1 miles south of, on southwest corner of T road west; paint spot on root of white oak tree, painted "796.6"..........796.44

Elizabeth, 1.7 miles south of, at northeast corner of crossroads, north end of tile drain under road at northeast, painted "768.9" 768.70

Elizabeth, 2.7 miles south of, on east side of road at T road west; paint spot on rock, painted "773.2" 773.02

Township line between Posey and Taylor townships.............775.1

Elizabeth, 3.2 miles south of, at southwest corner of crossroads, 200 feet east of Glenwood Church; paint spot on top of white oak stump, painted "795.2" 795.04

Buena Vista, center of, on northwest corner of street crossing, 700 feet southwest of Catholic Church; iron post stamped "646"...645.877

Buena Vista, 1.4 miles south of, on east side of road in front of residence of John Cutchlow; chiseled square, painted "742.6"..742.41

Buena Vista, 2.96 miles south of; chiseled square on east abutment of small culvert under road, painted "721.2".................720.97

Evans Landing, 0.5 mile northwest of, at northwest corner of T road north, 600 feet east of old Catholic Church; paint spot on rock 430.32

Evans Landing, 60 feet east of Presbyterian Church, in corner of field owned by R. N. Davis; iron post stamped "456"..........455.834

Evans Landing, surface of water in Ohio River at 2:30 p. m., October 25, 1910 ....370.2

West Point, Indiana Bank Building; aluminum tablet stamped "441" 441.068

[Preliminary Values Subject to Correction.]

HAUBSTADT, NEWBURG, NEW HARMONY, POSEYVILLE, PRINCETON AND VINCENNES QUADRANGLES.

Gibson, Knox, Posey and Vanderburgh Counties.

The elevations in the following list are based upon bench mark A-3 at Vincennes, a bench mark of the Coast and Geodetic Survey transcontinental precise level line. It is a cut on the stone ledge on the northwest front of the courthouse. The elevation of this is now accepted at 433.445 feet above mean sea level.

A double line of levels was carried south from this to Princeton and a similar line was previously run from bench mark "Z" at Washington to Petersburg. The work here listed combines with the previous work to the east which is published in another list, and both have been given a mean value from the two sources.

The leveling was done in 1901 under the direction of C. W. Goodlove by D. D. Doty, except line to Yankeetown which was run in 1903 under W. H. Lovell by F. M. Goodhue.

Standard bench marks set in the course of this work are stamped with the letters "VIN" in addition to the figures of elevation.

Vincennes, South Along Evansville, Terre Haute Railroad, to Princeton. (Double-Rodded Line.)

Feet.

Decker, zero gauge on White River 386.09
Hazleton, south of station, 6 feet north of second telegraph pole; iron post stamped "422 VIN" 422.670

Princeton, West Along Louisville, Evansville and St. Louis Railroad, to Mt. Carmel, Illinois. (Double-Rodded Line.)

Feet.

Beck, crossing at station; top of rail ....403.
T. 1 N., R. 12 W., southeast corner of Section 36, 48 feet south of track, at southwest corner of crossing; iron post stamped "397.6 VIN" 397.692

From Francisco and From Princeton, to Maxam; Thence Southwest via Highway and Canal to Point Two Miles North of Fort Branch.

Feet.

Port Gibson, at Old Wabash and Erie Canal, 10 feet southwest of southeast corner of bridge over Pigeon Creek; iron post stamped "427 VIN" 427.367

Princeton, South Along Evansville and Terre Haute Railroad via Fort Branch to Steaser.

Feet.

Princeton, south side of courthouse, at east entrance to basemenet; bronze tablet stamped "500 VIN" 500.843
Fort Branch, 20 feet southeast of southeast corner of station; iron post stamped "454 VIN" 454.849
Haubstadt, 10.8 feet west of southeast corner of station; iron post stamped "473 VIN" 473.425
St. James, 20 feet south of station, 22 feet west of track; iron post stamped "477 VIN" 477.422

Fort Branch, West Along Evansville and Terre Haute Railroad via Owensville to Poseyville.

Feet.

Owensville, 40 feet north of 6th splice at west end of station, on main track; iron post stamped "506 VIN"....................................507.061

Mt. Carmel, Southeast Along Southern Railway and Public Roads via East Mount Carmel, Indiana, to Owensville, Indiana.

Feet.

East Mt. Carmel, 4.5 miles south of, iron bridge over Blair ditch, 90 feet north of northwest corner of, at northwest corner of crossroads, inside fence; iron post stamped "391 VIN"........391.542

Staser, East Along Highway, to T. 4 S., R. 10 W., Section 25.

Feet.

T. 4 S., R. 10 W., at center of Section 25, at northwest corner of road crossing, at schoolhouse No. 3; iron post stamped "428 VIN" 429.404

Smyth Station, West Along Southern Railroad to T. 6 S., R. 10 W., Southwest Corner of, Thence North Along Evansville and Terre Haute Railroad to Staser.

Feet.

T. 6 N., R. 10 W., in northwest quarter of Section 9, at junction of railroads, about 15 feet east of first joint north of north end of frog; iron post stamped "385 VIN" 385.783

T. 5 S., R. 10 W., at northwest corner of Section 8, Inglefield, at southwest corner of crossing; iron post stamped "470 VIN".... 470.638

T. 6 S., R. 10 W., Southwest Corner of, West One Mile; Thence Northwest Along Illinois Central Railroad via Armstrong to Martin; Thence East Along Highway to Inglefield.

Feet.

T. 6 S., R. 11 W., northeast corner of Section 2, at Hillside Switch; iron post stamped "393 VIN" 393.752

Armstrong, T. 5 S., R. 11 W., center of Section 9, 20 feet south of crossing; iron post stamped "469 VIN" 469.471

Martins, 3 feet from southeast corner of station; iron post stamped "431 VIN" 431.690

T. 4 S., R. 11 W., quarter corner east side of Section 34, highest corner of post 470.01

Martin, Northwest Along Illinois Central Railroad to Poseyville; Thence Along Highway East and North to Cynthiana.

Feet.

Poseyville, 15 feet south of southeast corner of station; iron post stamped "434 VIN" 434.825

Poseyville, South and Southwest Along Evansville and Terre Haute Railroad via Wadesville and Oliver to Solitude. (Mean of Two Direct Lines.)

Feet.

Wadesville, 1 foot north of north side of station; iron post stamped "467 VIN" 467.405

Oliver, between rails of main line and switch; iron post stamped "409 VIN" 409.766

Solitude, at southeast corner of cinder platform; iron post stamped "377 VIN" 377.632

Poseyville, West Along Illinois Central Railroad via Stewartsville, to Grayville.

Feet.

Stewartsville, 20 feet west of 5th telegraph pole west of, at junction of tracks; iron post stamped "469 VIN" 469.726

Griffin, 70 feet east of station, 20 feet north of track; iron post stamped "385 VIN" 385.260

Stewartsville, Southwest Along Branch Railroad, to New Harmony.

Feet.

New Harmony, center of north window sill of New Harmony Banking Company Building; bronze tablet stamped "384 VIN".....384.590

New Harmony, at north side of entrance of Murphy Library, at west end of top step; bronze tablet stamped "387 VIN".......387.135

New Harmony, Wabash River at ferry in northwestern part of town, surface of water, July 29, 1901......................355.0

Belt Line and Illinois Central Railroad Junction South to Evansville.

Feet.

Evansville, in southwest corner of Willard Library yard; iron post (meridian mark) stamped "386 VIN" 387.148

Evansville, at east entrance to Custom House, on floor; bronze tablet stamped "394 VIN" 394.645

Evansville, Ohio River, surface of water, June 10, 1901............351.5

Evansville, Ohio River, water gauge zero 329.53

Gilbert Grove (Five Miles East of Evansville), East Along E. S. & N. R. R. via Newburg, to Yankeetown. (Single Spur Line.)

Feet.

Newburg, Citizens Bank, left side of main entrance, in center of marble base stone, 2 feet from ground; bronze tablet stamped "400 LOUISVILLE" 400.348

Yankeetown, 0.4 mile from Yankeetown Corner; east side of Main street, in brick foundation of bay window of Wesley Johnson's house; in northwest face; aluminum tablet stamped "515 LOUISVILLE" 515.540

Henderson, Kentucky, Across Ohio River Bridge; Thence Along River Road (Indiana) to Evansville. (Mean of Two Lines.)

Feet.

Henderson, southeast corner of third abutment pier of Louisville and Nashville Railroad bridge over Ohio River (Indiana side), in second stone above ground; chiseled cross 365.81

GENERAL INDEX.