

INDIANA.

DEPARTMENT

OF

Geology and Natural Resources.

NINETEENTH ANNUAL REPORT.

S. S. GORBY,
STATE GEOLOGIST.

1894.

TO THE GOVERNOR,

INDIANAPOLIS:

WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING.

THE STATE OF INDIANA,
EXECUTIVE DEPARTMENT,
NOVEMBER 20, 1894. }

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MYRON D. KING,
Private Secretary.

Filed in the office of the Secretary of State of the State of Indiana, November 20, 1894.

W. R. MYERS,
Secretary of State.

Received the within report and delivered to the printer November 20, 1894.

J. B. MAYNARD,
Clerk Printing Bureau.

State of Indiana,
Department of Geology and Natural Resources,

INDIANAPOLIS, IND., September 4, 1894.

TO HON. CLAUDE MATTHEWS,
Governor of Indiana:

SIR—Herewith I submit the Nineteenth Report of the Department of Geology and Natural Resources. The report embraces reports of the State Inspector of Mines, State Inspector of Oils, State Supervisor of Natural Gas, accompanied by a geological map of Indiana, showing location of stone quarries and natural gas and oil areas.

It is hoped the report will be a valuable aid to those interested in the geology or natural history of the State, whether in an economic or purely scientific sense.

Respectfully submitted,

S. S. GORBY,
State Geologist.

ASSISTANTS TO THE STATE GEOLOGIST.

E. T. J. JORDAN	Supervisor of Natural Gas.
N. J. HYDE	Supervisor of Mineral Oils.
THOMAS McQUADE	State Inspector of Mines.
MOSES N. ELROD	Geologist.
A. C. BENEDICT	Geologist.
O. P. HAY	Ichthyologist.

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INTRODUCTORY.

This volume, the nineteenth in serial number of the reports issued by the Department of Geology and Natural Resources, is the report for the year 1893. It comprises the following papers, prepared by the assistants of the State Geologist, S. S. Gorby:

“THE GEOLOGY OF CASS COUNTY.”

In this paper the topography and general geology of Cass County are briefly treated by Messrs. M. N. Elrod and A. C. Benedict. Under the head of “Paleozoic Geology” a number of well and quarry sections in the county are given and commented upon.

“REPORT OF INSPECTOR OF MINES,”

AND

“REPORT OF STATE SUPERVISOR OF OILS.”

These reports, prepared by Thomas McQuade, State Inspector of Mines, and Nelson J. Hyde, State Supervisor of Oils, follow the above, and are largely statistical in their make-up.

“REPORT OF STATE SUPERVISOR OF NATURAL GAS.”

Prof. E. T. J. Jordan, the State Supervisor of Natural Gas, in a report extending over twenty-three pages, shows that the area in the State in which this valuable fuel is found did not increase during the year 1893. According to his belief, based upon careful inspection of gas plants and measurements of pressure in wells, the history of the Indiana gas field is to be that of every other field hitherto discovered—a gradual but sure diminution of the supply of gas. The failure has already begun, as shown by the diminished initial pressure and by the increased pressure of salt water. No gas is being formed at the present time, and only the most careful saving of the amount in store will keep the gas pressure above the water pressure for any great length of time. The careful attention of all producers and consumers of natural gas is directed to this, the latest published report of the State Gas Supervisor.

"THE LAMPREYS AND FISHES OF INDIANA."

All students of Natural History in the State will welcome with delight this valuable paper on the fishes inhabiting our streams and lakes. That it was prepared by Dr. O. P. Hay, formerly Professor of Zoölogy at Butler University, is sufficient guarantee of its accuracy and thoroughness. Dr. Hay has been for many years a careful collector and student of fishes and other creeping, crawling and swimming vertebrates. He has published numerous papers on them, among the most valuable and extensive of which was the treatise on the "Batrachians and Reptiles of Indiana," which appeared in the seventeenth report of this department.

In the present paper 150 kinds of lampreys, and fishes found in Indiana, are carefully described, and the descriptions are preceded by analytical keys, so that with a little careful attention a person who has never before seen a specimen of the kind in hand, can readily determine its family, scientific, and common names, and its relative systematic position among the other fishes of the State. The streams and other localities inhabited by each species, as far as known, are given, and the feeding habits and relative food value of each are fully mentioned, making it, all in all, the only comprehensive and thorough treatise on Indiana fishes ever published.

GEOLOGY OF CASS COUNTY.

BY M. N. ELROD, M. D., AND A. C. BENEDICT.

HISTORICAL AND DESCRIPTIVE.

Cass County is bounded on the east by Miami County, on the north by Fulton and Pulaski, on the west by White and Carroll and on the south by Carroll and Howard. It is twenty-four miles long on the east side by twenty-two miles wide on the north end. On the west side and south end the boundary line follows an irregular course; commencing at the northwest corner of the county it runs twelve miles south, three miles east, three miles south, eight miles east, nine miles south and eleven miles east, and includes within its limits 420 sections of land of 256,174 acres, as reported for taxation.

Cass County was included in Tippecanoe until 1828. The organization of the county was completed April 13, 1829, under acts of the Legislature passed December 18, 1828, and January 19, 1829, and at that time embraced all that portion of the State now included in the counties of Miami, Wabash, Fulton, Marshall, Kosciusko and St. Joseph, and parts of Laporte, Starke and Pulaski. The county seat was located at Logansport August 10, 1829. The county is divided into fourteen civil townships: Boone, Harrison, Bethlehem, Adams, Miami, Clay, Eel, Noble and Jefferson on the north side of the Wabash River, and Clinton, Washington, Tipton, Jackson and Deer Creek on the south side.

Logansport is located at the confluence of Eel River with the Wabash, near the center of the county. It was named in honor of Captain Logan, a Shawnee Chief, who lost his life in November, 1812, because of his fidelity to the whites, and not for Logan, the Mingo, as many suppose. The original plat of the town contained 111 lots, with streets 66 feet wide, except Broadway which is 82½ feet wide, and the same generous proportions have been preserved in all additional plats. No city of its size has better streets and sidewalks. Over one hundred miles of solid, commodious, well-drained, graveled or macadamized highways, with more than half as many miles of stone and cement sidewalks, have been built. The main thoroughfares are traversed by many miles of electric street railway, and well lighted with gas and arc lights. The water supply is

abundant and wholesome. The main part of the city lies nearly two miles distant from the junction of the rivers; its central elevation is crowded with churches, representing all the leading denominations; its west slope is covered with handsome business blocks, "while the more retired streets are lined with beautiful homes, from the mansion of wealth to the cottage of labor."

The natural gas plant of Logansport is one of the very best. It is supplied from the heart of the Indiana field, in which the company has 7,000 acres of territory.

The main line is twenty-six miles of eight-inch, screw joint, standard pipe. The gas is distributed to the city consumers through about fifty miles of piping. There are eight beautiful public school buildings within the corporate limits. Of these the Central, or High School, building is the largest. This building is 104 by 118 feet, three stories above the basement, and was erected at a cost of \$70,000.

The railroads centering here give employment to several hundred men, the majority of whom are in the Panhandle repair shops and yards. In addition to these are many other shops, together with factories, mills and foundries.

The location of Logansport, between and at the confluence of two broad and beautiful streams, has rendered necessary nine long bridges. Five of them are used for general traffic and four are beautiful and costly railway structures.

Royal Centre, an incorporated town, on the Pittsburgh, Cincinnati, Chicago & St. Louis Railway, eleven miles northwest, and Walton, on the same road, nine miles southeast of Logansport, are the principal towns in the county, the first having a population of 600 and the second 800. There are twenty-five postoffice towns and villages outside of Logansport, nearly all of them located on railroads. Seven of them are money-order offices.

The county is well supplied with railroads and Logansport is a railway center second to but few cities in the State. In these roads three systems are represented. The Wabash by its main line and the Eel River Division; the Pennsylvania by the Indianapolis, Richmond, Columbus, Chicago and Peoria Divisions; and the Vandalia by the Terre Haute, Logansport & Michigan Division.

Excellent turnpikes and gravel roads cross the county in every direction, affording its citizens easy and rapid transportation. The gravel, everywhere available, should be used until every mud road in the county is macadamized. The principal pikes are the Logansport and Marion; Logansport and Western; Logansport and Rock Creek; Logansport and Northern; Logansport and Burlington and the Logansport and Wabash.

TOPOGRAPHY.

In the immediate vicinity of Wabash and Eel Rivers the surface is undulating and broken; back from the rivers the country is level. All the southern part, in its natural state, was heavily timbered bottoms or table-land; the center is mostly bottom, with some high bluff land; the northern is principally prairie.

By reference to the table of elevations it will be seen that Waverly is 83 feet above the Wabash Railway station at Logansport; Lucerne, 209 feet; Gephart, 156; Lake Cicott, 105; Summit, one and three-fourths miles east of Clymers, 139 feet; Galveston, 199 feet; and Onward, 167 feet.

The drainage of the county is determined by the Wabash and Eel River valleys passing from east to west, and the highlands of the northern parts of Deer Creek and Jackson Townships, south of the Wabash River, and the high lands of the southern parts of Harrison and Boone Townships. The streams of Deer Creek, Jackson, Tipton and Washington Townships are Deer Creek and Big Rock Creek, which run nearly due west and empty into the Wabash in Carroll County. Pipe Creek enters the county from Miami and running north unites its waters with those of the Wabash opposite Lewisburg. Twelve Mile Creek drains the northeast part of the county and empties into Eel River. Crooked Creek joins the Wabash near the Carroll County line. All the other creeks of the county flow into the Wabash or Eel Rivers, except a few small streams in the northwest part of the county, which flow into the Tippecanoe River.

Lake Cicott, in Jefferson Township, is one mile long, east and west, and has an average width, north and south, of one-fourth of a mile; greatest depth, 64 feet. The bluffs on all sides are twenty-five feet high, except on the east side, where they are wanting, so that in times of high water it drains into Crooked Creek through an old lake bed lying between it and the creek. It contains sunfish, two kinds of catfish, and a small grass pike. It is not fed by any regular stream, and has no outlet except for flood water.

The principal agricultural product is corn, and according to recent statistics the county has an average yield of 55 bushels an acre, which is larger than that of any other county in the State. The warm, loamy alluvial soil of the river bottoms, in favorable years, produce immense crops of wheat. All agricultural products are successfully grown, and with the variety of soil, furnished by valley and upland, is given the greatest possible diversity to farming. These varieties of soil are so evenly adjusted as to prevent a complete crop failure throughout the county; and it is to this fact that the general thrift of the farmer, and those dependent upon him, is due. In its primeval state much of the

land in Cass County was wet and swampy, but the best of land when thoroughly drained. The portions especially requiring drainage, upland prairie, are readily recognized by the absence of creeks, as shown on any good map of the county.

GENERAL GEOLOGY.

DESCRIPTIVE AND DYNAMIC.

CONNECTED SECTION.

QUATERNARY.

Recent Period.

Soil	5 feet.
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Drift Period.

Glacial clay, sand and gravel	0 to 150 "
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DEVONIAN AGE.

Upper Helderberg Group.

Amorphous dove-colored stone	0 to 25 "
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Buff quarry-stone, Fitch's quarry, etc	0 to 50 "
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Blue limestone, Lux & Lux's quarry	0 to 10 "
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Stromatopora beds, Keepport's limekilns	10 "
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Schoharie grit	0 to 5 "
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SILURIAN AGE.

UPPER SILURIAN DIVISION.

Lower Helderberg Group.

Waterlime strata, Pipe Creek falls	0 to 10 "
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Niagara Group.

Niagara limestone	0 to 10 "
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Total	0 to 275 feet.
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All the surface stone of Cass County is referred to the Devonian and Silurian systems. In the vicinity of Logansport and west from that place, including the quarries at Georgetown, the country rocks belong to the Upper Helderberg Group of the Devonian Age. The lowest member of this group, the Schoharie grit, is only seen on Deer Creek in Jackson Township. The next member, in descending order of the geological scale, is the waterlime formation of the Lower Helderberg, which outcrops in the bed of Pipe Creek at the Pipe Creek Falls. That the dark stone, with a strong smell of petroleum, seen only at this place in the county, is the equivalent of the beds at Kokomo seems very probable on lithological grounds alone; and this inference is confirmed when it is taken into consideration that the Pipe Creek Falls and the Kokomo quarries are very nearly on the same geological level and altitude above

the ocean. No fossils were found to confirm the conclusions drawn from the physical appearance of the exposure, and it is freely granted that the character of the stone in the Wabash Valley so rapidly changes within a few hundred feet on the same horizon, that any determination where no fossils are seen, must be of doubtful value, yet that this is its true place seems very probable. Below the Waterlime strata comes the Niagara Group limestone in the channel of Pipe Creek, in the bed of the Wabash River east of Cass, at Cedar Island, immediately south of Keepport's quarry, and perhaps at Miller's Falls, near Waverly. Because of the general dip to the west, the Niagara stone disappears under the bed of the Wabash before reaching Logansport.

It has been claimed that the Lower Helderberg Group, other than the Waterlime member, has been identified in this county at a point one-fourth of a mile above the Vandalia Railway bridge at Logansport, but as only one imperfect fossil could be found the determination can not be confirmed. On the contrary, it must be an error, and this is made more than probable when it is remembered that the same party, who claims to have found Lower Helderberg rocks in Cass County, refers the quarry stone of South Wabash to the same group. Fossils are abundant at South Wabash, and it is hard to understand on what grounds the quarry stone of that locality can be referred to any other group than the Niagara. The cephalopods, of which there are six genera and many species here found, have all been described as from rocks of the Niagara Age. The genus *Pisocrinus*, a characteristic fossil of the Niagara rocks at Lockport, N. Y., St. Paul, Hartsville, Versailles, and at many other places in Indiana, is quite common in the quarry stone of Wabash County. It also occurs in rocks of an equivalent age in England. In view of the fact that such authorities as De Koninck, Hall, Miller, Newell and Pengueberg have all united in pronouncing the *Pisocrinus* beds of Niagara Age, and that the presence of *Echinodermata* is the most delicate test the paleontologist can apply in determining the geological horizon of a given strata, further proof is desired before any of the rocks of the Wabash Valley, and especially in Cass and Wabash Counties, except the Waterlime formation, are referred to the Lower Helderberg Group.

All the rocky strata of the county lie as they were deposited at the bottom of the ocean, other than the changes wrought by the continental elevations that made the interior of North America dry land. The general dip is to the west, a few degrees south. This is true of the entire Wabash Valley, and in fact of the whole State. There are local exceptions to this statement, but they are of very limited extent, rarely extending more than a few yards, and are not to be taken into consideration in studying the geology of a county, nor even a township.

Irregular bedding was seen at many places, among the most conspicuous examples being those exposed at Keepert's limekilns and at the Pipe Creek Falls. At the latter place the strata grow thinner in one direction and thicker in the other. In this county, as in Wabash, the greatest apparent departure from normal stratification is confined to the Niagara rocks, or those immediately overlying them.

The theory that the rocks of the Wabash Valley have been disturbed and upturned by a local upheaval co-extensive with the limits of the State, finds no support in the geology of Cass County. Nowhere was seen the equivalent of the porous or "picket rocks" so characteristic of what has been described as an upheaval. It is admitted, however, that no general disturbance of the strata, either at Delphi or Wabash City, could have occurred without leaving some impress on the rocks of this county, and for this reason it may be worth while to show briefly why we do not think there has been any change caused in the relationship of the strata of the Wabash Valley since the formation of the Cincinnati Arch.

Prof. John Collett pointed out in the Geological Survey of Indiana, 1872, that the mass of "compact, porous limestone, irregularly bedded and dipping N. W. at 45 degrees," at Hanging Rock, near the mouth of the Salamonie River, was underlaid by "horizontal clay stones" and five feet of "choice blue limestone." This section alone was sufficient, in his mind, to disprove the evidences of an upheaval seen at other points, notably those at Wabash City and Delphi. To this exposure at Hanging Rock others of a similar character on the Salamonie and in the vicinity of La Gro have been added, showing clearly under the porous stone even-bedded strata with clay or shale partings, such as only occur in true stratification wholly undisturbed by any influence other than that which elevated the continent. Second, the "porous picket rock" is not an exotic production intruded into the place where now found, but an indigenous country rock in which the lithological characters have been changed by chemical action. At Shutz's Cone, near La Gro, all the gradations of change can be traced from the unaltered hydraulic limestone beds of the base to the hard, porous stone of the apex. Third, the lines of separation between the strata of the cones, on which the tilted appearance of the stone depends, are not planes of stratification, but a modified form of joint structure. But, aside from any question of a subterranean disturbance in the Wabash Valley at the close of the Niagara Period, many very remarkable phenomena in stratification and lithification are presented that need further elucidation. A careful study of this region would add a chapter to stratigraphical geology of great interest not now found in any American text-book.

The lower strata, the blue limestone of Lux & Lux's quarry, is of Devonian age, filled with Upper Helderberg fossils, and is the equivalent

of the famous blue quarry stone of Vernon, Jennings County, Indiana, and is an excellent building stone. The buff arenaceous material overlying the blue stone is the equivalent of the rather soft, banded, semi-buff limestone overlying the blue at Vernon. At Lux & Lux's quarry the arenaceous material is the highest member of the Upper Helderberg shown, but going west along the Wabash River this stone dips rapidly to the west until, at the quarries two or three miles below the city, it has a thickness of thirty or more feet. It is here capped by a considerable thickness of hard, amorphous dove-colored limestone. Passing on down the Wabash the even-bedded buff-colored limestone is seen outcropping in the west bank of the river fifty or more feet in thickness, still capped by the dove-colored stone. Opposite Georgetown, still further down the stream, there is only a few feet of the even-bedded stone exposed in the east bank of the river. Here the amorphous, dove-colored stone is replaced by a gray stratified stone filled with poorly preserved Devonian fossils.

ECONOMIC GEOLOGY.

As to the quality of the stone seen in Cass County it is not necessary to go into details. In the days of the old Wabash and Erie Canal great quantities of the even-bedded, buff stone was quarried and used in bridge and architectural work. It has stood the test of time well, and is destined to hold its place in the market with the best. Before the present financial depression came the quarry interests of the county were growing daily in value and importance, and are destined to grow in the future.

Logansport has always been famous for the production of excellent lime, and with the modern advantage of natural gas will steadily increase its output. The lime produced is caustic and has been used by many gas companies for years as a deodorizer. It is an excellent lime, when thoroughly slacked, for plastering purposes, and makes a hard, compact wall, free from blisters. For mason work it makes a mortar which is generally harder and more enduring than common bricks.

DRIFT.

The glacial clays, sand and gravel, cover the whole county, except on the creeks and rivers. On the uplands it seems to be unmodified, and in places has a depth of 150 feet. The sand ridges of the northern part of the county are peculiar, and deserve study in connection with the surface geology of the adjoining counties. The same is true of the trail of bowlders seen in Bethlehem Township. Bowlders are more common north of the Wabash River.

PALEOZOIC GEOLOGY.

LOCAL DETAILS.

TALBOTT & PARKER'S LIME KILN.

Two miles west of Logansport, on the State line division of the Pennsylvania Railroad, Eel Township.

Soil	2 ft. 6 in.
Hard, dove-colored, concretionary limestone, not regularly bedded	11 ft. 0 in.
Rough bedded, dove-colored limestone	10 in.
Rough bedded, dove-colored limestone	8 in.
Total	15 ft. 0 in.

The concretions seen in this quarry vary in size from that of a hulled walnut to that of one's fist, and are cemented together by a greenish white material that weathers black. From the center of the quarry the stone dips in every direction as if it had been deposited on a low mound, and indicative that it was formed in an eddy.

One-eighth of a mile west of the Talbott & Parker kiln an exposure by the side of the railroad gave the following:

SECTION.

Eel Township.

Soil	6 ft. 0 in.
Conchoidal, concretionary limestone	1 ft. 6 in.
Parting, a trace.	
Conchoidal, concretionary limestone	2 ft. 0 in.
Parting, a trace.	
Irregularly bedded, conchoidal, concretionary, dove-colored limestone	2 ft. 0 in.
Covered slope to base of rail	4 ft. 0 in.
Total	15 ft. 6 in.

The dip here is slightly to the east. The stone of the last section occupies a higher place in the series and immediately overlies the stone exposed in the old lime kiln quarries of Talbott & Parker.

SECTION OF WILLIAM TALBOTT'S QUARRY.

Three miles west of Logansport, on the south side of the State line division of the Pennsylvania Railroad, Eel Township.

Soil and covered slope	12 ft. 0 in.
Thin fissile, buff limestone	3 ft. 0 in.
Heavy bedded, buff limestone	1 ft. 3 in.
Soft buff limestone	0 ft. 7 in.
Hard buff limestone	0 ft. 9 in.
Hard buff limestone	1 ft. 9 in.
Irregularly bedded, fissile limestone	4 ft. 4 in.
Even bedded, buff limestone	1 ft. 2 in.
Irregularly bedded, gray limestone	0 ft. 8 in.
Rotten, buff limestone	0 ft. 2 in.
Vermicular buff limestone	1 ft. 0 in.
Hard, buff limestone	0 ft. 6 in.
Hard, buff limestone	1 ft. 0 in.
Hard, buff limestone	0 ft. 8 in.
Hard, buff limestone	0 ft. 8 in.
Total	30 ft. 4 in.

The bottom of the quarry shows an arenaceous limestone stratum. No fossils, except some obscure casts, were seen here, and, in fact, this is true of all equivalent exposures of this rock in the county. This stone lies horizontally bedded in every outcrop except one, that at Georgetown, where it has a slight dip to the west.

A few rods south of William Talbott's quarry, in a gravel pit, limestone boulders were seen corresponding lithologically with the stone at Talbott & Parker's lime kiln quarries, and these boulders no doubt were derived from stone that capped this quarry before glacial action removed it.

SECTION OF DR. FITCH'S QUARRY.

North bank of the Wabash River, three and a half miles west of Logansport, Eel Township.

Soil and covered slope	10 ft. 0 in.
Hard, dove-colored, cherty limestone with chert bands	12 ft. 0 in.
Massive, heavy bedded, dove-colored limestone, even bedded	10 ft. 0 in.
Rough bedded, dove-colored limestone	1 ft. 4 in.
Rough bedded, dove-colored limestone	1 ft. 0 in.
Rough bedded, dove-colored limestone	1 ft. 8 in.
Irregularly bedded, fissile, gray limestone	4 ft. 0 in.
Fissile, buff limestone	2 ft. 10 in.
Silicious, dove-colored limestone to bottom of the valley	5 ft. 0 in.
Total	47 ft. 10 in.

Below the farm house and just west of Fitch's Glen the dove-colored stone has thinned to fifteen feet, as shown in the perpendicular face of

the bluff; but the buff stone, owing to its softness, was covered in the greater part by the soil of the slope. The thickness of the latter is here estimated at thirty feet.

H. M. WHISTLER'S QUARRY.

Pipe Creek, one mile above its junction with the Wabash River, Tipton Township.	
Soil	1 ft. 8 in.
Buff-gray limestone, that splits into thin layers	6 ft. 0 in.
Even-bedded, gray limestone	9 in.
Even-bedded, gray limestone	10 in.
Even-bedded, gray limestone	10 in.
Even-bedded, gray limestone	7 in.
Even-bedded, gray limestone, to bed of stream	10 in.
Total	11 ft. 6 in.

This, so far as seen, is the best building stone in the county. The iron contained in it being thoroughly oxidized, it is not affected by atmospheric changes, and when once thoroughly seasoned will withstand all changes of atmosphere. When this quarry is worked farther back, and when the unseasoned stone is removed from atmospheric influences, it will be found that the six feet of thin material has become solid ledges of from six to twelve inches in thickness, but not as valuable a stone as that of the lower strata.

A short distance up the creek from Whistler's is another quarry that shows the following:

SECTION.

Soil	2 ft. 0 in.
Buff limestone	6 in.
Buff limestone	6 in.
Buff limestone	7 in.
Gray limestone	10 in.
Gray limestone	3 in.
Gray limestone	5 in.
Buff limestone	8 in.
Thin-shell buff limestone	7 in.
Buff limestone	6 in.
Buff limestone	3 in.
Buff limestone	2 in.
Buff limestone	10 in.
Buff limestone	1 ft. 2 in.
Buff limestone to stream	2 ft. 2 in.
Total	11 ft. 5 in.

This is a very fine stone, of much the same quality of that seen in the Whistler quarry, but more evenly bedded. The dip here is 2° north.

On the bank of the creek in the rear of the Pipe Creek school-house there is a twenty-foot exposure of unstratified buff stone with sand holes and miniature caves in it. This outcrop overlies that of the last section.

SECTION ON PIPE CREEK.

Near the school-house.

Soil and slope	5 ft. 0 in.
Buff magnesian limestone, obscurely bedded, and breaking into irregular pieces	11 ft. 0 in.
Heavy bedded, buff limestone	2 ft. 0 in.
Heavy bedded, buff limestone	2 ft. 0 in.
Heavy bedded, buff limestone	2 ft. 5 in.
Heavy bedded, buff limestone	1 ft. 8 in.
Heavy bedded, buff limestone	10 in.
Rotten, amorphous stone to the water's edge	1 ft. 8 in.
Total	26 ft. 7 in.

SECTION AT ADAMSBORO.

East end of the bridge over Eel River.

Soil	1 ft. 2 in.
Hard, gray magnesian limestone containing <i>Stromatopora perforata</i> , <i>Favosites limitaris</i> , <i>Favosites polymorpha</i> , <i>F. emmornisia</i> , <i>Productella</i> , sp.?, <i>Streptorhynchus</i> , sp.?, <i>Atrypa reticularis</i> , <i>Platyceras</i> , sp.?, and a number of undetermined corals and polyzoa to the water's edge	10 ft. 0 in.
Total	11 ft. 2 in.

SECTION AT MILLER'S FALLS.

Two miles southwest of Waverly, Miami Township.

Rough-bedded, uneven, thin gray limestone, containing <i>Stromatopora</i> , sp.?, and <i>Favosites polymorpha</i>	12 ft. 0 in.
Rough-bedded limestone (Niagara) to the bottom of the fall	3 ft. 0 in.
Total	15 ft. 0 in.

This stream occupies a preglacial channel that starts west from the Wabash River, opposite the mouth of the Mississinewa, above Peru, and runs in a western direction until it reaches a point about one mile west of Waverly, where it turns south and intersects the Wabash one-half mile west of Lewisburg. At the time of our visit a diminutive streamlet was trickling over the rocks where once a volume of water poured.

SECTION AT CEDAR ISLAND.

Soil	4 ft. 0 in.
Buff limestone.	3 in.
Buff limestone.	4 in.
Chert band	2 in.
Buff limestone.	5 in.
Buff limestone.	5 in.
Buff limestone.	4 in.
Buff limestone.	5 in.
Buff limestone.	3 in.
Buff limestone.	4 in.
Buff limestone.	4 in.
Buff limestone.	3 in.
Buff limestone.	3 in.
Buff limestone.	4 in.
Buff limestone.	2 in.
Buff limestone.	4 in.
Buff limestone.	3 in.
Buff limestone.	4 in.
Buff limestone.	2 in.
Buff limestone.	6 in.
Total	10 ft. 3 in.

This stone is referred to the Niagara Group on lithological grounds alone, as no fossils could be found. The dip is five degrees to the west, and the strata seems to thicken rapidly in the same direction. Fifty feet west of this exposure an outcropping was seen, in what appeared to be an abandoned quarry, which showed intercalated, wedge-shaped strata that greatly increased the apparent dip of the rock. At Keepport's limekiln this stone underlies the Devonian, and can be traced one-half mile east along the Wabash Railroad, where it disappears, dipping to the east; west from Keepport's it dips at about the same rate along the river, until it finally disappears under the bed of the river.

SECTION AT KEEPPORT'S LIMEKILN.

Gray limestone, bedding very irregular	4 ft. 0 in.
Blue limestone, bedding obscure, Upper Helderberg Group	4 ft. 0 in.
Blue limestone to the bottom of the quarry, bedding not obvious except near the vertical seams, vertical seams infrequent. What stratification is shown rapidly changes, and thin. Dip slight and variable	4 ft. 0 in.
Total	12 ft. 0 in.

The two upper members of this section contain great numbers of *Stromatopora*, some of them one foot in diameter, but their presence does not interfere in burning the stone to lime, as they are not siliceous.

South of the railroad, near the last section, and underlying it, the following exposure was seen in an abandoned quarry and the stone seen in it is referred to the Niagara Group:

SECTION.

Dark limestone	2 ft. 0 in.
Dry parting	4 in.
Thin bedded limestone	2 ft. 2 in.
Heavy blue limestone	1 ft. 2 in.
Buff limestone	2 ft. 9 in.
Buff limestone	9 in.
Buff limestone, apparently arenaceous, bedding irregular	3 ft. 4 in.
Total	12 ft. 6 in.

SECTION ON THE FARM OF W. H. TYNER.

Across the river from Georgetown, Clinton Township.

Soil	14 ft. 0 in.
Limestone	51 ft. 0 in.
Total	65 ft. 0 in.

This stone is reported very hard and the drillers say they were all day making a depth of six inches. At the bottom of the bore "slate of a dark color" was struck. This so-called strata was probably the Niagara shale that is frequently found underlying the Upper Helderberg Group of Devonian Age.

SECTION NEAR GEORGETOWN.

East bank of the Wabash River, Clinton Township.

Soil	3 ft. 0 in.
Gray limestone, varying to buff, in places sandy	10 ft. 0 in.
Dark colored, fissile limestone, breaking into small pieces	4 ft. 6 in.
Heavy bedded, dark arenaceous limestone	2 ft. 0 in.
Fissile, gray, arenaceous limestone to bed of the river	3 ft. 0 in.
Total	22 ft. 6 in.

The upper member of this section contains an abundance of crinoidal remains with a great many corals, all too poorly preserved to be identified. The surface of the next member, where exposed, shows evidence of having been eroded into channels and hummocks before the overlying rock was deposited.

SECTION IN JEFFERSON TOWNSHIP,

One-half mile above Georgetown.

Soil	3 ft. 0 in.
Dark limestone, full of crinoidal remains, very rough bedded	2 ft. 0 in.
Dark limestone, full of crinoidal remains, very rough bedded	3 in.
Fissile, light colored material, full of comminuted crinoids, resting on a hard blue siliceous stone that is locally a "fire rock"	2 ft. 0 in.
Total	7 ft. 3 in.

This is the only exposure of stone seen in the township and is, together with the stone just across the river, referred, on lithological grounds alone, to the Waterlime Group, but is thought to be correct because of its dark color and strong smell of petroleum when freshly fractured.

On the farm of John Stanffer, near the forks of Deer Creek, there is an outcrop of Schoharie grit about five feet in thickness, that is underlaid and covered by buff limestone. At another point on Deer Creek there is an outcrop of gray magnesian limestone for one and a half miles that has a vertical exposure of ten feet.

SECTION AT ANTON GLEITZ'S QUARRY.

Near Long Cliff.

Soil	2 ft. 0 in.
Hard, concretionary, dove-colored limestone	18 ft. 0 in.
Covered slope	20 ft. 0 in.
Thin-bedded, buff, arenaceous limestone	6 ft. 6 in.
Heavy-bedded buff limestone	12 ft. 6 in.
Covered slope to river bed where was seen heavy-bedded, dove-colored limestone	8 ft. 0 in.
Total	67 ft. 0 in.

Between the bottom of the quarry proper and the dove-colored stone seen in the river bank there is five feet of thin-bedded, dark, magnesian limestone, followed by the same thickness of lighter colored stone that shows color bands of deposition.

SECTION AT LUX & LUX'S QUARRY.

City of Logansport.

Soil, gravel and bowlders	5 ft. 0 in.
Buff arenaceous limestone, strata from 3 inches to 1 foot in thick- ness, bedding very irregular, closed vertical seams frequent at all angles	10 ft. 6 in.
Blue limestone, good quarry stone	8 ft. 0 in.
Total	23 ft. 6 in.

At the time of our visit it was not possible to see the whole of the blue limestone uncovered by the quarrymen, because of the high water which covered the lower members of the exposure. The portions seen show

DRIFT PERIOD.

LOCAL DETAILS.

SECTION IN LOGANSPOBT.

Corner Broadway and Seventh Streets.

Soil	3 ft. 0 in.
Stratified gravel	8 ft. 0 in.
Total	11 ft. 0 in.

This section reaches down to a level of the street grade, but the gravel probably continues to the underlying Upper Helderberg rocks, as they were seen cropping out at the corner of Broadway and Sixth Street.

SECTION OF GRAVEL PIT.

North bank of Eel River, near the upper dam, Eel Township.

Soil	2 ft. 4 in.
Gravel to rock	32 ft. 0 in.
Total	34 ft. 4 in.

This is a good coarse gravel with numerous boulders in it, varying in size from an egg to a barrel or larger. At one place is shown a lens-shaped mass of much finer gray colored gravel without any boulders in it. The other beds are strongly colored with oxide of iron.

Generally in the southern part of Adams Township seven or eight feet of gravelly soil overlies from two to six feet of yellow clay. Under the clay is a bed of coarse gravel that is water bearing. Occasionally the gravelly yellow clay is much thicker before water is found. Good road gravel is abundant in beds that have been worked to a depth of ten feet and probably reach a much greater depth. The northern part of the township is locally known as "the barrens" and is made up of a succession of sand ridges and prairies. The latter is first-class farming land when properly underdrained. For years many farmers did not appreciate the value of ditching for this kind of soil, and consequently it was neglected for the dryer lands of the southern part of the township. The sand ridges have a general east and west direction.

SECTION ON EEL RIVER.

One mile east of Adamsboro in Clay Township.

Soil	5 ft. 0 in.
Coarse gray gravel	10 ft. 0 in.
Fine yellow sand	5 ft. 0 in.
Fine gray gravel	5 ft. 0 in.
Total	25 ft. 0 in.

There is a large amount of gravel in the northeast part of this township. One quarter of a mile north of here, a good exposure of the upper member of this section was seen in a ravine leading into Eel River.

WELL ON THE FARM OF MARION KRIDER.

Sec. 31, town. 28, range 3 east. Adams Township.

Soil, sandy loam	15 ft. 0 in.
Blue clay	25 ft. 0 in.
Gravel	3 ft. 0 in.
Blue clay	46 ft. 0 in.
Water-bearing gravel	7 ft. 0 in.
Total	96 ft. 0 in.

GRAVEL PIT.

Sec. 31, town. 28, range 3 east.

Soil	3 ft.
Good, coarse, gray gravel	6 ft.
Gray sand	3 ft.
Total	12 ft.

This gravel is a fine road material, and the sand is excellent for masonry and plastering purposes.

GENERAL SECTION AT ALTONA.

Harrison Township.

Soil	1 ft.
Yellow clay with an occasional sand parting	6 ft.
Blue clay	25 ft.
Total	32 ft.

SECTION OF OSCAR SARGENT'S WELL.

Bethlehem Township, sec. 21, town. 28, range 2 east.

Soil	3 ft.
Yellow clay	10 ft.
Gravel	2 ft.
Blue clay	115 ft.
Total	130 ft.

SECTION OF HORACE SMITH'S WELL.

Bethlehem Township, sec. 27, town. 28, range 2 east.

Sandy loam	6 ft.
Fine gravel	8 ft.
Yellow clay	12 ft.
Gravel	8 ft.
Quicksand	56 ft.
Coarse water-bearing gravel	3 ft.
Total	93 ft.

SECTION OF GRAVEL PIT.

On the farm of D. Calvert, Bethlehem Township, sec. 33, town. 28, range 2 east.

Soil	10 ft.
Good gravel	20 ft.
Total	30 ft.

This pit furnishes fine road-making material, and it was used on the Michigan Pike.

SECTION OF SAMUEL GRABLE'S WELL.

South of Fletcher's Lake, Bethlehem Township.

Soil	1 ft.
Yellow clay	10 ft.
Yellow and gray sand	2 ft.
Water bearing gravel	3 ft.
Total	16 ft.

This is a very shallow well for this neighborhood. One mile southwest Mr. Pindar has a driven well that is 150 feet in depth. East of Grable's Mr. Bennett went down 100 feet before finding water.

In the south part of this township good gravel for road making is abundant, in beds from ten to fourteen feet thick, under two feet of soil. Gravel, regularly stratified, with beds of good plaster sand are common, in strata from eight inches to two feet thick, in sections 23, 24, 25, 33, 34 and 35. Boulders are rather common and vary in diameter from a few inches to six by eight feet in size. They are frequently used for foundation stone under light structures. A trail of them, with an average width of one-fourth of a mile, extends across the township in a northwest and southeast direction.

SECTION OF MR. DONOVAN'S WELL.

Harrison Township, section 13, town. 28, range 1 east.

Soil.	2 ft.
Yellow clay	8 ft.
Blue clay	15 ft.
Water bearing gravel	1 ft.
Total	26 ft.

Wells in this neighborhood vary in depth from twenty to eighty feet.

SECTION OF JAMES CASS' WELL.

Harrison Township.

Soil, a sandy loam	12 ft.
Blue clay	68 ft.
Water bearing gravel	6 ft.
Total	<u>86 ft.</u>

A well on the farm of Richard Burton, sec. 4, town. 28, range 1 east, gave very nearly the same section as that of Mr. Cass.

SECTION OF GRAVEL PIT.

On the farm of John Eglin, near Jacktown, Harrison Township.

Loam	4 ft.
Good, coarse, gray gravel, with bands and pockets of coarse gray sand . . .	<u>10 ft.</u>
Total	14 ft.

This bed of gravel outcrops for two miles along the bank of Big Indian Creek, in the northern part of the township.

The soil of the western part of Harrison Township is a rich, warm loam that produces abundant crops. In places the surface is level and swampy, the swamps being surrounded by low, round knolls and ridges. When ditched the unsightly swamps are transferred into the best of farming land.

SECTION OF GEORGE HIRD'S WELL.

Jacktown, Harrison Township.

Soil	3 ft.
Gravel, with partings and pockets of sand to water bearing stratum . . .	<u>42 ft.</u>
Total	45 ft.

SECTION OF WELL.

Royal Centre, Boone Township.

Soil	3 ft.
Sand	2 ft.
Blue clay to water bearing gravel	<u>12 ft.</u>
Total	17 ft.

The south half of Boone and the northern and eastern parts of Jefferson Township are traversed by parallel sand ridges, varying in height from ten to thirty feet. The sand is of a yellow color, and the ridges have a general trend from northeast to southwest.

SECTION NEAR LAKE CICOTT.

On the railroad, 100 yards west of the station, Jefferson Township.

Soil	5 ft.
Fine gravel to road-bed	18 ft.
Total	23 ft.

A short distance west of here the gravel changes to a fine ferruginous sand.

SECTION OF DRIVEN WELL.

Lake Cicott.

Sandy soil	8 ft.
Yellow clay and gravel	8 ft.
Fine gravel	5 ft.
Blue glacial clay	5 ft.
Water-bearing gravel	2 ft.
Total	28 ft.

J. E. BUCHANAN'S WELL.

Jefferson Township, sec. 14, town. 27, range 1 west.

Sandy soil	6 ft.
Sand and gravel	8 ft.
Yellow glacial clay	7 ft.
Blue glacial clay	2 ft.
Coarse, white gravel	4 ft.
Yellow, ferruginous gravel	4 ft.
Gray glacial clay	1 ft.
Total	32 ft.

After passing through the last member of the section, water rose six feet in the well, and is locally known as "iron water."

SECTION ON THE FARM OF L. E. ROGERS.

Sec 17, town. 27, range 1 west, Jefferson Township.

Soil	2 ft.
Red glacial clay	11 ft.
Coarse gravel	13 ft.
Gray glacial clay, with sand partings	6 ft.
Water-bearing gravel	6 ft.
Total	38 ft.

In this township the sand ridges have a northwest and southeast direction. One ridge of this sand had a thickness of twenty-five feet and was capped with yellow clay from two to four feet thick.

SECTION OF GRAVEL PIT.

On the railroad one-fourth of a mile east of Curveton.

Soil and sand	18 ft. to 24 ft.
Good, coarse, gray gravel	15 ft. to 30 ft.
Total	33 ft. to 54 ft.

This exposure extends along the railroad for three-quarters of a mile, and about 75,000 car loads have been taken out in the last fifteen years.

SECTION OF GRAVEL PIT.

On the farm of Samuel Robinson, Noble Township.

Soil	3 ft.
Gray gravel, with sand strata	10 ft.
Total	13 ft.

Ten feet is all the gravel here exposed, but it probably extends much deeper.

In Clay Township the soil has a depth of from one to ten feet, and under this cones from ten to twenty feet of gray hard-pan clay, with sand partings that are generally water bearing. Along the hills are numerous springs wherever the sand partings of the hard-pan come to the surface.

SECTION OF GLACIAL DRIFT.

North Bank of Wabash River, One-fourth of a Mile Below the Lewisburg Bridge.

Soil	5 ft.
Obscurely stratified gravel, with bowlders varying from one-half to twenty pounds in weight	15 ft.
Gray hard-pan to bed of the canal	20 ft.
Total	40 ft.

A section taken 100 feet away from this would vary, as the bedding changes rapidly in either direction.

SECTION OF OWEN ENGLIN'S WELL.

Walton.

Black loam	1 ft. 6 in.
Yellow clay, changing to a clay sand	15 ft. 0 in.
Total	16 ft. 6 in.

David Englin, in digging a well in Walton, reports that at a depth of seven feet the earth sounded hollow, and on breaking through the crust water two feet deep was found that has furnished a never-failing supply.

SECTION OF M. H. THOMAS'S WELL.

Galveston.

Soil, gravel and clay	58 ft.
Limestone	5 ft.
Total	63 ft.

This well is on higher ground than the gas well and, consequently, the water does not overflow.

SECTION OF GRAVEL PIT.

On the farm of Samuel Wallace, Jackson Township, sec. 34, town. 25, range 3, east.

Soil	3 ft.
Coarse, yellow gravel	20 ft.
Total	23 ft.

This is on the second bottom of Deer Creek. In the bluffs above the pits the gravel is alternated with strata of sand and clay. The continuity of the sand beds is broken by perpendicular seams of clay that vary from three to six feet in thickness.

SECTION ON THE FARM OF A. BURKIT.

South Part of Washington Township.

Yellow loam	5 ft.
Gravelly loam	5 ft.
Blue clay	5 ft.
Hard, yellow, gravelly clay, to water bearing gravel	3 ft.
Total	18 ft.

The last member of this section is so hard it has to be loosened with a pick.

SECTION ON THE FARM OF OLIVER BAUGHMAN.

North Part of Washington Township.

Yellow loam	6 ft.
Gravelly loam	16 ft.
Blue clay	3 ft.
Water-bearing gravel	2 ft.
Total	27 ft.

There is no gravel available in this township for roadmaking purposes. Boulders are very scarce, and the same is true of the southern part of Tipton Township. Fifteen feet of good road gravel under one foot of soil was seen on the farm of John Hines in Clinton Township, and the bed is exposed for more than half a mile.

An average of six wells in sections 15 and 16, township 26, range 1 east, gave the following:

SECTION.

Soil, black rich loam	2 to 3 ft.
Yellow glacial clay	8 to 10 ft.
Blue glacial clay to water	6 to 10 ft.
Total	16 to 23 ft.

GAS AND OIL WELLS.

GAS WELLS AT LOGANSFORT.

West of Eel River, on the Barnett Farm.

Soil, gravel and clay	80 ft.
Blue, hard limestone	70 ft.
White limestone	335 ft.
Gray shale, slightly gritty	200 ft.
Coffee-colored shale	240 ft.
Trenton limestone	— ft.
Total	925 ft.

No gas.

At twenty-five feet in the Trenton limestone sulphuretted hydrogen water was found, which flows from the top of the well. The Trenton rock at this well is said to have been a dark colored, hard stone for one hundred feet, gradually changing, as the well was sunk deeper, to rotten stone.

SECTION OF OIL WELL.

Walton.

Soil, gravel and clay	80 ft.
Limestone	520 ft.
Shale	400 ft.
Trenton limestone	34 ft.
Total	1,034 ft.

Oil was found at one thousand feet and is a heavy lubricating oil, and is used locally in preference to the best West Virginia oil.

GAS WELL AT GALVESTON.

Soil	4 ft.
Glacial clay and gravel	36 ft.
Limestone	400 ft.
Shale	400 ft.
Trenton limestone	20 ft.
Total	<u>860 ft.</u>

At eighty feet artesian water was found. No other veins of water were found until salt water was struck in the Trenton. No gas.

OIL WELL AT ROYAL CENTER.

No. 1.

Soil	5 ft.
Glacial gravel mixed with yellow clay	85 ft.
Gray limestone, the lower part blue, and probably Niagara Group stone	400 ft.
Hudson River and Utica shales	481 ft.
Trenton limestone	20 ft.
Total	<u>991 ft.</u>

OIL WELL AT ROYAL CENTER.

No. 2.

Soil and drift	109 ft.
Limestone	486 ft.
Hudson River and Utica shales	330 ft.
Oil in Trenton limestone	15 ft.
To salt water	26 ft.
Total	<u>966 ft.</u>

These wells when first drilled flowed two and a half barrels of dark lubricating oil daily.

ELEVATIONS OF INDIANA RAILWAYS PASSING THROUGH CASS AND WABASH COUNTIES.

COMPILED BY M. N. ELROD AND A. C. BENEDICT.

The altitudes given in the following tables, except those of the Wabash and Vandalia systems, in which the same datum was used, are reduced to the level of the railroad crossings of the Wabash and Pennsylvania at Logansport, and the Wabash and the Chicago & Erie at Huntington, the Wabash being taken as the standard.

The datum of the Wabash and Vandalia railways is fully explained in the following extract from a letter written by Mr. W. S. Lincoln, chief engineer of the Wabash Company, at St. Louis, Mo.:

“Enclosed please find elevations of our lines through the State of Indiana. They are based on the datum of the City Directrix of St. Louis, the elevation of which is 433.978 feet above tide of the Gulf of Mexico. The elevation of the St. Louis datum has been changed a number of times, it being computed at one time at 403.0 feet, later at 413.9 above tide of Gulf of Mexico, but now is computed at 433.978 feet by the city office and the Mississippi River Commission of the United States, although the United States Geological Survey still considers it to be 413.9 feet, and owing to this fact these elevations may not strictly conform with those of several other roads centering here, they probably having used the former elevations of the city datum.”

The altitudes here given, however, are not computed from the elevation of the datum used by Mr. Lincoln, but from the more recent determinations of the United States Coast and Geodetic Survey, by whom heights have been determined by the most refined geodetic methods. According to the latest determinations the St. Louis City Directrix, as given in Prof. Henry Gannett's Dictionary of Altitudes, is 416 feet above tide water.

In making these compilations we are indebted to Mr. W. S. Lincoln, of the Wabash Company; Mr. Ben McKeen, Engineer of the Vandalia; Mr. Aug. Mordecai, Roadmaster of the Chicago & Erie Railroad Company; Mr. M. U. Becker, Chief Engineer of the Pennsylvania System West of Pittsburgh, and to Prof. Gannett's Dictionary of Altitudes, second edition.

WABASH RAILROAD.

<i>Stations.</i>	<i>Elevation.</i>
Ohio and Indiana State line	731.40
Woodburn	741.00
Car Creek Station	747.40
Crossing of N. Y., St. L. & C. at New Haven	741.00
New Haven	742.40
Summit, one mile east of Fort Wayne, grade and surface	781.40
Crossing of P., Ft. W. & Chicago Railway, Fort Wayne, grade	774.40
Fort Wayne Station and Calhoun Street	764.00
St. Mary's River bridge, grade	753.00
St. Mary's River bridge, low water	726.40
St. Mary's River bridge, extreme bottom	723.40
Fort Wayne, Cincinnati & Louisville Railway crossing	773.00
Midway	751.00
Prairie Switch	744.00
Aboite	740.00
Little River bridge, 169, near county line, grade	740.00
Little River bridge, 169, near county line, bottom	731.40
Line between Allen and Huntington counties	740.00
Roanoke Station	740.00
Bend of Little River, two miles west of Mahon, grade	734.00
Bend of Little River, two miles west of Mahon, low water	712.00
Bend of Little River, two miles west of Mahon, bottom	717.40
Bend of Little River, two miles west of Mahon, high water	731.00
Union	735.00
Lillie	735.00
Huntington, crossing Chicago & Atlantic Railway, grade	729.00
Huntington Station	719.00
Little River, grade	707.00
Little River, low water	692.40
Little River, extreme bottom	689.40
Wabash River bridge west of Huntington, grade	707.00
Wabash River bridge west of Huntington, bottom	680.40
Wabash River bridge west of Huntington, low water	688.00
Loose Creek bridge, grade	701.00
Loose Creek bridge, bottom	686.00
Andrews Station, central yard	699.00
Line between Wabash and Huntington counties	684.40
Wabash River at Belden, Wabash County, grade	684.40
Wabash River at Belden, Wabash County, low water	663.40
Wabash River at Belden, Wabash County, extreme bottom	659.90
Wabash & Erie Canal east of Lagro, grade	698.40
Wabash & Erie Canal east of Lagro, extreme bottom	678.40
Lagro Creek bridge, Wabash County, grade	684.40
Lagro Creek bridge, Wabash County, extreme bottom	664.40
Lagro Station, Wabash County	687.40
Crossing C., W. & M. Ry., $\frac{3}{4}$ mile east of Wabash, grade	712.40
Crossing C., W. & M. Ry., $\frac{3}{4}$ mile east of C., W. & M. Ry., grade	692.40
Wabash City station	727.40
Chesnut Creek Wabash City, grade	704.40

WABASH RAILROAD—Continued.

<i>Stations.</i>	<i>Elevation.</i>
Charley Creek, Wabash City, extreme bottom	675.40
Helm's Creek, Wabash County, grade	700.40
Helm's Creek, Wabash County, extreme bottom	666.40
Kentners, Wabash County, grade	676.40
Kentners, Wabash County, extreme bottom	649.40
Keller's Station, Rich Valley P. O., Wabash County	649.40
County line, Miami and Wabash counties	667.40
Erie	649.40
Peru, I. P. & C. Ry. crossing	639.90
Peru Station	641.40
County line, Cass and Miami counties	678.40
Waverly, Cass County	673.40
Cass Station, Keyport's lime kilns	624.40
Wabash & Erie Canal bridge, East Logansport, grade	616.10
Wabash & Erie Canal bridge, East Logansport, bottom	697.40
Logansport, center line of 17th Street produced south to main track	602.40
Logansport Station	590.40
Logansport Crossing Panhandle Ry	591.40
Wabash River bridge, Logansport, grade	597.40
Wabash River bridge, Logansport, average bottom	568.40
Summit 1½ miles east of Clymers	729.90
Clymers, Station, Cass County	719.90
Crossing, Wabash and L., C. & S. W. Ry., west of Clymers	713.40
Carroll and Cass County line	702.40
Burrows	695.90
Rock Creek, grade	668.40
Rock Creek, extreme bottom	620.40
Rockfield Station	691.40
Delphi crossing Wabash and L., N. A. & C. Ry.	553.40
Delphi Station	541.40
Deer Creek, West Delphi, grade	565.90
Deer Creek, West Delphi, extreme bottom	525.40
Colburn	651.40
Sugar Creek, grade	650.40
Sugar Creek, natural surface, average bottom	628.40
Buck Creek Station	659.40
Wild Cat Creek bridge, grade	576.40
Wild Cat Creek bridge, extreme bottom	523.40
Lafayette Station and Main Street	579.40
Lafayette Junction, Wabash and I., C. & L. and L. E. & W.	570.40
Durkees Run, Lafayette, grade	575.40
Durkees Run, Lafayette, extreme bottom	517.40
Wea Creek bridge, grade	591.80
Wea Creek bridge, extreme bottom	530.40
L., N. A. & C. Ry. crossing Wabash Ry., grade	617.40
L., N. A. & C. Ry. crossing Wabash Ry., extreme bottom	599.40
Wea Station	605.40
West Point	609.40
Flint Creek, grade	520.40

WABASH RAILROAD—Continued.

<i>Stations.</i>	<i>Elevation.</i>
Flint Creek, extreme bottom	542.40
Monaqua Creek, grade	567.40
Monaqua Creek, extreme bottom	535.40
Grindstone Creek, grade	560.40
Grindstone Creek, extreme bottom.	521.40
Turkey Run, 1½ miles east of Independence, grade	569.40
Turkey Run, 1½ miles east of Independence, extreme bottom.	521.40
Hemphill's Branch, grade.	544.40
Hemphill's Branch, extreme bottom	520.40
Independence	544.40
Attica Station	533.40
Junction A., C. & S., head block	531.90
C. & G. S. Ry., under crossing	513.40
Wabash River bridge, Attica, west end, grade	532.40
Wabash River bridge, Attica, east end, grade.	530.40
Wabash River bridge, Attica, Flint Creek bottom.	484.40
Williamsport Station, grade.	601.90
Williamsport Ravine, extreme bottom	530.40
Summit between Rock Creek and Williamsport, grade.	698.40
Summit between Rock Creek and Williamsport, natural surface	705.40
Rock Creek, one mile east of Lebanon, grade	654.40
Rock Creek, one mile east of Lebanon, average bottom	625.40
West Lebanon and connection with H. R. & E. Ry	683.90
Foster's branch of Redwood Creek, grade.	656.40
Marshfield	689.90
Sumner, Wabash, C. & E. I. connection	677.40
Sumner crossing of C. & E. I. R. R	673.40
State Line Station	703.40
State line between Illinois and Indiana, grade	709.40
State line between Illinois and Indiana, natural surface	713.40

EEL RIVER DIVISION OF WABASH RAILWAY.

<i>Station.</i>	<i>Elevation.</i>
Logansport, Wabash depot	590.40
Crossing of Eel River with Chicago branch of Pan Handle Railway	586.90
Connection of Seventeenth Street produced to Eel River Railway track	606.40
Bottom of Eel River at Seventeenth Street produced west	590.40
Adamsboro, Cass County	658.40
Hooover's, Cass County	682.40
Mexico	591.40
Denver crossing of I., P. C. & Eel River R. R	697.40
Chili	717.40
Eel River bridge, 2 miles west of county line, grade	718.40
Eel River bridge, 2 miles west of county line, extreme bottom	683.40
County line, Wabash and Miami counties	734.40
Roann, Wabash County	743.40
Bear Grass Creek, 3 miles north of Roann, grade	732.40
Bear Grass Creek, 3 miles north of Roann, average bottom	720.40
Laketon station, Wabash County	754.40

EEL RIVER DIVISION OF WABASH RAILWAY—Continued.

<i>Stations.</i>	<i>Elevation.</i>
Laketon, crossing of Chicago & Erie Railway	745.40
Eel River at North Manchester, grade	750.40
Eel River at North Manchester, bottom	726.40
North Manchester, crossing C., W. & M. Ry	761.40
North Manchester station, Wabash County	768.40
Eel River at Liberty Mills, grade	764.40
Eel River at Liberty Mills, bottom	745.40
Liberty Mills station, Wabash County	766.40
County line between Wabash and Kosciusko counties	783.40
County line between Kosciusko and Whitley counties	796.40
Collamer	785.40
Eel River at Collamer, grade	781.40
Eel River at Collamer, bottom	763.40
South Whitley	800.40
Spring Creek, $\frac{1}{3}$ of mile north of South Whitley, grade	806.40
Spring Creek, $\frac{1}{3}$ of mile north of South Whitley, bottom	784.40
Taylor's Station	856.40
Crossing of P., Ft. W. & C. Ry	836.40
Columbia City	830.40
Collins	862.40
Churubusco	887.40
County line between Whitley and Allen counties	878.40
County line between Allen and Noble counties	871.40
Potters	872.40
La Otts	867.40
Crossing of G. R. & I. Ry	868.40
Cedar Station	852.40
Cedar Creek bridge near Auburn Junction, grade	856.40
Cedar Creek bridge near Auburn Junction, bottom	846.40
Crossing of Ft. W., J. & S. Ry	860.40
Auburn	857.40
Mooreville	867.40
Butler yard and L. S. & M. S. Ry	862.40

CHICAGO & ERIE RAILWAY.

<i>Station.</i>	<i>Elevation.</i>
Huntington, crossing Wabash Ry	729.00
Wabash & Erie Canal	745.00
Flint Creek bridge No. 1	774.00
Flint Creek bridge No. 2	759.00
Flint Creek bridge No. 3	757.50
Clear Creek	784.00
West Point	835.00
Line between Wabash and Huntington counties	824.00
Servia, New Madison, Wabash County	800.00
Bolivar, crossing of C., W. & M. Ry	780.00
Eel River Railroad crossing	739.00
Eel River bridge	739.00
Laketon, Wabash County	739.00

CHICAGO & ERIE RAILWAY—Continued.

<i>Stations.</i>	<i>Elevation.</i>
Silver Creek bridge	765.00
New Harrisburg, Wabash County	812.00
Outlet to Lake	870.50
Akron	843.00
Lake No. 16	802.50
Rochester, crossing L. E. & W. Ry	761.60
Rochester, Mill Creek	756.50
Rochester, Main Street	756.50

VANDALIA RAILWAY, LOGANSPOUT DIVISION.

<i>Stations.</i>	<i>Elevation.</i>
Terre Haute	486.22
Terre Haute, I. & St. L. R. R. Crossing	487.68
Ellsworth	486.34
Crossing C. & E. I. R. R	498.98
Heckland	512.34
Rosedale	530.64
Jessup	527.53
Catlin	540.76
Rockville	700.55
Sand Creek	587.75
Judson	605.10
Crossing I., D. & W. R. R., I., D. & W. track	654.52
Crossing I., D. & W. R. R., Vandalia track	531.92
Guion	627.15
Dooley	646.37
Waveland	732.30
Brown's Valley	808.55
New Market	804.54
North Union	807.50
Crawfordsville Junction, O., I. & W. R. R	786.13
Crawfordsville Junction, L., N. A. & C. R. R	786.12
Crawfordsville	768.35
Garfield	788.50
Darlington	760.16
Bowers	811.76
Colfax, C., C., C. & St. L. Ry	841.83
Manson	860.62
Frankfort, L. E. & W. R. R	859.14
Frankfort, T., St. L. & K. C. Ry	859.14
Frankfort, L., N. A. & C. Ry	859.14
Kilmore	830.67
Moran	800.21
Sedalia	777.84
Cutler	784.77
Bringhurst	723.08
Flora	703.09
Camden	664.32
Woodville	690.59

VANDALIA RAILWAY, LOGANSPOBT DIVISION—Continued.

<i>Stations.</i>	<i>Elevation.</i>
Clymers, Cass County, W., St. L. & P. R. R.	720.89
Crossing P., C., C. & St. L., State Line Division	599.49
Logansport, T. H. & I. R. R.	593.35
Crossing P., C., C. & St. L., Chicago Division	613.60
Logansport station	600.85
Verona, Cass County	750.35
Lucerne, Cass County	799.35
Grass Creek	767.85
Kewanna	780.35
Bruce Lake	774.35
DeLong, C. & E. R. R.	745.35
Marmot	742.35
Hibbard, N. Y., C. & St. L. R. R.	778.35
Twin Lakes	801.35
Plymouth, P., Ft. W. & C. R. R.	791.35
Plymouth station	794.35
Harris	836.35
LaPaz Junction, B. & O. R. R.	851.17
Lakeville	832.35
Nutwood	848.35
South Bend	728.35
South Bend, I. & L. M. Junction	744.85
Olivers, C. & G. T. R. R.	725.27
Rugby, L. S. & M. S. R. R.	733.56
Michigan State Line	768.64

PENNSYLVANIA RAILWAY, RICHMOND DIVISION.

<i>Station.</i>	<i>Elevation.</i>
Logansport Station	584.92
Wabash Railroad crossing	591.40
Wabash River bridge, rail	597.68
Wabash River, bottom	571.28
Minnow Run, Cass County	672.28
Minnow Run, Cass County, rail	687.78
Anoka Junction, Cass County	688.39
Wallbaum, Cass County	721.28
Shirk's Mill, Cass County	738.48
Big Rock Creek, Cass County	735.25
Big Rock Creek, Cass County, rail	745.28
Walton, Cass County	768.78
Lincoln, Cass County	777.98
Deer Creek, Cass County, north fork	742.28
Deer Creek, Cass County, rail	758.68
Deer Creek, Cass County, south fork	760.28
Deer Creek, Cass County, rail	786.78
Galveston, Cass County	789.68
Highest point north of Kokomo	824.85
L., P. & C. Ry. crossing	810.15

PENNSYLVANIA RAILWAY, RICHMOND DIVISION—Continued.

<i>Stations.</i>	<i>Elevation.</i>
T., C. & St. L. Ry. crossing	808.95
Windfall	854.59
Elwood	850.55
L., M. & B. Ry. crossing	851.51
Frankton	826.61
C., W. & M. Ry. crossing	867.70
Anderson	843.73
Middletown	946.09
Honey Creek Station	1,009.82
Ft. W., M. & C. Ry., west junction	1,065.17
I., B. & W. R. R. crossing	982.92
Ft. W., M. & C. Ry., east crossing	989.90
New Castle	1,016.94
Millville	1,180.38
Highest point on the road	1,149.46
Hagerstown	978.46
Richmond	953.81

PENNSYLVANIA RAILWAY, BRADFORD DIVISION.

<i>Station.</i>	<i>Elevation.</i>
Anoka Junction	688.39
Little Deer Creek, Cass County	709.00
Little Deer Creek, rail	739.48
Onward, Cass County	757.52
I., P. & C. Railway crossing	791.77
Bunker Hill	791.72
Marion	803.34
T., C. & St. L. Railway crossing	803.34
C., W. & M. Railway crossing	803.34
Jonesboro	837.65
Upland	931.49
Hartford City	900.59
Ft. W., M. & C. Ry. crossing	875.78
Dunkirk	938.99
Redkey	956.69
Ridgeville	983.69
Union City	1096.57
C., C., C. & I. Ry. crossing	1095.40

PENNSYLVANIA RAILWAY, CHICAGO DIVISION.

<i>Station.</i>	<i>Elevation.</i>
Peoria Junction, Logansport	582.38
Gephart, Cass County	746.88
Ford Crossing, Cass County	724.18
Royal Centre, Cass County	726.78
Little Indian Creek	708.28
Little Indian Creek, rail	715.58
Peonada	714.08

PENNSYLVANIA RAILWAY, CHICAGO DIVISION—Continued.

<i>Stations.</i>	<i>Elevation.</i>
Star City	708.88
Winamac	701.89
Gundrum	701.55
North Judson	692.91
I., I. & I. Ry. crossing	689.51
C. & E. Ry. crossing	688.43
English Lake	664.53
Pennymede	664.53
La Cross	668.73
Grassmen	677.03
Kouts	673.95
Le Roy	675.42
Crown Point	706.30
Chicago, Canal Street	582.87

PENNSYLVANIA RAILWAY, STATE LINE DIVISION.

<i>Station.</i>	<i>Elevation.</i>
Eel River bridge, bottom	568.28
Eel River bridge, rail	589.38
Peoria Junction	572.38
Fitches Switch, Cass County	577.11
Cottonwood Creek, Cass County	559.28
Cottonwood Creek, Cass County, rail	575.38
Paw Paw Creek, Cass County, rail	616.28
Paw Paw Creek, Cass County	575.38
Curveton	659.18
Crooked Creek, Cass County	598.28
Crooked Creek, Cass County, rail	644.38
Lake Chicott, Cass County	695.18
Burnettsville	701.51
Idaville	703.93
Monticello	666.89
Air Line branch of the Monon	667.10
L., N. A. & C. R. R. crossing	684.56
Reynolds	684.36
Seafeld	690.28
Walcott	705.74
Remington	726.20
Goodland	705.96
Kentland	662.62
State line	669.14

MISCELLANEOUS.

<i>Station.</i>	<i>Elevation.</i>
Lafontaine, Wabash County, C., W. & M. Ry	790.00
Treaty, Wabash County, C., W. & M. Ry	791.00
Urbana, Wabash County, C., W. & M. Ry	780.00
Rose Hill, Wabash County, C., W. & M. Ry	845.00

REPORT OF INSPECTOR OF MINES.

OFFICE OF INSPECTOR OF MINES, }
BRAZIL, IND., July, 1894. }

Hon. S. S. Gorby, State Geologist, Indianapolis, Ind.:

SIR—As required by statute, I herewith present my annual report for the year 1893, and the annual report of the Inspector of Mines for the same year.

THOMAS McQUADE,
Inspector of Mines, Indiana.

REPORT OF INSPECTOR OF MINES.

In beginning this report, I desire to say that I very much regret the delay in filing the same, but circumstances over which I had no control prevented my doing so earlier.

The total number of tons of coal of all kinds produced in Indiana was 4,358,897. The average number of men employed was 7,431. Total number of mines, 183. Total number coal-producing counties, 19. Total number scales tested, 8. Total number of fatal accidents, 22. Total number non-fatal accidents, 35. Average number of mules employed, 535.

LIST OF FATAL ACCIDENTS.

The following is a list of fatal accidents reported to me :

- February 16, 1893. F. P. Lewis, killed by fall of coal in Star mine, owned by Coal Bluff Co., in Vigo County.
- March 4, 1893. Barney Myers, killed by explosion of keg of powder in Hercules mine, owned by Coal Bluff Co., in Vigo County.
- March 13, 1893. John Johnson was killed by being run over by flat car at New Kentucky mine, No. 1, owned by New Kentucky Coal Co., in Parke County.
- March 16, 1893. Philip Boyer, killed by fall of slate in No. 2 mine, owned by Brazil Block Coal Co., in Clay County.
- April 5, 1893. Bernard Grillice, killed by fall of coal in No. 10 mine, owned by Brazil Block Coal Co., in Clay County.
- April 12, 1893. Isaac Anderson, killed by falling shed over flat car at Hazel Creek Coal Co.'s No. 1 mine, in Vermillion County.
- May 25, 1893. John Walkinshaw, killed by fall of slate in America Beauty mine, owned by Zeller & Sigler, in Clay County.
- July 5, 1893. Joe Craven, killed by bank cars running down incline and catching him in mouth of slope at No. 9 mine, owned by Parke County Coal Co., in Parke County.
- July 14, 1893. Alexander Waugh, killed by fall of slate in No. 3, owned by B. B. Coal Co., in Clay County.

- Aug. 11, 1893. S. J. Barker, killed by fall of slate in New Nickel Plate mine, owned by Jackson Coal Co., in Clay County.
- Aug. 18, 1893. Wm. McMahan, killed by fall of slate in Brier Hill mine, owned by John H. Zeller Coal Co., in Clay County.
- Aug. 20, 1893. Andrew Sipp, killed by coal flying from shot that he was trying to fire, said shot going off unexpectedly, in Anderson's No. 2 mine, in Vermillion County.
- Sept. 6, 1893. John W. Martin, killed by fall of slate in Mecca mine No. 1, owned by Mecca Mining Co., in Parke County.
- Sept. 2, 1893. Alexander Gillmore, killed while returning to a shot by its exploding unexpectedly, the coal from same striking him, while at work in Mecca mine No. 1, owned by Mecca Mining Co., in Parke County.
- Dec. 13, 1893. Fritz Telton, killed by fall of slate in Hercules mine, owned by Coal Bluff Co., in Vigo County.
- Dec. 15, 1893. Peter Zenie, killed by fall of slate in Anchor mine, owned by Coal Bluff Co., in Clay County.

LIST OF NON-FATAL ACCIDENTS.

- January 10, 1893. John Fleming, injured in abdomen and lower part of ribs by fall of slate in No. 8 mine, owned by Brazil Block Coal Co., in Clay County.
- January 16, 1893. John Patree, burned about face and hands by explosion of shot while drilling out tamping in side of hole that had failed to explode with a squib, in Hoosier Coal Co.'s mine, in Clay County.
- January 18, 1893. James Alsip, collar bone broken while coupling cars in No. 9 mine, owned by Brazil Block Coal Co., in Clay County.
- February 10, 1893. J. Russell, head and back injured by fall of slate in Gartside mine, owned by Watson, Little & Co., in Clay County.
- March 22, 1893. A. Graves, leg broken while riding between cars in No. 2 mine, owned by Crawford Coal Co., in Clay County.
- April 18, 1893. Edward Oliver, leg broken by being squeezed between bank cars at No. 7 mine, owned by Parke Coal Co., in Parke County.
- April 25, 1893. Frank Mertinger, leg broken by falling between bank cars and being run over in No. 6 mine, owned by Parke County Coal Co., in Parke County.
- May 23, 1893. J. R. Moore, foot mashed by fall of slate in No. 2 mine, owned by Crawford Coal Co., in Clay County.
- May 31, 1893. James Alley, arm dislocated and injured internally by cage being let down upon him at Brier Hill mine, owned by Morrier Coal Co., in Clay County.

- July 5, 1893. Otto Grogan, Wm. Blanketer and Rolley Grogan, all injured by empty cars coming down incline, with chain attached, and catching them in mouth of slope, at No. 9 mine, owned by Parke County Coal Co., in Parke County.
- July 8, 1893. Walter Slaters, leg broken by being squeezed between cars of coal and mule in No. 9 mine, owed by Parke County Coal Co., in Parke County.
- July 8, 1893. Ed. Godden, seriously injured about head by chunk of coal at No. 3 mine, owned by B. B. Coal Co., in Parke County.
- August 4, 1893. Elija Bridwaters, injured in back and legs by fall of slate in Eureka mine No. 1, owned by Eureka Block Coal Co., in Clay County.
- September 5, 1893. M. Kalafa, two ribs broken by fall of slate in No. 1 mine, owned by C. Ehrlich & Co., in Clay County.
- September 10, 1893. Wm. Russell, head injured by rock falling down Brazil shaft while shaft was being sunk, owned by Jackson Coal Co., in Clay County.
- November 15, 1893. Silas Leonhart, fell down shaft, breaking his shoulder and receiving internal injuries, in New Nickel Plate mine, owned by Jackson Coal Co., in Clay County.
- December 7, 1893. P. Quinne, head and back injured by fall of slate in Gartside mine, owned by Watson, Little & Co., in Clay County.

Below is given a list of scales tested, date of test, and brief statement as to condition of scales at time of test. It is a noticeable fact that but one scale tested last year was found incorrect, and that one was really not in use. The test was made for the purpose of determining whether or not the condition of the scale was such as to permit its use. While this is a creditable condition for our scales to be found in, yet the complaints so common among miners about weights still continue, but not to the extent of former years. In my judgment the law requiring test weights to be kept at the mines ready for use at any time has done much to give to the miner the opportunity of ascertaining at any time the exact condition of the scales at the mine where he works.

SCALES TESTED.

- February '27, 1893. New Nickel Plate mine, owned by Jackson Coal Co., in Clay County; scales tested and found correct.
- May 22, 1893. Grant mine, owned by Grant Coal Coal, located in Vigo County; scales tested and found incorrect.
- May 25, 1893. No. 9 mine, owned by B. Block Coal Co., in Clay County; scales tested and found incorrect.
- May 25, 1893. Gartside mine, owned by Watson, Little & Co., in Clay County; scales tested and found correct.

- July 24, 1893. Seelyville mine, owned by P. Ehrlich & Co., in Vigo County; scales tested and found correct.
- November 4, 1893. Eureka mine No. 2, owned by Eureka Coal Co., in Clay County; scales tested and found correct.
- November 4, 1893. No. 1 mine, owned by Crawford Coal Co., in Parke County; scales tested and found correct.
- November 21, 1893. No. 6 mine, owned by Parke County Coal Co., in Parke County; scales tested and found correct.

MINES INSPECTED.

CLAY COUNTY.

No. 1 Mine.

Owned by B. B. Coal Co. Located one and one-half miles north of Knightsville. This mine was worked out and abandoned during the year.

No. 2 Mine.

Owned by B. B. Coal Co. Located one mile northwest of Harmony. This mine was worked out and abandoned July 1, 1893.

No. 3 Mine.

Owned by Brazil Block Coal Co. Located two miles northwest of Harmony. This mine was visited several times. On June 1, at my request, the west side of top vein was abandoned, the roof being so bad it was considered too dangerous to work. On my last visit only a few men were working in top vein on east side of shaft. In bottom vein the ventilation was fairly good, but the coal was all low and it is not likely that this shaft will last long.

No. 4 Mine.

Owned by B. B. Coal Company. Located two miles north of Knightsville. This shaft was visited three times. On March 25th it was found that the air was not split so as to afford sufficient air to properly ventilate the mine. After notifying the Superintendent of the changes necessary, I gave him a limited time to do the work. On returning at the expiration of the allotted time, I found the mine in good condition.

No. 6 Mine.

Owned by the Brazil Block Coal Company. Located three miles north of Brazil. It was visited twice. On account of the probable falling in

of the entry in bottom vein leading to the drop shaft in the top vein, I asked the company to sink another escape shaft, which they did. This shaft is pretty well worked out, and will be abandoned about July 1.

No. 7 Mine.

Owned by B. B. Coal Company. Located two miles north of Brazil. Was worked out and abandoned February 18, 1893.

No. 8 Mine.

Owned by B. B. Coal Company. Located one mile north of Perth. This mine was visited twice. On my first visit I asked the company to sink an additional air-shaft on northwestern part of territory. On returning I found the company had put down a slope north of shaft, which is intended more for a place of ingress and egress for the men than for ventilation, as the company had put in a trail-rope to haul the coal. The general condition of this mine, however, was fair, although there is a large territory excavated, and in several places the water on the road is nearly a foot deep.

No. 9 Mine.

Owned by B. B. Coal Company. Located four miles southeast of Knightsville. This mine was visited twice. On my last visit I found they had opened the top vein that had been abandoned for years and were working thirty-six men in it. The coal being worked is but a small strip, and will not last longer than six months. I asked for a stairway to be put in air-shaft from the bottom to the top vein, and air-shaft enlarged. The bank boss promised to make the changes desired at once.

No. 10 Mine.

Owned by Brazil Block Coal Company. Located one mile east of No. 8 mine. This mine was visited twice, but was only inspected once, as it was not in operation at the time of my last visit. The general condition of mine, when inspected, was good.

Crawford No. 2 Mine.

This mine is owned by the Crawford Coal Company, and is located one mile northwest of Harmony. On my last visit to this mine I found two men working in what I considered a very dangerous place on main west entry. I requested the boss to give them another place, which was done.

The men were all working on pillars. The mine is worked out and abandoned now.

No. 3 Mine.

Owned by the Crawford Coal Company. Located three miles south of Harmony, is worked out and abandoned.

No. 4 Mine.

Owned by the Crawford Coal Company. Located two miles north of Brazil. This mine was visited twice. The general condition of the mine was good.

No. 5 Mine.

Owned by the Crawford Coal Company. Located four miles south of Brazil. This was visited twice. On my first visit I asked for certain changes which were not made, and I found it necessary to file affidavits to compel them to comply with the law. On my second visit I found the mine in very good condition. I asked for an additional split in the air shaft and it was cheerfully made.

No. 6 Mine.

Owned by the Crawford Coal Company. Located four miles south of Brazil. This mine is worked out and abandoned.

Columbia Mine.

Owned by Zeller & Sigler. Located one mile southwest of Knightsville. This mine was visited twice. Since my last report two tunnels have been driven from the bottom to the top vein. Both are on the east side of the shaft. On my last visit I ordered the main entry in the tunnel to be thoroughly timbered as the roof was very bad. Also one room in bottom vein sloped, on account of bad roof. In other respects the general condition of the mine is fair.

America Beauty.

Owned by Zeller & Sigler. Located one mile east of Asheville. This mine was visited twice, and on both visits was found in good condition.

Brier Hill Mine.

Owned by J. A. Zeller Coal Company. Located just south of Asheville. This is a new shaft. It is ninety feet deep. Coal J (or bottom

vein) is being worked. The coal is about three feet six inches thick. The mine is ventilated by fan. During the summer an escape shaft was put down. The general condition of the mine is good.

Big Four Mine.

Owned by the Clay County Coal Company. Located one-half mile north of Lodi. This is a new shaft. It is 132 feet deep. Coal I is being worked. The coal is about four feet six inches thick. It is ventilated by fan, and was in good condition when last visited.

New Nickel Plate Mine.

Owned by the Jackson Coal and Mining Company. Located one mile south of Benwood. At the time of my last visit to this mine they had just sunk a shaft to the bottom vein. The general condition of the mine was good, except a needed split in the air in the west side of the top vein. This change the bank boss promised to make at once.

Brazil Shaft.

Owned by the Jackson Coal and Mining Company. Located two miles northeast of Brazil. This is a new shaft. It is eighty-five feet deep. Three veins of coal are being operated, and the coal averages about four feet. The mine is ventilated by fans. At the time of my last visit to this mine they had not completed the work of covering cages, neither had they light at the bottom of shaft in the different veins. They also needed gates on top landing and an indicator on the engine. Also a bulletin board for timbers. The boss promised to make the improvements needed without delay, but the mine was stopped a short time afterwards. I am, therefore, unable to tell what changes were completed.

Newburg Mine No. 2.

Owned by the Gartsherie Coal Company, located one mile west of Turner, was visited twice. At the time of my last visit I stopped three men that were working on the second south entry, and asked the company to drive an air course and bring the air up to where the men were then working. This they very readily agreed to do.

Somers Mine.

Owned by J. Somers. Located one mile north of Staunton, was visited twice. Since my last report a slope was put down and is now in use for an escape. The general condition of the mine is good.

Ehrlich Mine.

Owned by Chris. Ehrlich (successor to P. Ehrlich & Co.), was visited twice, and although the mine was badly cut up, the general condition so far as health and safety was concerned was good.

Nellie Mine.

Owned by the Otter Creek Coal Company. Located one mile south of Brazil, was visited twice, and though many improvements were made between my first and second visits, still there was not enough air on the west side of the mine. I asked that another current of air be sent to the west side of the mine. This the bank boss agreed to do at once.

Fair View Mine.

Owned by the Otter Creek Coal Company. Located four miles northwest of Brazil. This is a new shaft. Two veins of coal are being operated. They are the top and bottom veins, or coal I and J. Coal I averages over four feet, while coal J averages about three feet six inches. This shaft is 100 feet deep. It is ventilated by fan. At my request an escape shaft was put down, and at the time of my last visit it was in good condition.

Gartside Mine.

Owned by Watson, Little & Co. Located one mile north of Knightsville. This mine was visited twice and found in good condition.

Eureka Mine No. 1.

Owned by the Eureka Block Coal Company. Located one-half mile east of Carbon. This mine was visited twice, and many changes required to be made in directing the air currents. At the time of my last visit the mine was not in operation, but seemed to be in good condition.

Eureka Mine No. 2.

Owned by the Eureka Block Coal Company. Located just north of Mine No. 1. It is a new shaft. It is 110 feet deep. Coal seams I and J are being worked. The mine is ventilated by fans. The average height of the coal is near four feet. They expect to connect with Mine No. 1 in a short time, and thus make an escape shaft.

World's Fair Mine.

Owned by the D. H. Davis Coal Company. Located one mile north of Brazil. This mine was visited twice and found in good condition both times.

Excelsior Mine No. 1.

Owned by Christ. Ehrlich, successor to the Hoosier Coal Company. This shaft had a big cave-in from the surface. At the time of my last visit the mine was pretty well cleaned up, and was at that time in good condition. An escape shaft was sunk for the benefit of those who work in the top vein.

Excelsior Mine No. 2.

Owned by Christ. Ehrlich. This is a small drift, ventilated by small furnace. It was opened the latter part of last year. There is but a small territory to excavate here, of what is called a rider vein, and it will be worked out and abandoned in 1894.

Pratt Mine.

Owned by the Coal Bluff Company. Located one mile west of Perth; was visited twice and found in good condition.

Anchor Mine.

Owned by the Coal Bluff Company. Located one mile southeast of Perth; was visited twice, but inspected only once, as the boilers were being cleaned at the time of one of my visits, and I did not go down into the mine. I found the mine in good condition.

Louise Mine.

Owned by Weaver, Getz & Co. This mine was visited several times, and a request made to have the water running down the escape shaft prevented from falling on persons ascending or descending the shaft. The company failed to do this work in a reasonable time, and were therefore prosecuted. Finally the work was done. The mine in other respects was in fair condition when last visited.

Harrison Mine No. 1.

Owned by the Indiana & Chicago Block Coal Company. Located four miles northeast of Clay City; was worked out and abandoned about August 1.

Harrison Mine No. 2.

Owned by the Chicago & Indiana Block Coal Company. Located just west of Mine No. 1. During the year a splendid air and escape shaft has been put down, and at the time of my last visit the mine was in good condition.

Diamond Mine.

Owned by the Diamond Coal Company. Located just a short distance northwest of Clay City. This shaft is worked out and abandoned.

Brier Hill Mine.

Owned by the Morrier Coal Company. Located one mile northwest of Clay City. This mine was visited several times and several changes required.

PARKE COUNTY.

Cox Mine No. 3.

Owned by the Brazil Block Coal Company. Located at Coxville. This mine was visited several times. On November 20th I ordered an additional split of air for the south side of the mine and several breakthroughs filled up. In other respects the mine was in good condition.

Otter Creek Mine.

Owned by the Brazil Block Coal Company. Located two miles northeast of Carbon. This mine was visited twice, and found in splendid condition.

No. 6 Mine.

Owned by the Parke County Coal Company. Located one mile northwest of Rosedale. This mine was visited twice. Its general condition is good. On the west side of the mine the company has put in a tail rope system. It is working satisfactorily, and there is some talk among other operators in this county of putting in a similar system of hauling coal and doing away with mules.

No. 7 Mine.

Owned by the Parke County Coal Company. Located one mile southeast of Minschell. This mine was visited twice, but owing to the fact that it was not in operation on either visit, I did not inspect it.

No. 8 Mine.

Owned by the Parke County Coal Company. Located one mile and a quarter southwest of Coxville. This mine was visited twice. On one occasion I found boys under 14 years of age employed in the mine. They were told to remain at home after that date until they are 14 years old. The general condition of the mine was good.

No. 9 Mine.

Owned by the Parke County Coal Company. Located one-half mile south of Coxville. This mine was visited three times. On November 22d I found that an additional split of air was necessary for the south side of the mine. I asked the bank boss to do the work within ten days; also, to clean the dirt out of the man-way. At the expiration of the ten days I returned and found things in good condition. On May 1, 1893, this company put in a tail-rope haulage system, and it is working very satisfactorily.

New Kentucky Mine No. 1.

Owned by New Kentucky Coal Company. Located at Clinton Locks. This mine was visited twice. I found several boys here, who were ordered out of the mine. The company were erecting a small fan at the bottom of down shaft. I suggested that work on this fan be stopped and a larger fan be erected on the escape shaft. This the superintendent refused to do, holding that the small fan in course of erection would supply sufficient air for present need. I do not deny the truthfulness of his position, but hold that within a short time additional facilities for ventilation at this mine will have to be made if the company expect to materially increase the number of persons employed.

New Kentucky Mine No. 2.

Owned by the New Kentucky Coal Company. Located one-half mile southwest of mine No. 1. This is a new shaft 149 feet deep. The coal is bituminous coal six feet thick. The mine is ventilated by fan. At my request they began sinking an escape shaft, which I presume is completed ere this. The condition of mine was good.

Mecca Mine No. 1.

Owned by Mecca Mining Company. Located one-half mile east of Mecca. This mine was visited several times during the year. On my

last visit I requested an over cast to be made so as to split the air current at the sixth south entry. When this work is done I think the general condition of the mine will be good. Some boys were employed in this mine that were under fourteen years of age whom I ordered out of the mine.

No. 2 Mine.

Owned by the Mecca Mining Company. Located one mile south of mine No. 1. This mine was sunk several years ago and abandoned on the presumption that there was no coal there. In August, of this year, however, the mine was cleaned up and some entries started which in a short time struck good coal. This shaft is 153 feet deep. The mine is ventilated by fan. The coal is about four feet thick and of good bituminous quality, and seems at this time to have a good future before it. At the time of my visit they needed safety catches on the cages and an indicator on the engine. Also an escape shaft. The bank boss promised that these improvements would be made at the earliest possible moment.

Crawford Mine No. 1.

Owned by the Crawford Coal Company. Located two miles northeast of Carbon. It is a shaft which is thirty feet deep to the bottom vein. This coal averages about four feet in thickness. This mine is ventilated by a fan, which produces 34,340 cubic feet of air per minute, 22,020 feet going on the north side of mine, where forty men and two mules are at work, and 12,320 feet on the south side, where forty men and two mules work. This mine was put down September 1. There is a man-way here which is in good shape. The only thing I object to is a lack of doors and brattice, which the boss agreed to fix at once. The mine is well laid off, and when the above work is done it will be in good condition. They also have two entries driven into the top vein, where eight men are now at work. This drift is ventilated by a separate fan from the one that ventilates the bottom vein. There are no rooms nor cross entries turned off of those entries, as the roof does not justify it at this time. It is looking better now, however, and it will be but a short time before enough men will be employed to bring this drift under the mining laws.

Superior Mine.

Owned by the Superior Coal Company. Located one and one-half miles east of Cassville. This is a new shaft, 106 feet deep. It is ventilated by a fan. The coal averages four feet thick. The mine was visited twice. At the time of my last visit stairs were needed in the escape

shaft, also several places need additional break-throughs and some breaks already made needed filling up. They also need one split in the air current on each side of the mine. After talking to Superintendent Zeller I received assurances that this work would be done at once.

McIntosh Mine.

Owned by J. McIntosh & Co. Located one and one-half miles east of Cassville. This is a new shaft 100 feet deep. It is ventilated by a fan. It was visited twice. On my last visit I left orders to have the break-throughs closed and made air tight, also to put a new cover on the north cage. At my request the company are putting down an escape shaft, which will be finished in a short time.

VERMILLION COUNTY.

Norton Creek Mine No. 2.

Owned by the Norton Creek Coal Company. This mine has been operated for several years and will be abandoned in a short time. The company has put down a shaft at the head of the works in this mine and expects to take all coal that now goes out of this slope and out of new shaft. This mine was visited twice, but owing to the fact that the company had gone into the hands of a receiver and was idle, I did not inspect it at the time of my last visit.

Norton Creek Mine No. 3.

Owned by Norton Creek Coal Company. Located one mile west of Clinton. This mine was visited twice. A third split in the air needed. I ordered an overcast made at the sixth south entry, also a cover on the north cage, and safety catches adjusted. Also gates on top of the shaft on the north side. The bank boss promised to have this work done at once.

Anderson Mine No. 1.

Owned by the Hazel Creek Coal Company. Located one mile northwest of Clinton. On account of the mine not being in operation all the year, it was only visited once, at which time I asked the company to close the mouth of all abandoned entries and make them air tight, so as to shut off noxious gases generated therein. Also to take down the loose draw slate between the fourth and fifth south entries. When this work is done I believe the general condition of this mine will be very good.

Anderson Mine No. 2.

Owned by the Hazel Creek Coal Company. Located one mile west of Clinton. This mine was found to lack a split in the air current, and on account of the company having failed to provide the same after they had been notified to do so, I filed an affidavit against the bank boss. The company plead guilty and he was fined. In all other respects the condition of the mine was good.

Thompson Hill Mine.

Owned by the Thompson Hill Company. Located one mile northwest of Clinton. This mine was visited twice. On my first visit objections were made to the amount of air in circulation; also, to lack of split in the air volume. Orders were given to change this, and on returning a second time I found this work almost completed. When the work there under way is finished, I think the condition of the mine will be good.

VIGO COUNTY.

Hercules Mine.

Owned by the Coal Bluff Coal Company. Located just west of Fontanet. This mine was visited twice and found in fair condition. The mine is pretty well worked out. Nearly all of the men now at work are drawing pillars.

Star Mine.

Owned by the Coal Bluff Coal Company. Located one-half mile south of Fontanet. This mine was visited three times and found in fair condition.

Victor Mine.

Owned by the Coal Bluff Coal Company. Located one mile southwest of Coal Bluff. This mine was visited twice. On my first visit an escape shaft was the only thing lacking to make the condition of the mine good. The second visit was made by the Assistant Inspector. In his report to me he does not mention the escape shaft. I therefore presume my request was complied with, and the mine is up to the requirements of the law.

Diamond Mine.

Owned by the Coal Bluff Coal Company. Located one mile south of Coal Bluff. I visited this mine twice during the year, but as it was idle at the time of such visits, I did not inspect it. Later it was visited by the Assistant Inspector and he reports the condition to be good.

Peerless Mine.

Owned by the Coal Bluff Coal Company. Located one mile north of Coal Bluff. This mine was visited twice. At the time of my first visit a very extensive squeeze was affecting the south side of the mine, and there was therefore only room for a few men on the north side of the mine, which was in good condition. On my second visit over eighty men were at work and a division in the air current was badly needed, which the company were then working upon. When this is done the condition of the mine will be good.

Seelyville Mine.

Owned by Julius Ehrlich, successor to P. Ehrlich & Co. Located one-half mile south of Seelyville. This mine was visited twice and found in good condition.

Grant Mine.

Owned by the Grant Coal and Mining Company. Located just east of the town of Grant. This mine has undergone several changes during the year, the company having erected a new pump building, new engine house, new engine and air compressor, with which the Ingersoll Mining Machines are operated. I had some trouble with this company during the year, caused by a failure on their part to weigh coal before it was screened. I filed an affidavit against them. When the case came for trial the company plead guilty and were fined. At the time of my last visit the general condition of the mine was good.

OWEN COUNTY.

Lancaster Mine No. 3.

Owned by the Lancaster Block Coal Company. Located four miles northeast of Clay City. This mine will be worked out and abandoned about March 1, 1894.

Lancashire Mine.

Owned by the Erman Coal Company, successor to J. Hyette. Located just west of Coal City. This mine was visited twice and found in good condition. It is not operated very extensively. The coal is low and the mine is not likely to last long.

Before giving tabulated statement I deem it proper to say that I. McIntosh & Co.'s new mine is not given or considered in any of the tables given. Neither is the Parke County Coal Company's new mine No. 10, in Parke County.

MONTHLY REPORT OF MINES IN CLAY COUNTY, IND., FOR JANUARY, 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Month.	Number Cubic Feet of Air Circulating in Mine per Minute.
	Gartsherre—					
Brazil Block Coal Co., Brazil	No. 1	60	4	6	22	7,192
Brazil Block Coal Co., Brazil	No. 2	44	5	4	24	10,000
Brazil Block Coal Co., Brazil	No. 3	58	4	5	22	10,000
Brazil Block Coal Co., Brazil	No. 4	160	10	7	22	22,000
Brazil Block Coal Co., Brazil	No. 6	48	4	4	24	85,000
Brazil Block Coal Co., Brazil	No. 7	48	5	5	26	10,000
Brazil Block Coal Co., Brazil	No. 8	199	13	18	24	38,760
Brazil Block Coal Co., Brazil	No. 9	125	8	10	22	20,000
Brazil Block Coal Co., Brazil	No. 10	10	8	9	25	16,030
Crawford Coal Co., Brazil	No. 2	102	5	7	26	23,400
Crawford Coal Co., Brazil	No. 3	58	6	3	24	15,400
Crawford Coal Co., Brazil	No. 4	32	4	3	24	7,100
Crawford Coal Co., Brazil	No. 5	64	6	3	26	10,750
Crawford Coal Co., Brazil	No. 6	45	7	2	25	8,500
Zeller & Siegler, Knightsville	Columbia	125	7	6	23	23,500
Zeller & Siegler, Knightsville	Am Beauty	105	5	4	22	23,500
Otter Creek Coal Co., Brazil	Nellie	105	6	6	23	15,500
Otter Creek Coal Co., Brazil	Fairview	55	4	1	18	15,000
McIntosh Coal Co., Brazil	Newburg No. 2	70	12	5	20	22,750
D. H. Davis Coal Co., Knightsville	World's Fair	200	8	5	23	35,000
Watson, Little & Co., Brazil	Gartside	137	21	13	25 ⁺	31,700
Jackson Coal Co., Brazil	N. Nickel Plate	104	6	4	26	20,600
Nickel-Plate Coal Co., Brazil	Chicago	40	6	3	24	15,000
Weaver, Getz & Co., Center Point	Church Hill	13	2	1	16 ⁺	9,000
Eureka Block Coal Co., Carbon	No. 1	152	1	9	23	31,500
Hoester Coal Co., Brazil	Hoosier	66	6	3	24	14,200
Weaver, Getz & Co., Center Point	Louise	109	6	5	22	13,500
P. Ehrlich & Co., Newburg	Newburg	68	8	4	20	23,200
Joseph Somers, Staunton	San Pedro	15	60	2	22	8,000
Briar Hill Block Coal Co., Clay City	Briar Hill	52	6	4	24	8,000
Diamond Block Coal Co., Clay City	Diamond	79	12	7	26	13,500
Chicago & Ind. Bl'k Coal Co., T. Haute	No. 1	50	6	10	24	23,000
Chicago & Ind. Bl'k Coal Co., T. Haute	No. 2	30	4	2	24	22,500
Coal Bluff Co., Terre Haute	Pratt	84	7	9	24	23,900
Coal Bluff Co., Terre Haute	Anchor	63	5	5	22	10,220

MONTHLY REPORT OF MINES IN CLAY COUNTY, IND., FOR FEBRUARY, 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Month.	Number Cubic Feet of Air Circulating in Mine per Minute.
	Gartsherre—					
Brazil Block Coal Co., Brazil	No. 1	42	5	5	18	6,192
Brazil Block Coal Co., Brazil	No. 2	42	4	3	22	10,000
Brazil Block Coal Co., Brazil	No. 3	82	4	5	20	10,000
Brazil Block Coal Co., Brazil	No. 4	162	11	7	20	22,000
Brazil Block Coal Co., Brazil	No. 6	53	4	4	22	8,500
Brazil Block Coal Co., Brazil	No. 7	22	4	2	10	10,000
Brazil Block Coal Co., Brazil	No. 8	160	13	18	22	38,000
Brazil Block Coal Co., Brazil	No. 9	130	8	10	22	22,000
Brazil Block Coal Co., Brazil	No. 10	80	8	9	20	16,030
Crawford Coal Co., Brazil	No. 2	88	5	7	22	19,200
Crawford Coal Co., Brazil	No. 3	50	6	3	21	16,000
Crawford Coal Co., Brazil	No. 4	28	5	3	20	7,150
Crawford Coal Co., Brazil	No. 5	74	6	3	23	10,200
Crawford Coal Co., Brazil	No. 6	50	6	3	24	10,765
Zeller & Sigler, Knightsville	Columbia	120	7	6	22	23,000
Zeller & Sigler, Knightsville	Am. Beauty	105	5	4	21	22,500
Otter Creek Coal Co., Brazil	Nellie	103	6	6	22	15,800
Otter Creek Coal Co., Brazil	Fairview	56	5	1	23	15,800
McIntosh Coal Co., Brazil	No. 2	70	12	5	22	22,750
D. H. Davis Co., Knightsville	World's Fair	170	8	5	22	30,000
Watson, Little & Co., Brazil	Gartside	146	22	15	19 $\frac{1}{2}$	27,700
Jackson Coal Co., Brazil	N. Nickel Plate	110	6	4	24	20,000
Nickel Plate Coal Co., Brazil	Chicago	32	5	3	24	15,000
Weaver, Getz & Co., Center Point	*Church Hill	13	2	1	12	9,000
Eureka Block Coal Co., Carbon	No. 1	147	16	9	22	27,000
Hoosier Coal Co., Brazil	Hoosier	60	6	3	22	15,600
Weaver, Getz & Co., Center Point	Louise	125	6	5	20	15,000
P. Ehrlich & Co., Newburg	Newburg	63	8	4	13	23,200
J. Somers, Staunton	S. P.	60	5	2	23	7,300
Briar Hill Block Coal Co., Clay City	Briar Hill	49	6	4	23	8,000
Diamond Block Coal Co., Clay City	Diamond	83	12	6	24	13,500
Chicago & Ind. B'k Coal Co., T. Haute	No. 1	42	6	10	23	22,000
Chicago & Ind. B'k Coal Co., T. Haute	No. 2	43	4	2	23	21,500
Coal Bluff Co., Terre Haute	Pratt	85	7	9	22	26,300
Coal Bluff Co., Terre Haute	Anchor	59	5	5	19	10,300

* Abandoned.

MONTHLY REPORT OF MINES IN CLAY COUNTY, IND., FOR MARCH, 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Month.	Number Cubic Feet of Air Circulating in Mine per Minute.
	Gartsherre—					
Brazil Block Coal Co., Brazil	No. 1	48	5	5	22	10,000
Brazil Block Coal Co., Brazil	No. 2	42	5	4	20	10,000
Brazil Block Coal Co., Brazil	No. 3	55	5	5	22	10,000
Brazil Block Coal Co., Brazil	No. 4	165	10	7	18	22,000
Brazil Block Coal Co., Brazil	No. 6	50	5	4	27	10,000
Brazil Block Coal Co., Brazil	No. 8	155	13	18	24	38,000
Brazil Block Coal Co., Brazil	No. 9	132	9	11	18	25,000
Brazil Block Coal Co., Brazil	No. 10	90	8	11	24	16,000
Crawford Coal Co., Brazil	No. 2	67	5	6	26	16,510
Crawford Coal Co., Brazil	No. 3	46	5	3	25	12,000
Crawford Coal Co., Brazil	No. 4	38	5	3	19	10,000
Crawford Coal Co., Brazil	No. 5	101	6	4	22	17,362
Crawford Coal Co., Brazil	No. 6	54	5	3	27	9,100
Zeller & Sigler, Knightsville	Columbia	130	7	6	17	22,500
Zeller & Sigler, Knightsville	Am. Beauty	110	5	3	13	23,500
Otter Creek Coal Co., Brazil	Nellie	101	6	6	18	15,800
Otter Creek Coal Co., Brazil	Fairview	79	5	1	22	15,800
McIntosh Coal Co., Brazil	No. 2	70	12	5	19	22,750
D. H. Davis Coal Co., Knightsville	World's Fair	125	7	5	16	30,000
Watson, Little & Co., Brazil	Gartside	168	19	15	24 ¹ / ₂	24,570
Jackson Coal Co., Brazil	New Nickel Plate	107	6	4	14	20,000
Nickel Plate Coal Co., Brazil	Chicago*	30	3	2	17	15,000
Eureka Block Coal Co., Carbon	No. 1	141	11	9	26	29,000
Hoosier Coal Co., Brazil	Hoosier	70	5	3	18	15,600
Weaver, Getz & Co., Center Point	Louise	151	6	5	19	18,000
P. Ehrlich & Co., Newburg	Newburg	59	8	4	12	23,200
J. Semers, Staunton	S. P	73	11	2	18	10,000
Briar Hill Block Coal Co., Clay City	Briar Hill	50	6	5	25	8,000
Diamond Block Coal Co., Clay City	Diamond	74	10	5	24	13,500
Chicago & Ind. Bl'k Coal Co., T. Haute	No. 1	35	6	9	22	23,500
Chicago & Ind. Bl'k Coal Co., T. Haute	No. 2	50	6	3	27	21,500
Coal Bluff Co., Terre Haute	Pratt	80	6	9	19 ¹ / ₂	25,000
Coal Bluff Co., Terre Haute	Anchor	65	5	5	22	9,900

* Abandoned.

MONTHLY REPORT OF MINES IN CLAY COUNTY, IND., FOR APRIL, 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Month.	Number Cubic Feet of Air Circulating in Mine per Minute.
	Gartsherre—					
Brazil Block Coal Co., Brazil	No. 1	45	6	4	20	10,000
Brazil Block Coal Co., Brazil	No. 2*	42	7	3	7	10,000
Brazil Block Coal Co., Brazil	No. 3	50	5	4	22	20,000
Brazil Block Coal Co., Brazil	No. 4	100	6	5	16	22,000
Brazil Block Coal Co., Brazil	No. 6	42	5	3	22	7,000
Brazil Block Coal Co., Brazil	No. 8	174	12	14	15	37,185
Brazil Block Coal Co., Brazil	No. 9	110	7	8	13	24,000
Brazil Block Coal Co., Brazil	No. 10	100	8	11	20	16,380
Crawford Coal Co., Brazil	No. 2	95	5	4	24	24,000
Crawford Coal Co., Brazil	No. 3	50	5	3	25	15,300
Crawford Coal Co., Brazil	No. 4	42	5	3	24	10,000
Crawford Coal Co., Brazil	No. 5	115	6	4	24	17,000
Crawford Coal Co., Brazil	No. 6	45	6	3	23	10,500
Zeller & Sigler, Knightsville	Columbia	125	7	6	17	23,000
Zeller & Sigler, Knightsville	Am Beauty	110	6	4	13	22,000
Otter Creek Coal Co., Brazil	Nellie	100	5	6	15	16,300
Otter Creek Coal Co., Brazil	Fairview	91	5	2	19	19,880
McIntosh Coal Co., Brazil	No. 2	10	12	5	19	22,750
D. H. Davis Coal Co., Knightsville	World's Fair	75	7	4	14	30,000
Watson, Little & Co., Brazil	Gartside	158	10	14	24	28,570
Jackson Coal Co., Brazil	N. Nickel Plate	153	7	5	18	15,000
Eureka Coal Co., Carbon	No. 1	152	10	9	10	19,600
Weaver, Getz & Co., Center Point	Louise	153	7	5	24	18,000
P. Ehrlich & Co., Newburg	Newburg	54	8	4	14	23,100
J. Somers, Staunton	San Pedro	52	12	2	15	6,000
Briar Hill Block Coal Co., Clay City	Briar Hill	48	8	5	20	7,800
Diamond Block Coal Co., Clay City	Diamond	55	13	6	22	13,500
Chicago & Ind. Bl'k Coal Co., T. Haute	No. 1	35	5	3	20	22,500
Chicago & Ind. Bl'k Coal Co., T. Haute	No. 2	60	5	5	13*	23,500
Coal Bluff Co., Terre Haute	Pratt	78	6	9	9	26,600
Coal Bluff Co., Terre Haute	Anchor	60	5	5	12	10,400

*Finished April 7, 1893.

MONTHLY REPORT OF MINES IN CLAY COUNTY, IND., FOR MAY, 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Month.	Number Cubic Feet of Air Circulating in Mine per Minute.
	Gartsherre—					
Brazil Block Coal Co., Brazil	No. 3	42	5	4	21	10,000
Brazil Block Coal Co., Brazil	No. 4	55	6	4	19	20,000
Brazil Block Coal Co., Brazil	No. 6	35	4	4	22	7,000
Brazil Block Coal Co., Brazil	No. 8	110	8	12	14	30,000
Brazil Block Coal Co., Brazil	No. 9	77	5	5	18	18,000
Brazil Block Coal Co., Brazil	No. 10	89	8	10	12	16,380
Crawford Coal Co., Brazil	No. 2	99	5	5	23	19,750
Crawford Coal Co., Brazil	No. 3	61	5	5	21	19,000
Crawford Coal Co., Brazil	No. 4	43	5	3	20	8,200
Crawford Coal Co., Brazil	No. 5	86	6	4	21	13,000
Crawford Coal Co., Brazil	No. 6	30	5	5	22	8,400
Zeller & Sigler, Knightsville	Columbia	115	7	7	20	22,250
Zeller & Sigler, Knightsville	Am. Beauty	95	7	3	19	22,000
Otter Creek Coal Co., Brazil	Nellie	102	4	16	17	11,330
Otter Creek Coal Co., Brazil	Fairview	88	6	3	20	19,860
McIntosh Coal Co., Brazil	Newburg No. 2	70	12	5	12	22,750
D. H. Davis Coal Co., Knightsville	World's Fair	80	6	4	13 $\frac{1}{2}$	30,000
Watson, Little & Co., Brazil	Gartside	156	10	12	15 $\frac{1}{2}$	23,450
Jackson Coal Co., Brazil	New Nickel Plate	151	7	20	20	15,000
Eureka Block Coal Co., Carbon	No. 1	95	10	9	9 $\frac{1}{2}$	20,400
Weaver, Getz & Co., Center Point	Louise	90	5	4	13 $\frac{1}{2}$	9,700
C. Ehrlich & Co., Newburg	Newburg	46	7	2	16	31,000
J. Somers, Staunton	S. P.	45	10	4	7	6,000
Briar Hill Block Coal Co., Clay City	Briar Hill	52	7	6	24	7,400
Diamond Block Coal Co., Clay City	Diamond	70	10	5	25	12,000
Chicago & Ind. Bl'k Coal Co., T. Haute	No. 1	22	4	4	10	24,000
Chicago & Ind. Bl'k Coal Co., T. Haute	No. 2	60	5	5	8 $\frac{1}{2}$	23,500
Coal Bluff Co., Terre Haute	Pratt	40	4	4	18	22,000
Coal Bluff Co., Terre Haute	Anchor	23	4	3	18	10,400

MONTHLY REPORT OF MINES IN CLAY COUNTY, IND., FOR JUNE, 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Month.	Number Cubic Feet of Air Circulating in Mine Per Minute.
	Gartsherre—					
Brazil Block Coal Co., Brazil	No. 3	36	5	4	22	10,000
Brazil Block Coal Co., Brazil	No. 4	65	6	4	19	20,000
Brazil Block Coal Co., Brazil	No. 6	42	4	4	22	7,000
Brazil Block Coal Co., Brazil	No. 8	110	8	12	11	30,000
Brazil Block Coal Co., Brazil	No. 9	74	5	5	19	18,000
Brazil Block Coal Co., Brazil	No. 10	75	8	10	16	16,000
Crawford Coal Co., Brazil	No. 2	82	5	5	20	24,500
Crawford Coal Co., Brazil	No. 3	44	5	3	13	15,700
Crawford Coal Co., Brazil	No. 4	60	5	3	14	11,000
Crawford Coal Co., Brazil	No. 5	93	6	5	9	17,300
Crawford Coal Co., Brazil	No. 6	43	6	3	12	9,700
Zeller & Sigler, Knightsville	Columbia	120	6	6	15	23,000
Zeller & Sigler, Knightsville	Am. Beauty	100	7	4	17	23,000
Otter Creek Coal Co., Brazil	Nellie	40	2	3	15	10,000
Otter Creek Coal Co., Brazil	Fairview	108	6	3	18	17,920
McIntosh Coal Co., Brazil	No. 2	73	12	5	16	22,750
J. H. Zeller Coal Co., Knightsville	Briar Hill	20	5	5	24	10,000
D. H. Davis Coal Co., Knightsville	World's Fair	80	6	4	5 $\frac{1}{2}$	30,000
Watson, Little & Co., Brazil	Gartside	133	10	14	6	20,690
Jackson Coal Co., Brazil	N. Nickel Plate	152	7	8	21	15,000
Eureka Coal Co., Carbon	No. 1	103	10	9	9	16,800
Weaver, Getz & Co., Center Point	*Louise					
C. Ehrlich, Newburg	Newburg	53	7	4	10	31,000
J. Somers, Staunton	San Pedro	46	10	2	6	6,000
Briar Hill Block Coal Co., Clay City	Briar Hill	48	7	6	21	7,400
Diamond Block Coal Co., Clay City	Diamond	63	7	5	24	12,000
Chicago & Ind. Bl'k Coal Co., T. Haute	No. 1	53	5	5	11	22,500
Chicago & Ind. Bl'k Coal Co., T. Haute	No. 2	45	5	5	9	23,000
Coal Bluff Co., Terre Haute	Pratt	23	3	3	6	20,500
Coal Bluff Co., Terre Haute	Anchor	11	2	1	11	10,400

*Idle entire month.

MONTHLY REPORT OF MINES IN CLAY COUNTY, IND., FOR JULY, 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Month.	Number of Cubic Feet of Air Circulating in Mine Per Minute.
	Gartsherre—					
Brazil Block Coal Co., Brazil	No. 3	34	5	4	18	10,000
Brazil Block Coal Co., Brazil	No. 4	208	10	8	21	24,070
Brazil Block Coal Co., Brazil	No. 5	40	4	4	24	7,000
Brazil Block Coal Co., Brazil	No. 6	120	8	13	12	35,000
Brazil Block Coal Co., Brazil	No. 8	90	9	9	15	25,000
Brazil Block Coal Co., Brazil	No. 9	55	7	8	9	20,000
Brazil Block Coal Co., Brazil	No. 10	106	5	5	20	24,000
Crawford Coal Co., Brazil	No. 2	45	5	3	18	18,000
Crawford Coal Co., Brazil	No. 3	48	5	3	18	9,000
Crawford Coal Co., Brazil	No. 4	113	7	5	19	18,600
Crawford Coal Co., Brazil	No. 5	42	5	3	17	17,000
Crawford Coal Co., Brazil	No. 6	110	5	6	20	22,000
Zeller & Sigler, Knightsville	Columbia	90	5	4	17	23,000
Zeller & Sigler, Knightsville	Am. Beauty	22	2	2	20	11,300
Otter Creek Coal Co., Brazil	Nellie	120	6	3	18	17,160
Otter Creek Coal Co., Brazil	Fairview	73	12	5	14	22,750
I. McIntosh, Brazil	No. 2	30	5	.	23	10,000
J. H. Zeller & Co., Knightsville	Briar Hill	80	6	4	9	30,000
D. H. Davis & Co., Knightsville	World's Fair	133	10	14	10†	20,570
Watson, Little & Co., Brazil	Gartside	141	7	5	21	15,000
Jackson Coal Co., Brazil	N. Nickel Plate	107	10	9	15	21,600
Eureka Block Coal Co., Carbon	No. 1					
Weaver, Getz & Co., Center Point	*Louise	31	7	6	6‡	29,000
C. Ehrlich & Co., Newburg	Newburg	44	9	2	11	6,000
J. Somers, Staunton	San Pedro	46	7	7	24	7,400
Briar Hill Block Coal Co., Clay City	Briar Hill	48	7	4	24	12,000
Diamond Block Coal Co., Clay City	Diamond	14	10	3	10	23,000
C. and I. Block Coal Co., Terre Haute	No. 1	50	5	5	9	23,500
C. and I. Block Coal Co., Terre Haute	No. 2	33	4	4	11	23,000
Coal Bluff Co., Terre Haute	Pratt	20	2	2	22†	10,400
Coal Bluff Co., Terre Haute	Anchor					

* Idle entire month.

† Eight hours.

MONTHLY REPORT OF MINES IN CLAY COUNTY, IND., FOR AUGUST, 1898.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Month.	Number Cubic Feet of Air Circulating in Mine per Minute.
	Gartsherre—					
Brazil Block Coal Co., Brazil	No. 3	24	4	4	16	10,000
Brazil Block Coal Co., Brazil	No. 4	206	16	9	27	24,500
Brazil Block Coal Co., Brazil	No. 6	48	5	6	24	10,000
Brazil Block Coal Co., Brazil	No. 8	166	8	13	13	36,897
Brazil Block Coal Co., Brazil	No. 9	95	6	9	25	25,000
Brazil Block Coal Co., Brazil	No. 10	45	7	3	12	20,000
Crawford Coal Co., Brazil	No. 2	74	5	3	27	20,000
Crawford Coal Co., Brazil	No. 3	35	4	2	25	18,000
Crawford Coal Co., Brazil	No. 4	70	5	2	21	10,200
Crawford Coal Co., Brazil	No. 5	141	7	5	22	19,000
Crawford Coal Co., Brazil	No. 6	38	4	3	20	6,200
Zeller & Sigler, Knightsville	Columbia	110	7	9	22	23,000
Zeller & Sigler, Knightsville	Am. Beauty	105	7	5	25	23,000
Otter Creek Coal Co., Brazil	Nellie	84	5	7	12	15,000
Otter Creek Coal Co., Brazil	Fairview	124	6	4	16	20,900
I. McIntosh Coal Co., Brazil	No. 2	76	12	5	18	22,750
J. H. Zeller & Co., Knightsville	B. H.	45	5	1	24	12,000
D. H. Davis Coal Co., Knightsville	World's Fair	93	7	5	10	30,000
Watson, Little & Co., Brazil	Gartside	141	10	14	16 $\frac{1}{2}$	22,050
Jackson Coal Co., Brazil	New Nickel Plate	120	7	4	21	100,000
Eureka Coal Co., Carbon	No. 1	115	10	8	12 $\frac{1}{2}$	16,500
Weaver, Getz & Co., Center Point	Louise*					
C. Ehrlich & Co., Newburg	Newburg	57	8	4	10	36,000
J. Somers, Staunton	S. P.	50	9	2	9	7,350
Briar Hill Block Coal Co., Clay City	Briar Hill	48	7	4	22	8,000
Diamond Block Coal Co., Clay City	Diamond	54	10	4	25	125,000
Chicago & Ind. Bl'k Coal Co., T. Haute	No. 1	16	3	3	14	24,000
Clay County Block Coal Co., Brazil	Gladstone	21	7	4	24	3,000
Chicago & Ind. Bl'k Coal Co., T. Haute	No. 2	70	6	5	12	23,000
Coal Bluff Co., Terre Haute	Pratt	80	7	8	20	25,400
Coal Bluff Co., Terre Haute	Anchor	45	3	4	23	8,850

* Idle entire month.

MONTHLY REPORT OF MINES IN CLAY COUNTY, IND., FOR SEPTEMBER, 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Month.	Number Cubic Feet of Air Circulating in Mine per Minute.
Brazil Block Coal Co., Brazil	Gartsherre—					
Brazil Block Coal Co., Brazil	No. 3	36	5	3	23	20,000
Brazil Block Coal Co., Brazil	No. 4	205	10	3	21	24,000
Brazil Block Coal Co., Brazil	No. 6	43	4	5	24	9,600
Brazil Block Coal Co., Brazil	No. 8	125	8	12	13	35,000
Brazil Block Coal Co., Brazil	No. 9	105	6	9	18	25,000
Brazil Block Coal Co., Brazil	No. 10	35	3	4	19	16,740
Crawford Coal Co., Brazil	No. 2 ^s	44	4	2	19	18,000
Crawford Coal Co., Brazil	No. 3	35	5	2	21	15,000
Crawford Coal Co., Brazil	No. 4	93	5	2	17	13,000
Crawford Coal Co., Brazil	No. 5	119	7	3	24	18,000
Crawford Coal Co., Brazil	No. 6	30	5	3	21	8,000
Zeller & Sigler, Knightsville	Columbia	110	7	9	8	22,350
Zeller & Sigler, Knightsville	Am. Beauty	106	7	4	12	22,500
Otter Creek Coal Co., Brazil	Nellie	106	5	7	14	14,750
Otter Creek Coal Co., Brazil	Fairview	120	6	4	14 ⁺	21,280
I. McIntosh Coal Co., Brazil	No. 2	76	12	5	17	22,750
J. H. Zeller & Co., Knightsville	Briar Hill	60	5	1	23	15,000
D. H. Davis Coal Co., Knightsville	World's Fair	93	7	5	10	30,000
Watson, Little & Co., Brazil	Gartside	137	10	14	15 ⁺	23,850
Jackson Coal Co., Brazil	N. Nickel Plate	128	7	5	24	100,000
Jackson Coal Co., Brazil	Brazil	52	4		24	
Enreka Block Coal Co., Carbon	No. 1	113	14	8	14 ⁺	14,300
C. Ehrlich & Co., Perth	No. 1	43	5	3	13	17,500
C. Ehrlich & Co., Perth	No. 2	25	1	1	8	8,890
Weaver, Getz & Co., Centre Point	Louise†					
C. Ehrlich & Co., Turner	Newburg	51	8	4	9	30,000
J. Somers, Staunton	San Pedro	54	9	2	9	8,000
Briar Hill Block Coal Co., Clay City	Briar Hill	48	7	4	18	8,000
Diamond Block Coal Co., Clay City	Diamond	52	7	4	23	12,500
Chicago & Ind. Bl'k Coal Co., T. Haute	No. 11	16	3	3	16	23,000
Clay County Bl'k Coal Co., Brazil	Gladstone	27	5		23	3,000
Chicago & Ind. Bl'k Coal Co., T. Haute	No. 2	80	6	5	12	23,500
Coal Bluff Coal Co., Terre Haute	Pratt	75	7	8	13	25,000
Coal Bluff Coal Co., Terre Haute	Anchor	43	3	4	21	9,000

* Worked out and abandoned. † Idle entire month. ‡ Worked out and abandoned.

MONTHLY REPORT OF MINES IN CLAY COUNTY, IND., FOR OCTOBER, 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Month.	Number Cubic Feet of Air Circulating in Mine per Minute.
	Gartsherre—					
Brazil Block Coal Co., Brazil	No. 1	14	4	2	12	10,000
Brazil Block Coal Co., Brazil	No. 3	50	5	4	20	15,000
Brazil Block Coal Co., Brazil	No. 4	222	15	6	23	24,730
Brazil Block Coal Co., Brazil	No. 6	66	4	17	17	10,600
Brazil Block Coal Co., Brazil	No. 8	174	13	7	6	36,000
Brazil Block Coal Co., Brazil	No. 9	99	7	12	11	19,000
Brazil Block Coal Co., Brazil	No. 10	9	5	7	1	16,740
Crawford Coal Co., Brazil	No. 3	24	4	1	12	15,000
Crawford Coal Co., Brazil	No. 4	115	5	6	20	12,900
Crawford Coal Co., Brazil	No. 5	150	7	8	25	19,000
Zeller & Sigler, Knightsville	Columbia	110	7	8	9	22,000
Zeller & Sigler, Knightsville	Am Beauty	120	8	4	7	22,000
Otter Creek Coal Co., Brazil	Nellie	97	4	6	8	11,600
Otter Creek Coal Co., Brazil	Fairview	121	6	4	9	22,400
I. McIntosh Coal Co., Brazil	No. 2	78	12	5	22	22,750
J. H. Zeller Coal Co., Knightsville	Briar Hill	75	6	2	20	10,000
D. H. Davis Co., Knightsville	World's Fair	100	7	5	10	30,000
Watson, Little & Co., Brazil	Gartside	136	10	14	12	23,940
Jackson Coal Co., Brazil	New Nickel Plate	138	8	5	24	100,000
Eureka Block Coal Co., Carbon	No. 2	16	3		9	
Jackson Coal Co., Brazil	Brazil	74	5		23	21,000
Eureka Block Coal Co., Carbon	No. 1	121	9	8	12	14,500
C. Ehrlich & Co., Perth	No. 1	33	2	1	10	9,400
C. Ehrlich & Co., Perth	No. 2	72	9	4	10	33,000
Weaver, Getz & Co., Center Point	*Louise					
C. Ehrlich, Turner	Newburg	52	7	3	8	12,400
J. Somers, Staunton	S. P.	56	9	2	12	8,000*
Briar Hill Block Coal Co., Clay City	Briar Hill	46	7	4	23	7,000
Diamond Block Coal Co., Clay City	Diamond	39	7		15	12,500
Clay County Block Coal Co., Brazil	Glad.	30	5		24	4,000
Chicago & Ind. B ^l k Coal Co., T. Haute	No. 2	90	6	7	9†	23,000
Coal Bluff Co., Terre Haute	Pratt.	75	7	8	12	24,000
Coal Bluff Co., Terre Haute	Anchor	48	3	4	19	8,900

* Idle entire month.

MONTHLY REPORT OF MINES IN CLAY COUNTY, IND., FOR NOVEMBER, 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Month.	Number Cubic Feet of Air Circulating in Mine per Minute.
	Gartsherre—					
Brazil Block Coal Co., Brazil	No. 1	14	4	2	17	10,000
Brazil Block Coal Co., Brazil	No. 3	55	5	3	16	15,000
Brazil Block Coal Co., Brazil	No. 4	197	12	10	16	22,218
Brazil Block Coal Co., Brazil	No. 6	53	4	4	13	9,000
Brazil Block Coal Co., Brazil	No. 8	183	13	12	9	22,915
Brazil Block Coal Co., Brazil	No. 9	44		2	9	10,000
Brazil Block Coal Co., Brazil	No. 10	9		2	9	20,000
Crawford Coal Co., Brazil	No. 4	89	4	2	20	13,060
Crawford Coal Co., Brazil	No. 5	158	7	6	16	18,500
Crawford Coal Co., Brazil	No. 6	17	4	6	15	7,000
Zeller & Sigler, Knightsville	Columbia	105	7	3	10 ¹	22,250
Zeller & Sigler, Knightsville	Am. Beauty	105	7	4	9	22,250
Otter Creek Coal Co., Brazil	Nellie	66	2	3	7	11,800
Otter Creek Coal Co., Brazil	Fairview	114	6	3	10	22,900
I. McIntosh Coal Co., Brazil	Newburg No. 2	70	12	5	9	22,750
J. H. Zeller & Co., Knightsville	Briar Hill	80		2	14	16,000
D. H. Davis & Co., Knightsville	World's Fair	100	7	7	8 ¹	30,000
Watson, Little & Co., Brazil	Gartside	145	9	15	12	19,300
Jackson Coal Co., Brazil	New Nickel Plate	146	8	6	15	100,000
Eureka Block Coal Co., Carbon	No. 2	26	1	1	10	5,000
Jackson Coal Co., Brazil	Brazil	111	3	6	24	10,000
Eureka Block Coal Co., Carbon	No. 1	37	1	1	9 ¹	14,400
C. Ehrlich & Co., Perth	No. 1	69	4	4	15	10,200
C. Ehrlich & Co., Perth	No. 2	69	4	4	11	34,600
Weaver, Getz & Co., Center Point	Louise	126	9	4	11	12,500
P. Ehrlich & Co., Turner	Newburg	62	3	3	13	12,800
J. Somers, Staunton	San Pedro	46	9	2	13	8,000
Briar Hill Block Coal Co., Clay City	Briar Hill	45	7	3	15	7,000
Diamond Block Coal Co., Clay City	Diamond	23	6		24	12,500
Clay County Block Coal Co., Brazil	Diamond	43	5		20	5,000
Chicago & Ind. Bl'k Coal Co., T. Haute	No. 2	98	8	7	10	23,500
Coal Bluff Co., Terre Haute	Pratt	70	6	7	10 ¹	25,000
Coal Bluff Co., Terre Haute	Anchor	45	3	4	19	9,290

MONTHLY REPORT OF MINES IN CLAY COUNTY, IND., FOR DECEMBER, 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Month.	Number Cubic Feet of Air Circulating in Mine per Minute.
Brazil Block Coal Co., Brazil	Gartscherre—					
Brazil Block Coal Co., Brazil	No. 1	16	4	2	22	10,000
Brazil Block Coal Co., Brazil	No. 2*					
Brazil Block Coal Co., Brazil	No. 3	50	5	3	18	12,000
Brazil Block Coal Co., Brazil	No. 4	213	12	10	18	22,400
Brazil Block Coal Co., Brazil	No. 6	46	4	4	20	7,900
Brazil Block Coal Co., Brazil	No. 8	161	9	12	11	25,528
Brazil Block Coal Co., Brazil	No. 9	55	5	4	8	20,000
Brazil Block Coal Co., Brazil	No. 10†					
Crawford Coal Co., Brazil	No. 5	142	8	6	11	20,444
Crawford Coal Co., Brazil	No. 4	118	5	5	18	14,200
Zeller & Sigler, Knightsville	Am. Beauty	110	8	4	10	23,000
Zeller & Sigler, Knightsville	Columbian	110	7	7	12	22,000
Otter Creek Coal Co., Brazil	Nellie	75	2	3	18	15,100
Otter Creek Coal Co., Brazil	Fairview	136	6	5	12	23,100
I. McIntosh Coal Co., Brazil	Newburg, No. 2	65	12	5	10	22,750
J. H. Zeller & Co., Knightsville	Briar Hill	80	6	2	14	8,000
D. H. Davis Coal Co., Knightsville	World's Fair	110	7	5	13	30,000
Watson, Little & Co., Brazil	Gartside	145	10	15	13‡	19,910
Jackson Coal Co., Brazil	New Nickel Plate	141	7	5	11	100,000
Eureka Block Coal Co., Carbon	No. 2	33	3	1	12	5,000
Jackson Coal Co., Brazil	Brazil	83	5	1	20	10,000
Eureka Block Coal Co., Carbon	No. 1	57	8	4	10‡	14,300
C. Ehrlich & Co., Perth	No. 1	39	2	1	18	10,600
C. Ehrlich & Co., Perth	No. 2	67	9	4	13	35,000
Weaver, Getz & Co., Center Point	Louise	145	5	4	8	15,700
C. Ehrlich & Co., Turner	Newburg	63	8	3	21	14,500
J. Somers, Staunton	San Pedro	63	9	2	15	3,000
Briar Hill Block Coal Co., Clay City	Briar Hill	46	7	4	21	7,000
Diamond Block Coal Co., Clay City	Diamond	19	6	6	22	12,500
Clay County Block Coal Co., Brazil	Gladstone	78	6	6	14	9,000
Chicago & Ind. Bl'k Coal Co., T. Haute	No. 2	109	7	7	8‡	23,000
Coal Bluff Co., Terre Haute	Pratt	60	6	6	10	24,500
Coal Bluff Co., Terre Haute	Anchor	43	3	7	22	8,700

* Abandoned January 2, 1894.

† Shut down.

MONTHLY REPORT OF MINES IN VERMILION COUNTY, IND., FOR JANUARY, 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Month.	Number Cubic Feet of Air Circulating in Mine per Minute.
Hazel Creek Coal Co., Clinton	Hazel Creek	95	15	12	22	28,050
Hazel Creek Coal Co., Clinton	Fern Hill	98	14	7	22	32,098
Thompson Hill Mining Co., Clinton	Thompson Hill	75	7	4	22	7,500
Norton Creek Coal Co., Clinton	No. 2				19	

MONTHLY REPORT OF MINES IN VERMILLION COUNTY, IND., FOR FEBRUARY, 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Month.	Number Cubic Feet of Air Circulating in Mine per Minute.
Hazel Creek Coal Co., Clinton	Hazel Creek . . .	98	16	12	17	28,050
Hazel Creek Coal Co., Clinton	Fern Hill	95	14	7	17	32,098
Thompson Hill Mining Co., Clinton	Thompson Hill . .	70	7	4	20	7,500
Norton Creek Coal Co., Clinton	No. 2 . . . . .	..	..	..	18	..

MONTHLY REPORT OF MINES IN VERMILLION COUNTY, IND., FOR MARCH, 1893.

Hazel Creek Coal Co., Clinton	Hazel Creek . . .	90	15	12	14	28,050
Hazel Creek Coal Co., Clinton	Fern Hill	92	14	7	12	32,098
Thompson Hill Mining Co., Clinton	Thompson Hill . .	65	7	4	13	7,500
Norton Creek Coal Co., Clinton	No. 2 . . . . .	..	..	..	21	..

MONTHLY REPORT OF MINES IN VERMILLION COUNTY, IND., FOR APRIL, 1893.

Hazel Creek Coal Co., Clinton	Hazel Creek . . .	50	10	12	3 $\frac{1}{2}$	120,000
Hazel Creek Coal Co., Clinton	Fern Hill	125	12	8	10 $\frac{1}{2}$	144,000
Thompson Hill Mining Co., Clinton	Thompson Hill . .	80	20	5	20	8,500
Norton Creek Coal Co., Clinton	No. 2 . . . . .	..	..	..	15	..

MONTHLY REPORT OF MINES IN VERMILLION COUNTY, IND., FOR MAY, 1893.

Hazel Creek Coal Co., Clinton	Hazel Creek . . .	..	3	..	..	..
Hazel Creek Coal Co., Clinton	Fern Hill	185	11	10	15	56,800
Thompson Hill Mining Co., Clinton	Thompson Hill . .	81	15	6	12	8,500
Norton Creek Coal Co., Clinton	No. 2 . . . . .	..	..	..	18	..

MONTHLY REPORT OF MINES IN VERMILLION COUNTY, IND., FOR JUNE, 1893.

Hazel Creek Coal Co., Clinton	*Hazel Creek . . .	..	3	..	..	..
Hazel Creek Coal Co., Clinton	Fern Hill	165	11	11	10	56,800
Thompson Hill Mining Co., Clinton	Thompson Hill . .	45	6	4	7	8,500
Norton Creek Coal Co., Clinton	No. 2 . . . . .	..	..	..	7 $\frac{1}{2}$	..

* Not in operation.

MONTHLY REPORT OF MINES IN VERMILLION COUNTY, IND., FOR JULY, 1893

Hazel Creek Coal Co., Clinton	*Hazel Creek . . .	..	..	..	..	..
Hazel Creek Coal Co., Clinton	Fern Hill	185	11	11	15	56,800
Thompson Hill Coal Co., Clinton	Thompson Hill . .	76	10	5	10	8,500
Norton Creek Coal Co., Clinton	No. 4 . . . . .	..	..	..	12	..

* Not in operation.

MONTHLY REPORT OF MINES IN VERMILLION COUNTY, IND., FOR AUGUST, 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Month.	Number Cubic Feet of Air Circulating in Mine per Minute.
Hazel Creek Coal Co., Clinton	*Hazel Creek	197	15	14	11	51,000
Hazel Creek Coal Co., Clinton	Fern Hill	80	10	5	13	8,500
Thompson Hill Coal Co., Clinton	Thompson Hill					
Norton Creek Coal Co., Clinton	*No. 2					

* Not in operation.

MONTHLY REPORT OF MINES IN VERMILLION COUNTY, IND., FOR SEPTEMBER, 1893.

Hazel Creek Coal Co., Clinton	Hazel Creek*	203	18	16	15	52,000
Hazel Creek Coal Co., Clinton	Fern Hill	85	10	5	11	85,000
Thompson Hill Co., Clinton	Thompson Hill					

* Not in operation.

MONTHLY REPORT OF MINES IN VERMILLION COUNTY, IND., FOR OCTOBER, 1893.

Hazel Creek Coal Co., Clinton	Hazel Creek	75	10	14	15	48,000
Hazel Creek Coal Co., Clinton	Fern Hill	203	18	16	14	52,000
Thompson Hill Co., Clinton	Thompson Hill	72	10	5	14	8,500
Torrey Coal Co., Clinton	No. 4	115	15	5	15	17,800

MONTHLY REPORT OF MINES IN VERMILLION COUNTY, IND., FOR NOVEMBER, 1893.

Hazel Creek Coal Co., Clinton, Ind.	Hazel Creek	90	12	14	13	48,000
Hazel Creek Coal Co., Clinton, Ind.	F. Hill	201	18	16	13	52,000
Thompson Hill Co., Clinton, Ind.	T. Hill	65	8	5	5	8,500
Torrey Coal & Mining Co., Clinton, Ind.	No. 4	145	20	7	12	17,900

MONTHLY REPORT OF MINES IN VERMILLION COUNTY, IND., FOR DECEMBER, 1893.

Hazel Creek Coal Co., Clinton, Ind.	Hazel Creek	91	12	14	14	48,000
Hazel Creek Coal Co., Clinton, Ind.	F. Hill	203	18	16	14	52,000
*Thompson Hill Co., Clinton, Ind.	T. Hill					
Torrey Coal Co., Clinton, Ind.	No. 4	155	20	8	20	18,000

* Not in operation.

MONTHLY REPORT OF MINES IN VIGO COUNTY, IND., FOR JANUARY, 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Mine.	Number Cubic Feet of Air Circulating in Mine per Minute.
Coal Bluff Coal Co., Terre Haute . . .	Hercules	114	17	14	21	47,500
Coal Bluff Coal Co., Terre Haute . . .	Star	85	9	8	22	34,000
Coal Bluff Coal Co., Terre Haute . . .	Diamond	85	5	4	17	12,700
Coal Bluff Coal Co., Terre Haute . . .	Victor	25	3	2	22	21,000
Western Indiana Coal Co., Terre Haute	Peerless	55	5	3	21	16,000
P. Ehrlich & Co., Seelyville	Seelyville	60	8	5	24	20,000
Grant Coal and Mining Co., Burnett . . .	Grant	100	10	6	21	25,000

MONTHLY REPORT OF MINES IN VIGO COUNTY, IND., FOR FEBRUARY, 1893.

Coal Bluff Coal Co., Terre Haute . . .	Hercules	112	16	14	23	48,000
Coal Bluff Coal Co., Terre Haute . . .	Star	88	8	8	18 $\frac{1}{2}$	32,700
Coal Bluff Coal Co., Terre Haute . . .	Diamond	82	5	4	26 $\frac{1}{2}$	13,400
Coal Bluff Coal Co., Terre Haute . . .	Victor	25	2	2	22	
Western Indiana Coal Co., Terre Haute	Peerless	62	5	3	19	17,000
P. Ehrlich & Co., Seelyville	Seelyville	60	8	5	21	20,000
Grant Coal and Mining Co., Burnett . . .	Grant	100	10	7	23	25,000

MONTHLY REPORT OF MINES IN VIGO COUNTY, IND., FOR MARCH, 1893.

Coal Bluff Coal Co., Terre Haute . . .	Hercules	115	16	13	25	46,800
Coal Bluff Coal Co., Terre Haute . . .	Star	82	8	8	24	35,400
Coal Bluff Coal Co., Terre Haute . . .	Diamond	80	5	4	22	12,500
Coal Bluff Coal Co., Terre Haute . . .	Victor	34	4	2	23	
Western Indiana Coal Co., Terre Haute	Peerless	67	6	3	17	18,000
P. Ehrlich & Co., Seelyville	Seelyville	50	8	5	19	20,000
Grant Coal Mining Co., Burnett	Grant	100	10	7	26	25,000

MONTHLY REPORT OF MINES IN VIGO COUNTY, IND., FOR APRIL, 1893.

Coal Bluff Coal Co., Terre Haute . . .	Hercules	112	13	13	26	47,400
Coal Bluff Coal Co., Terre Haute . . .	Star	85	8	8	22	34,900
Coal Bluff Coal Co., Terre Haute . . .	Diamond	75	5	4	16	13,900
Coal Bluff Coal Co., Terre Haute . . .	Victor	35	4	3	21	
Western Indiana Coal Co., Terre Haute	Peerless	48	7	3	11	18,000
P. Ehrlich & Co., Seelyville	Seelyville	46	8	5	23	20,000
Grant Coal Mining Co., Burnett	Grant	100	10	7	20	25,000

MONTHLY REPORT OF MINES IN VIGO COUNTY, IND., FOR MAY, 1893.

Coal Bluff Coal Co., Terre Haute . . .	Hercules	121	13	12	13	46,000
Coal Bluff Coal Co., Terre Haute . . .	Star	95	6	7	13	22,500
Coal Bluff Coal Co., Terre Haute . . .	Diamond	80	6	4	12	25,000
Coal Bluff Coal Co., Terre Haute . . .	Victor	45	4	2	11	17,500
Western Indiana Coal Co., Terre Haute	Peerless	34	7	2	5	16,000
J. Ehrlich Coal Co., Seelyville	Seelyville	51	7	5	5	15,200
Grant Coal and Mining Co., Burnett . . .	Grant	76	11	5	7	28,000

MONTHLY REPORT OF MINES IN VIGO COUNTY, IND., FOR JUNE, 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Month.	Number Cubic Feet Air of Circulating in Mine per Minute.
Coal Bluff Coal Co., Terre Haute . . .	Hercules	125	13	13	23	47,500
Coal Bluff Coal Co., Terre Haute . . .	Star	103	7	8	23	23,000
Coal Bluff Coal Co., Terre Haute . . .	Diamond	90	7	4	21	25,400
Coal Bluff Coal Co., Terre Haute . . .	Victor	53	6	3	19	18,500
Western Indiana Coal Co., Terre Haute	Peerless	36	7	2	8	15,000
J. Ehrlich Coal Co., Seelyville	Seelyville	53	7	5	16	15,000
Grant Coal and Mining Co., Burnett . .	Grant	56	11	5	23	28,000

MONTHLY REPORT OF MINES IN VIGO COUNTY, IND., FOR JULY, 1893.

Coal Bluff Co., Terre Haute	Hercules	110	10	11	18	45,000
Coal Bluff Co., Terre Haute	Star	105	7	8	18	24,000
Coal Bluff Co., Terre Haute	Diamond	90	7	4	19	24,900
Coal Bluff Co., Terre Haute	Victor	55	6	3	16	18,000
Western Indiana Coal Co., Terre Haute	Peerless	34	7	2	11	15,000
J. Ehrlich Coal Co., Seelyville	Seelyville	48	7	5	13	15,000
Grant Coal and Mining Co., Burnett . .	Grant	51	10	5	8	28,000

MONTHLY REPORT OF MINES IN VIGO COUNTY, IND., FOR AUGUST, 1893.

Coal Bluff Co., Terre Haute	Hercules	100	13	12	18†	38,000
Coal Bluff Co., Terre Haute	Star	110	7	11	15	24,000
Coal Bluff Co., Terre Haute	Diamond	102	7	4	12	20,500
Coal Bluff Co., Terre Haute	*Victor . . . . .	..	..	..	..	..
Western Indiana Coal Co., Terre Haute	†Peerless . . . . .	..	..	..	..	..
J. Ehrlich Coal Co., Seelyville	Seelyville	60	7	5	9	15,000
Grant Coal and Mining Co., Burnett . .	Grant	50	9	6	2	35,000

* This mine operated in small way from August to January 1. † Not in operation this month.

MONTHLY REPORT OF MINES IN VIGO COUNTY, IND., FOR SEPTEMBER, 1893.

Coal Bluff Coal Co., Terre Haute . . .	Hercules	98	12	12	24	38,500
Coal Bluff Coal Co., Terre Haute . . .	Star	105	7	11	22†	..
Coal Bluff Coal Co., Terre Haute . . .	Diamond	100	6	4	18†	..
Coal Bluff Coal Co., Terre Haute . . .	Peerless* . . . . .	..	..	..	..	..
J. Ehrlich Coal Co., Seelyville	Seelyville	53	7	5	8	5,000
Grant Coal and Mining Co., Burnett . .	Grant	70	10	8	17	35,000

* Not in operation in September; assumed control September 1.

MONTHLY REPORT OF MINES IN VIGO COUNTY, IND., FOR OCTOBER, 1893.

Coal Bluff Coal Co., Terre Haute . . .	Hercules	102	12	12	23	39,000
Coal Bluff Coal Co., Terre Haute . . .	Star	105	7	11	25	23,700
Coal Bluff Coal Co., Terre Haute . . .	Diamond	98	6	4	23	21,000
Coal Bluff Coal Co., Terre Haute . . .	Peerless	45	4	2	15	21,200
J. Ehrlich Coal Co., Seelyville	Seelyville	52	6	5	8	18,000
Grant Coal and Mining Co., Burnett . .	Grant	70	10	8	17	40,000

MONTHLY REPORT OF MINES IN VIGO COUNTY, IND., FOR NOVEMBER, 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Month.	Number Cubic Feet of Air Circulating in Mine per Minute.
Coal Bluff Coal Co., Terre Haute . . .	Hercules	100	12	12	25	37,000
Coal Bluff Coal Co., Terre Haute . . .	Star	110	7	11	24½	24,000
Coal Bluff Coal Co., Terre Haute . . .	Diamond	104	6	4	19	20,700
Coal Bluff Coal Co., Terre Haute . . .	Peerless	85	4	3	11	21,000
J. Ehrlich Coal Co., Seelyville	Seelyville	58	8	5	24	19,000
Grant Coal and Mining Co., Burnett . .	Grant	80	12	11	27-	40,000

MONTHLY REPORT OF MINES IN VIGO COUNTY, IND., FOR DECEMBER, 1893.

Coal Bluff Coal Co., Terre Haute . . .	Hercules	104	12	12	24	38,700
Coal Bluff Coal Co., Terre Haute . . .	Star	110	7	11	23	24,200
Coal Bluff Coal Co., Terre Haute . . .	Diamond	97	6	4	20½	19,800
Coal Bluff Coal Co., Terre Haute . . .	Peerless	80	4	4	20	20,600
J. Ehrlich Coal Co., Seelyville	Seelyville	60	8	5	16	19,000
Grant Coal and Mining Co., Burnett . .	Grant	80	12	12	22½	40,000

MONTHLY REPORT OF MINES IN PARKE COUNTY, IND., FOR JANUARY, 1893.

Brazil Block Coal Co., Brazil	Otter Creek	52	5	3	20	2,000
Brazil Block Coal Co., Brazil	Coxville No. 3	140	11	10	23	25,000
New Kentucky Coal Co., Clinton	No. 1	94	17	7	21½	20,000
New Kentucky Coal Co., Clinton	No. 2	24	10	1	25	19,800
Mecca Mining Co., Rockville	Mecca M'ng Co.	59	5	4	24	24,680
Parke County Coal Co., Rosedale	No. 6	103	30	13	25	35,740
Parke County Coal Co., Rosedale	No. 7	45	4	5	18	27,000
Parke County Coal Co., Rosedale	No. 8	40	6	3	25	21,000
Parke County Coal Co., Rosedale	No. 9	75	10	8	24½	25,600

MONTHLY REPORT OF MINES IN PARKE COUNTY, IND., FOR FEBRUARY, 1893.

Brazil Block Coal Co., Brazil	Otter Creek	75	6	4	21	20,000
Brazil Block Coal Co., Brazil	Coxville No. 3	140	11	10	24	22,000
New Kentucky Coal Co., Clinton	No. 1	100	18	8	18½	20,000
New Kentucky Coal Co., Clinton	No. 2	23	11	1	24	19,800
Mecca Mining Co., Rockville	Mecca M'ng Co.	54	5	4	21	24,680
Parke County Coal Co., Rosedale	No. 6	107	21	13	24	35,740
Parke County Coal Co., Rosedale	No. 7	43	4	5	15½	25,800
Parke County Coal Co., Rosedale	No. 8	45	6	3	22	23,000
Parke County Coal Co., Rosedale	No. 9	80	10	9	21½	25,600

MONTHLY REPORT OF MINES IN PARKE COUNTY, IND., FOR MARCH, 1893.

Brazil Block Coal Co., Brazil	Otter Creek	80	7	4	22	20,000
Brazil Block Coal Co., Brazil	Coxville No. 3	140	10	11	23	25,000
New Kentucky Coal Co., Clinton	No. 1	85	17	7	21	30,000
New Kentucky Coal Co., Clinton	No. 2	43	12	2	25	20,000
Mecca Mining Co., Rockville	Mecca M'ng Co.	63	5	5	17	24,680
Parke County Coal Co., Rosedale	No. 6	109	21	13	26½	34,900
Parke County Coal Co., Rosedale	No. 7	45	4	5	16½	27,000
Parke County Coal Co., Rosedale	No. 8	48	6	4	26	22,400
Parke County Coal Co., Rosedale	No. 9	85	10	9	22	25,300

MONTHLY REPORT OF MINES IN PARKE COUNTY, IND., FOR APRIL, 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Month.	Number Cubic Feet of Air Circulating in Mine per Minute.
Brazil Block Coal Co., Brazil	Otter Creek	86	5	3	9	22,000
Brazil Block Coal Co., Brazil	Coxville No. 3	36	8	2	25	10,000
New Kentucky Coal Co., Clinton	No. 1	77	16	6	18	30,000
New Kentucky Coal Co., Clinton	No. 2	60	8	2	22½	30,000
Mecca Mining Co., Rockville	Mecca Min'g Co.	52	5	5	8	21,000
Parke County Coal Co., Rosedale	No. 6	112	21	15	22½	35,000
Parke County Coal Co., Rosedale	No. 7	47	4	5	8½	28,000
Parke County Coal Co., Rosedale	No. 8	50	7	6	23½	22,600
Parke County Coal Co., Rosedale	No. 9	37	10	9	22½	25,000

MONTHLY REPORT OF MINES IN PARKE COUNTY, IND., FOR MAY, 1893.

Brazil Block Coal Co., Brazil	Otter Creek	90	5	4	17	20,000
Brazil Block Coal Co., Brazil	Coxville No. 3	45	11	3	11	10,000
New Kentucky Coal Co., Clinton	No. 1	72	14	6	25	30,000
New Kentucky Coal Co., Clinton	No. 2	52	10	3	24	40,000
Mecca Mining Co., Rockville	Mecca Mining Co	62	5	5	24	21,000
Parke County Coal Co., Rosedale	No. 6	110	21	15	15½	32,000
Parke County Coal Co., Rosedale	No. 7	48	8	5	11½	29,000
Parke County Coal Co., Rosedale	No. 8	53	7	6	15½	25,000
Parke County Coal Co., Rosedale	No. 9	95	10	9	14½	30,500

MONTHLY REPORT OF MINES IN PARKE COUNTY, IND., FOR JUNE, 1893.

Brazil Block Coal Co., Brazil	Otter Creek	78	5	4	17	20,000
Brazil Block Coal Co., Brazil	Coxville No. 3	72	12	4	22	10,000
New Kentucky Coal Co., Clinton	No. 1	63	16	5	18	30,000
New Kentucky Coal Co., Clinton	No. 2	63	9	3	20	40,000
Mecca Mining Co., Rockville	Mecca Mining Co	74	6	6	25	21,000
Parke County Coal Co., Rosedale	No. 6	112	21	15	19½	33,000
Parke County Coal Co., Rosedale	No. 7	45	4	6	10½	30,400
Parke County Coal Co., Rosedale	No. 8	55	7	6	20½	28,800
Parke County Coal Co., Rosedale	No. 9	84	10	8	17½	27,800

MONTHLY REPORT OF MINES IN PARKE COUNTY, IND., FOR JULY, 1893.

Brazil Block Coal Co., Brazil	Otter Creek	90	5	4	14	30,000
Brazil Block Coal Co., Brazil	Coxville No. 3	70	14	6	12	22,000
New Kentucky Coal Co., Clinton	No. 1	60	13	5	22	30,000
New Kentucky Coal Co., Clinton	No. 2	70	12	5	24	40,000
Mecca Mining Co., Rockville	Mecca Mining Co	65	6	6	16	20,000
Parke County Coal Co., Rosedale	No. 6	102	21	15	17½	31,000
Parke County Coal Co., Rosedale	No. 7	33	4	5	8	25,300
Parke County Coal Co., Rosedale	No. 8	52	7	6	18½	27,000
Parke County Coal Co., Rosedale	No. 9	75	10	8	14½	289,000

MONTHLY REPORT OF MINES IN PARKE COUNTY, IND., FOR AUGUST, 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Month.	Number Cubic Feet of Air Circulating in Mine per Minute.
Brazil Block Coal Co., Brazil	Otter Creek	98	5	4	20	30,000
Brazil Block Coal Co., Brazil	Coxville No. 3	80	14	6	19	22,000
New Kentucky Coal Co., Clinton	No. 1	136	22	7	24½	30,000
New Kentucky Coal Co., Clinton	No. 2	148	18	5	27	40,000
Mecca Mining Co., Rockville	Mecca Mining Co	63	5	5	16	21,000
Parke County Coal Co., Rosedale	No. 6	165	21	15	12½	32,900
Parke County Coal Co., Rosedale	No. 7	27	4	4	10½	28,000
Parke County Coal Co., Rosedale	No. 8	56	7	7	18	28,000
Parke County Coal Co., Rosedale	No. 9	76	10	8	14½	29,000
Superior Block Coal Co., Brazil	Superior	76	12	1	23	9,000

MONTHLY REPORT OF MINES IN PARKE COUNTY, IND., FOR SEPTEMBER, 1893.

B. B. Coal Co., Brazil	Otter Creek	115	5	4	18	30,000
B. B. Coal Co., Brazil	Coxville No. 3	85	14	6	19	22,000
New Kentucky Coal Co., Clinton	No. 1	78	21	5	22½	30,000
New Kentucky Coal Co., Clinton	No. 2	143	17	5	24	40,000
Mecca Mining Co., Rockville	Mecca M'ng Co	67	5	5	17	21,000
Parke County Coal Co., Rosedale	No. 6	108	21	15	15½	33,000
Parke County Coal Co., Rosedale	No. 7	28	4	4	15½	29,000
Parke County Coal Co., Rosedale	No. 8	53	7	7	18	27,000
Parke County Coal Co., Rosedale	No. 9	80	11	8	19½	30,000
Superior Coal Co., Brazil	Superior	125	5	3	25	18,000

MONTHLY REPORT OF MINES IN PARKE COUNTY, IND., FOR OCTOBER, 1893.

B. B. Coal Co., Brazil	Otter Creek	102	7	3	14	18,600
B. B. Coal Co., Brazil	Coxville No. 3	105	14	8	20	34,900
New Kentucky Coal Co., Clinton	No. 1	98	13	6	19	30,000
New Kentucky Coal Co., Clinton	No. 2	116	10	5	18½	40,000
Mecca Mining Co., Rockville	Mecca M'ng Co	71	6	6	19	21,000
Parke County Coal Co., Rosedale	No. 6	115	22	15	23	33,000
Parke County Coal Co., Rosedale	No. 7	27	4	4	16½	27,000
Parke County Coal Co., Rosedale	No. 8	45	7	5	23½	25,000
Parke County Coal Co., Rosedale	No. 9	75	10	8	24	26,800
Superior Coal Co., Brazil	Superior	160	5	3	23	21,000
Crawford Coal Co., Brazil	No. 1	77	9	5	8	21,500

MONTHLY REPORT OF MINES IN PARKE COUNTY, IND., FOR NOVEMBER, 1893.

B. B. Coal Co., Brazil	Otter Creek	111	7	5	4½	32,660
B. B. Coal Co., Brazil	Coxville, No. 3	105	15	3	15	35,000
New Kentucky Coal Co., Clinton	No. 1	137	13	8	21	30,000
New Kentucky Coal Co., Clinton	No. 2	65	8	4	7	21,000
Mecca Mining Co., Rockville	Mecca M'ng Co	78	6	7	21	21,000
Parke Coal Co., Rosedale	No. 6	108	21	15	14½	32,000
Parke Coal Co., Rosedale	No. 7	29	4	4	15½	26,400
Parke Coal Co., Rosedale	No. 8	53	7	5	13	26,000
Parke Coal Co., Rosedale	No. 9	80	10	9	9	28,300
Superior Coal Co., Brazil	Superior	200	6	4	17	28,000
Crawford Coal Co., Brazil	No. 1	109	8	3	25	28,000

MONTHLY REPORT OF MINES IN PARKE COUNTY, IND., FOR DECEMBER, 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	No. of Days Worked in Month.	Number Cubic Feet of Air Circulating in Mine per Minute.
B. B. Coal Co., Brazil	Otter Creek	134	6	6		32,350
B. B. Coal Co., Brazil	Coxville, No. 3	105	16	10	19	30,000
New Kentucky Coal Co., Clinton	No. 1.	142	17	9	22	20,000
New Kentucky Coal Co., Clinton	No. 2*.					
Mecca Mining Co., Rockville	Mecca M'ng Co.	96	6	7	22	21,000
Parke Coal Co., Rosedale	No. 6.	110	22	16	144	31,400
Parke Coal Co., Rosedale	No. 7.	38	5	6	154	30,000
Parke Coal Co., Rosedale	No. 8.	56	7	6	163	27,300
Parke Coal Co., Rosedale	No. 9.	87	11	9	163	28,000
Superior Coal Co., Brazil	Superior	225	6	5	20	30,000
Crawford Coal Co., Brazil	No. 1.	141	8	3	16	22,500

*Not in operation during month.

MONTHLY REPORT OF MINES IN OWEN COUNTY, IND., FOR 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Month.	Number Cubic Feet of Air Circulating in Mine per Minute.	Amount of Money Invested in Improvements During Month.	Number of Tons of Screened Coal Produced.	Number of Tons of Mine Run Coal Produced.	Number of Tons of Slack Produced.	Number of Tons of Coal Manufactured Into Coke.	Number of Accidents.	Remarks.
Lancaster Block Coal Co., Clay City.	No. 3.	42	5	4	21			2,325		855			This report is for Jan., 1893.
J. F. Hyatt, Coal City.	E. C.	18		2	24	4,300		755		340			This report is for Jan., 1893.
Lancaster Coal Co., Clay City.	No. 3.	35		4	19			3,241		692			This report is for Feb., 1893.
J. F. Hyatt, Coal City.	E. C.	14		2	23	3,900		665		360			This report is for Feb., 1893.
Lancaster Coal Co., Clay City.	No. 3.	30		4	21			1,841		374			This report is for March, 1893.
J. F. Hyatt, Coal City.	E. C.	12		2	26	3,600		670		330			This report is for March, 1893.
Lancaster Coal Co., Clay City.	No. 3.	40		3	19			795		422			This report is for April, 1893.
Lancaster Coal Co., Clay City.	No. 3.	35		5	10			917		317			This report is for April, 1893.
Lancaster Coal Co., Clay City.	No. 3.	30		5	13			1,576		715			This report is for June, 1893.
Lancaster Coal Co., Clay City.	No. 3.	30		4	12			1,430		644			This report is for July, 1893.
Lancaster Coal Co., Clay City.	No. 3.	35		5	15			2,000		642			This report is for August, 1893.
Lancaster Coal Co., Clay City.	No. 3.	36		5	12			1,453		779			This report is for Sept., 1893.
Lancaster Coal Co., Clay City.	No. 3.	30		5	13			1,939		1,065			This report is for Oct., 1893.
Lancaster Coal Co., Clay City.	No. 3.	35		4	6			931		285			This report is for Nov., 1893.
Lancaster Coal Co., Clay City.	No. 3.	30		4	9			1,188		518			This report is for Dec., 1893.

MONTHLY REPORT OF MINES IN FOUNTAIN COUNTY, IND., FOR 1893.

NAME AND ADDRESS OF COMPANY.	NAME OF MINE.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used in Mine.	Number of Days Worked in Month.	Number Cubic Feet of Air Circulating in Mine per Minute.	Amount of Money Invested in Improvements During Month.	Number of Tons of Screened Coal Produced.	Number of Tons of Mine Run Coal Produced.	Number of Tons of Slack Produced.	Number of Tons of Coal Manufactured Into Coke.	Number of Accidents.	Remarks.
Shipman Coal Co., Cayuga	Shipman	44	7	4	20½	9,700	\$102 60	318	2,749	115	..	..	This report is for Jan., 1893.
Shipman Coal Co., Cayuga	Shipman	43	7	4	13½	9,800	..	307	1,373	110	..	..	This report is for Feb., 1893.
Shipman Coal Co., Cayuga	Shipman	46	4	4	23	9,300	12 74	96	3,542	50	..	..	This report is for March, 1893.
Shipman Coal Co., Cayuga	Shipman	42	6	4	13½	10,500	..	370	2,162	225	..	..	This report is for April, 1893.
Shipman Coal Co., Cayuga	Shipman	38	5	5	6½	10,800	494 00	51	950	20	..	..	This report is for May, 1893.
Shipman Coal Co., Cayuga	Shipman	48	8	5	10	10,000	..	251	2,092	165	..	..	This report is for June, 1893.
Shipman Coal Co., Cayuga	Shipman	51	9	5	14½	10,700	..	333	2,386	120	..	..	This report is for July, 1893.
Shipman Coal Co., Cayuga	Shipman	52	7	5	13	10,600	..	75	2,283	25	..	..	This report is for August, 1893.
Shipman Coal Co., Cayuga	Shipman	44	8	6	14½	10,700	..	100	2,662	33	..	..	This report is for Sept., 1893.
Shipman Coal Co., Cayuga	Shipman	44	8	6	15	18,500	..	440	2,849	190	..	..	This report is for Oct., 1893.
Shipman Coal Co., Cayuga	Shipman	47	8	6	13	17,000	..	80	2,408	30	..	..	This report is for Nov., 1893.
Shipman Coal Co., Cayuga	Shipman	..	..	..	..	..	550 00	..	..	..	..	..	Not in operation in Dec., 1893.

Table Showing Average Number of Persons Employed Inside Mines, also Average Number of Persons Employed Outside Mines, also Average Number of Mules Used in Respective Counties, Etc.

NAME OF COUNTY.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules Used.	Estimated Number of Men in Small Mines, to which the Law does not Apply.	Estimated Number Tons of Coal Produced Out of Small Mines.	Estimated Number of Small Mines to which the Law Does Not Apply.
Clay	2,454	229	165	30	9,000	5
Daviess	429	50	55	16	6,700	5
Fountain	45	7	5	10	3,000	3
Green	484	45	40	4	500	4
Gibson	30	10	3	3	500	1
Knox	41	10	4	5	500	2
Owen	33	25	4	5	1,250	4
Perry	64	9	10	24	9,600	9
Parke	715	98	59	6	1,500	4
Pike	259	66	33	17	2,000	9
Sullivan	585	101	53	8	900	8
Spencer	14	3	1	75	6,500	7
Vigo	509	54	38	50	15,000	8
Vermillion	312	38	27	6	1,000	5
Vanderburgh	255	54	31	4	800	3
Warrick	63	17	7	7	900	4
Dubois	.....	.....	.....	9	1,000	4
Martin	.....	.....	.....	4	800	3
Warren	.....	.....	.....	4	600	2
Total	6,392	816	535	222	47,250	86

REPORT OF MINES IN CLAY COUNTY FOR THE YEAR 1893.

MONTH.	Number of Mines Operated During Month.	Amount of Money Invested in Improvements.	Total Tons Screened Coal Produced.	Total Tons Mine Run Coal Produced.	Total Tons Slack Produced.
January	36	\$907 70	129,788	5,077	26,294
February	35	708 95	117,146	5,449	27,073
March	35	1,160 26	118,850	5,889	24,875
April	31	521 50	84,433	5,133	19,850
May	29	904 81	82,709	5,915	19,300
June	31	10,325 10	62,776	1,279	16,182
July	31	1,683 99	73,011	584	16,989
August	31	3,800 00	71,317	12,236	20,117
September	34	1,762 20	81,753	3,473	18,836
October	34	2,897 65	79,127	2,015	16,725
November	34	2,651 00	73,024	1,623	15,986
December	34	2,131 00	78,643	3,661	15,703
Total	.....	\$28,952 16	1,054,579	59,349	239,090

REPORT OF MINES IN GIBSON COUNTY FOR THE YEAR 1893.

August	1	\$20 00	.....	1,400	.....
September	1	.....	.....	1,800	.....
October	1	10 00	.....	2,000	.....
November	2	25 00	.....	2,150	.....
December	2	25 00	.....	3,031	.....
Total	.....	\$80 00	.....	10,381	.....

REPORT OF MINES IN GREENE COUNTY FOR THE YEAR 1893.

MONTH.	Number of Mines Operated During Month.	Amount Money Invested in Improvements.	Total Tons Screened Coal Produced.	Total Tons Mine Run Coal Produced.	Total Tons Slack Produced.
January	3		\$24,951	38,627	13,676
February	3		25,931	41,124	16,191
March	3		20,646	33,561	12,915
April	3		9,883	16,480	11,692
May	3		24,987	7,113	2,805
June	3		20,194	7,700	3,039
July	3		19,344	8,100	3,241
August	3		18,358	10,370	6,376
September	3		14,437	10,200	6,487
October	4		23,621	28,306	5,868
November	4		14,903	13,697	400
December	4		21,798	25,825	10,179
Total			\$239,035	243,103	92,869

REPORT OF MINES IN DAVIESS COUNTY FOR THE YEAR 1893.

January	7	\$175 00	13,635	15,686	4,231
February	7	225 00	10,086	15,334	3,505
March	7		7,913	17,296	2,660
April	7	50 00	5,333	16,929	1,007
May	7	25 00	4,548	10,492	724
June	7	25 00	9,080	7,580	1,695
July	7		8,715	1,475	1,520
August	7		8,257	7,510	1,100
September	7	200 00	14,401	6,145	3,848
October	8	700 00	14,744	7,579	3,330
November	8	415 00	14,502	6,814	3,353
December	8	1,025 00	14,015	7,774	53,601
Total		\$1,840 00	125,259	118,615	60,574

REPORT OF MINES IN SPENCER COUNTY FOR THE YEAR 1893.

January	1		262	465	90
February	1		306	330	96
March	1		264	369	80
April	1		75	437	20
May	1		8	434	
June	1		75	400	
July	1		8	48	
August	1		20	40	
September	1		50	85	
October	1		74	188	20
November	1		186	78	50
December	1		188	205	60
Total			1,516	3,079	416

MONTHLY REPORT OF MINES IN SULLIVAN COUNTY, IND., FOR 1893.

MONTH.	Number of Mines.	Amount of Money Invested in Improvements During Month.	Number Tons Screened Coal Produced.	Number Tons Mine Run Coal Produced.	Number Tons Slack Produced.	Number Tons Coal Manufactured into Coke.	Number Accidents.
January	9	\$110 79	22,288	8,885	4,964		
February	9	7 58	10,953	23,677	4,870		
March	9		30,361	14,569	8,745	1,175	
April	9		17,227	4,871	5,798	770	
May	9	280 43	15,054	9,004	4,358	785	
June	9	265 00	7,915	8,951	2,928		
July	9	243 50	8,064	10,132	2,735		
August	9	8 65	7,312	7,578	2,335		
September	10	3,605 97	17,442	10,235	2,611		
October	10	1,518 95	31,737	17,884	6,348	820	1
November	10	1,129 45	25,762	28,995	9,096	930	1
December	10		42,290	5,550	11,150	970	
Total		\$3,800 40	231,403	155,681	65,935	5,450	2

REPORT OF MINES IN PIKE COUNTY, IND., FOR THE YEAR 1893.

MONTH.	No. of Mines in Operation During Month.	Amount of Money Invested in Improvements.	Total Tons Screened Coal Produced.	Total Tons Mine Run Coal Produced.	Total Tons Slack Produced.	How Much Manufactured into Coke.
January	22		2,520	17,159	2,750	
February	22		2,316	17,250	2,123	
March	22		2,000	16,228	1,800	
April	22		2,217	18,907	1,000	
May	22		2,000	14,028	2,000	
June	22		1,700	10,012	1,000	
July	22		1,500	9,355	5,890	
August	22		1,200	11,020	1,650	
September	22		19,700	8,035	3,985	
October	22		2,023	17,931	2,568	
November	22		1,602	17,886	1,450	82
December	22		802	18,093	1,374	
Total			39,580	178,004	27,590	82

REPORT OF MINES IN PARKE COUNTY, IND., FOR THE YEAR 1893.

January			34,455	8,877	1,070
February			34,128	9,914	10,459
March			37,427	12,859	10,754
April			26,394	9,137	8,166
May			19,742	10,722	6,147
June			28,950	9,252	9,635
July		\$618 00	22,769	11,765	6,659
August		1,200 00	28,088	18,451	7,587
September		830 00	19,422	16,763	10,686
October		1,000 00	41,057	7,108	11,039
November		500 00	41,984		19,265
December		500 00	43,383		17,079
Total		\$4,648 00	378,099	114,828	118,517

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REPORT OF MINES IN PERRY COUNTY, IND., FOR THE YEAR 1893.

MONTHS.	Number of Mines.	Amount of Money Invested in Improvements.	Total Tons Screened Coal Produced.	Total Tons Mine Run Coal Produced.	Total Tons of Slack Produced.
January	2		871	1,674	208
February	2		602	2,652	204
March	2		482	2,170	179
April	2		510	2,539	183
May	2		1,200	1,100	90
June	2		970	1,200	300
July	2		1,120	900	200
August	2		400	1,430	150
September	2		500	1,485	175
October	2		449	1,589	171
November	2		553	2,093	201
December	2		605	2,287	204
Total			8,262	20,910	2,137

REPORT OF MINES IN VIGO COUNTY, IND., FOR THE YEAR 1893.

January		\$300 00	23,269	8,648	11,590
February		500 00	23,089	8,317	9,753
March		500 00	24,898	11,167	9,465
April		1,000 00	20,048	4,825	10,260
May			9,908	575	4,030
June			22,478	1,042	8,460
July		500 00	18,536	1,130	7,485
August		3,150 00	15,691	1,572	4,684
September		4,081 00	18,513	1,459	6,620
October		899 00	22,307	2,480	7,554
November		8,861 00	23,767	1,491	11,620
December		650 00	24,361	393	12,090
Total		\$20,631 00	247,066	43,119	103,581

REPORT OF MINES IN VERMILLION COUNTY, IND., FOR THE YEAR 1893.

MONTH.	Number of Mines Operated During Month.	Number of Persons Employed Inside.	Number of Persons Employed Outside.	Number of Mules or Horses Used.	Number of Days Worked.	Amount of Money Invested in Improvements.	Total Tons Screened Coal Produced.	Total Tons Mine Run Coal Produced.	Total Tons Slack Produced.
January	4	288	26	23	95	\$1,325 00	20,637	1,820	7,450
February	4	263	37	23	72	515 00	16,962	1,666	5,370
March						1,000 00	13,925	1,563	4,914
April						325 00	12,116	4,175	2,965
May							12,031	1,745	3,851
June							8,328		2,890
July							12,100	852	3,555
August						9,146	9,146	1,445	3,640
September						14,753	14,753	1,823	3,856
October						20,327	20,327	1,750	7,015
November						682 50	21,800		7,423
December						10 50	22,762	2,400	8,141
Total						\$4,898 50	184,977	19,239	60,790

REPORT OF MINES IN VANDERBURG COUNTY, IND., FOR THE YEAR 1893.

MONTHS.	Number of Mines.	Amount of Money Invested in Improvements.	Total Tons Screened Coal Produced.	Total Tons Mine Run Coal Produced.	Total Tons of Slack Produced.
January	5	\$1,550 00	11,686	8,414	2,721
February	5	500 00	8,603	7,086	2,039
March	5	150 00	38,623	6,370	5,384
April	5	125 00	4,795	6,459	5,083
May	5	125 00	4,886	6,196	4,695
June	5	125 00	4,630	6,296	9,180
July	5	.....	4,320	7,850	1,330
August	5	.....	6,304	10,676	1,618
September	5	.....	5,512	15,305	1,930
October	5	6,000 00	7,182	4,593	2,341
November	5	240 00	8,724	8,501	3,505
December	6	.....	9,624	10,161	2,175
Total . . . . .	.....	\$6,815 00	114,689	97,857	41,491

REPORT OF MINES IN WARRICK COUNTY, IND., FOR THE YEAR 1893.

January	3	.....	1,285	7,404	260
February	3	.....	709	5,131	422
March	3	\$193 00	368	5,443	109
April	3	.....	300	3,559	100
May	3	50 00	1,640	1,352	64
June	3	.....	2,160	300	50
July	3	.....	1,910	200	26
August	3	.....	1,610	1,445	180
September	3	.....	2,220	1,525	262
October	3	75 00	334	7,218	310
November	3	.....	608	7,789	350
December	3	.....	832	6,468	80
Total . . . . .	.....	\$318 00	13,976	47,834	2,198

REPORT OF MINES IN KNOX COUNTY, IND., FOR THE YEAR 1893.

January	2	\$71 24	2,378	30	1,533
February	2	57 10	2,216	131	1,482
March	2	.....	1,133	25	188
April	2	211 36	875	48	583
May	2	520 00	1,018	99	640
June	2	.....	1,030	70	650
July	2	46 22	900	55	430
August	2	.....	655	230	381
September	2	.....	830	355	475
October	2	.....	2,198	152	1,370
November	2	.....	1,616	50	1,040
December	2	.....	1,859	65	1,149
Total . . . . .	.....	\$905 92	16,505	1,290	9,881

Table Showing Number of Mines; Also Amount of Money Invested in Mine Improvements; Also Number of Tons of Screened Coal, Mine Run Coal and Slack, as Shown by Monthly Reports for Year 1898.

NAME OF COUNTY.	Number of Mine.	Amount of Money Invested in Im- provements.	Number of Tons of Screened Coal.	Number of Tons of Mine Run Coal.	Number of Tons of Slack Coal.	Total Tons of All Grades of Coal.
Clay.	34	\$28,952 16	1,054,579	59,349	239,090	1,353,018
Daviess.	8	1,841 00	125,259	118,615	60,574	404,448
Fountain.	1	1,159 34	2,421	25,455	10,025	37,901
Green.	4		239,035	243,103	92,869	575,007
Gibson.	2	80 00		10,381		10,381
Knox.	2	905 92	16,505	1,290	9,881	27,676
Owen.	1		21,774		8,278	30,052
Perry.	2		8,262	20,910	2,137	31,309
Parke.	11	4,648 00	78,099	114,828	118,517	311,444
Pike.	2		39,580	178,004	27,590	245,174
Sullivan.	10	3,800 40	231,203	155,681	5,450	392,334
Spencer.	1		1,516	3,079	416	5,011
Vigo.	6	20,431 00	247,066	43,119	103,581	393,766
Vermillien.	4	5,097 90	187,086	* 18,402	58,593	264,081
Vanderburgh.	4	8,815 00	146,689	77,957	41,491	266,037
Warrick.	3	318 00	13,976	47,834	2,198	64,008
Total.	97	\$76,058 66	2,413,050	1,117,907	780,690	4,311,647

REPORT OF ASSISTANT MINE INSPECTOR.

To the Hon. Thomas McQuade:

I respectfully submit my third annual report for fractional part of calendar year ending October 10, 1893.

Respectfully,

WELMAN LACKEY.

KNOX COUNTY.

BICKNELL MINE.

Operated by the Bicknell Coal Co., located at Bicknell, on I. & V. R. R. Inspected once and found to be in good condition, almost every feature of the law being complied with.

VINCENNES MINE.

Operated by the Vincennes Coal Co., located one-half mile east of Vincennes. This mine was abandoned on account of being unprofitable, the machinery being removed to Dugger, Sullivan County, Ind.

PROSPECT HILL MINE.

Operated by Frank Clark, located at Vincennes. It was inspected July 26. Less than ten men were employed in the mine. The ventilation was bad, the airways being partially closed on account of heaving of fire-clay.

WARRICK COUNTY.

LANDER MINE.

Operated by the Lander-Woolley Coal Co., located one mile east of Boonville, on branch of Air Line R. R. Machines are used for mining coal in this mine. It was inspected August 3, and found in good condition.

GOUGH MINE.

Operated by Robert Gough, located one-half mile east of Boonville, on branch of Air Line R. R. It was inspected August 3. Less than ten men are employed in this mine.

STAR MINE.

Operated by John Archbold. Located at Newburgh, on the Ohio River. It was lying idle on account of repairs, on August 7; when visited.

CHANDLER MINE.

Located at Chandler, on the Boonevill Branch of the Air Line R. R. Operated by Clemment & Co., successors to Hall & Bruce. This mine was not inspected, as it was lying idle for repairs at the time of my visit.

VANDERBURGH COUNTY.

INGLESIDES MINES.

Located at Evansville, on the Ohio River. Operated by John Ingle & Co. This mine was inspected on August 4. The ventilation was good. This mine is the oldest mine in the State. The excavation is very large. An endless rope is used for drawing coal in main entry, a distance of thirteen hundred yards. Other improvements are being made by putting new engines in, repairing tippel and hoisting shaft.

COÖPERATIVE MINE.

Located one mile east of Evansville. Operated by the Evansville Coal Co., successors to the Evansville Coöperative Coal Co. It was inspected August 5 and found in bad condition. The ventilation was bad on account of the fan box not being properly closed, the law being violated in several instances. Notice was given the mining boss, Frank Lockhart, to make needed repairs.

SUNNYSIDE MINE.

Located at Evansville. Operated by the Sunnyside Coal and Coke Company. It was inspected on August 6. The ventilation of the mine was generally good. They had not complied with the law in regard to a second outlet or man-way, for the violation of which I had entered suit. The case is still pending in Vanderburgh Circuit Court.

SUNNYSIDE MINE NO. 2.

Located just west of Evansville. Operated by the Sunnyside Coal and Coke Co. This mine was not inspected on account of its being idle at the time of my visit on August 5.

DIAMOND MINE.

Located northwest of Evansville. Operated by the Diamond Coal Mining Co. This mine was flooded with water at the time of my visit, and was not inspected.

FIRST AVENUE MINE.

Located northeast of Evansville. Operated by the First Avenue Coal Mining Co. This mine was inspected on August 7. The mine was not in very good condition. This company is very indifferent in regard to complying with the law; consequently they have been prosecuted and fined for violating mining laws. However, some improvements have been made since my last visit.

GIBSON COUNTY.

FRISCO MINE.

Located at Francisco, on the Airline Railroad, six miles east of Princeton, operated by Robert Lander, successor to A. E. Powell. It was inspected on August 1. It had just been started, after lying idle for six months, and was in bad condition. Another visit was made in September, when I found the mine in very good condition.

SPENCER COUNTY.

LINCOLN MINE.

Located one mile from Lincoln City, on the Cannelton branch of the Airline Railroad. Owned by Henry Schaefer. This mine is operated principally for fire-clay, the coal being very low. Was not inspected on my last visit, as the mine was flooded with water.

GREENE COUNTY.

FLUEHART MINE.

Located one mile southwest of Linton, on the Greene County coal branch of the Indianapolis & Vincennes Railroad. Operated by the Linton Coal and Mining Co. It was inspected April 14, and found in bad condition. It was visited again in a short time and found in generally good condition.

ISLAND MINE No. 2.

Located one-half mile west of Linton. Operated by the Island Coal Company. This mine was inspected on January 26. The mine was in very good condition, with the exception of the ventilation, which was bad, on account of break-throughs being left open. This violation was prosecuted in Squire G. W. Ellis' court in Linton. The case was venired to Squire Wakefield's court at Switz City. The law was held insufficient to hold prisoner, and an appeal was taken to the Circuit Court. The case is still pending.

SUMMIT MINE.

Located one-half mile west of Linton, on a branch of the I. & V. and I. & I. S. R. R's. Operated by the Summit Coal Co. This mine was inspected January 2, and found in good condition, excepting break-throughs, which were not bratticed as required by law. Consequently I prosecuted them in four cases in Squire Ellis' court. They were convicted, and fined ten dollars in each case.

PIKE COUNTY.

AYRSHIRE MINE.

Located five miles east of Oakland City, on the Air Line R. R. Owned by David Ingle. It was inspected on August 2, and found to be in good condition. This is a shaft just east of the old slope, and part of the workings are those worked by the old slope. Eighty miners, twenty-five day-men and fourteen mules are employed inside. Coal is found at a depth of 22 feet, and of fine quality. Some men are still employed in the old slope for the purpose of coaling railroad engines.

BLACKBURN MINE.

Located at Blackburn, on the E. & I. R. R. This mine is now owned by S. W. Little. It was lying idle for repairs, at the time of my visit.

LITTLE'S MINE.

Located six miles southeast of Petersburg, on the E. & I. R. R. This mine was inspected July 31, and found in good condition.

PERRY COUNTY.

TROY MINE.

Located at Troy, owned by Bergenroth Bros., was inspected once and found in good condition.

CANNELTON MINE.

Located two miles east of Cannelton. Operated by the American Cannel Coal Co. It was lying idle for repairs at the time of my visit.

DAVIESS COUNTY.

MUTUAL MINE.

Owned by the Mutual Mining Co., located one mile south of Cannelburgh. This mine was inspected July 27, and found to be in good condition. A new cage had been put in since my last visit.

WILSON MINE.

Located near Montgomery on the O. & M. Railroad. Owned by the Wilson Coal Company. Two visits were made to this mine. On my first visit found the air very bad, but on my second visit found the mine in generally good condition.

WILSON MINE NO. 2.

Owned by Wilson & Sons. Located three miles west of Washington on the E. & I. Railroad. The roof is bad on account of water percolating through. In other respects the condition of the mine was good on July 28, the time of my visit.

MAPLE VALLEY MINE..

Owned by Cable & Co. Located two miles and one-half southwest of Washington. When last visited it was found to be in good working condition. All the men employed were working on pillars.

MINE No. 4.

Owned by Cable & Co.; located two miles south of Washington. This mine was inspected July 28, and found in good working condition.

MINE No. 7.

Owned by Cable & Co.; located one and one-half miles west of Washington. This mine was inspected July 28, and found in good condition.

MINE No. 9.

Owned by Cable & Co.; located two and one-half miles southwest of Washington. This mine was in good working condition when last inspected. This is part of the Maple Valley mine, the shaft being sunk in the north works. Experienced some trouble with this company in regard to delivering timber. I made a special visit on this account, after which the timber was delivered, as requested by me.

MURREY AND BAILEY MINE.

Operated by Sam. Rogers. Located six miles southwest of Washington on the E. & I. R. R. This mine was not inspected, as they were idle at time of my visit.

SULLIVAN COUNTY.

DUGGER MINE.

Operated by the Dugger & Neal Coal Co., located at Dugger, on the I. & I. S. R. R. and I. & V. Coal Branch. Was inspected January 4. The ventilation was found to be bad on account of breakthroughs being left open. For this offense I entered suit in 'Squire Lusader's court at Sullivan. A later visit was made, when I found the breakthroughs closed and the air generally good.

JUMBO MINE.

Operated by the Jackson Hill Coal and Coke Company, located at Hartersville, on branch of E. & T. H. R. R. This mine was inspected June 24. I found the ventilation bad on account of the main airway being closed by a fall of slate, which I ordered removed. I returned again in a short time and found the mine in good condition generally.

ALUM CAVE MINE.

Operated by the New Pittsburgh Coal and Coke Co., located at Alum Cave, on branch of the E. & T. H. R. R. It was inspected July 11, and found in good working condition.

OLD PITTSBURGH MINE.

Owned by the Old Pittsburgh Coal Co. Located at Hymera, on a branch of the E. & T. H. R. R. It was inspected January 21. The mine was in very good condition, with the exception that the air in some parts of the mine was bad, on account of the break throughs being left open, which they at once remedied. Coal is mined by machines. Power used, electricity.

STARK MINE.

Operated by Milton Stark & Son. Located at Hymera. This mine was inspected January 31. The condition of the mine was good, excepting there was no manway around the bottom of the shaft. For this offense they were fined, after which they complied with the law.

HANCOCK MINE.

Operated by Hancock & Conkel. Located at Farnsworth, on the I. & I. S. R. R. Five miles east of Sullivan. It was inspected January 24 and found in good working condition.

CURRYVILLE MINE.

Operated by the Curryville Coal and Coke Company, located one-half mile north of Shelburn on the E. & T. H. Railroad. It was inspected July 13. The ventilation was good. There were no safety catches on the cages, but they were making the needed repairs at the time of my visit.

SHELburn MINE.

Operated by the Shelburn Coal Company, located at Shelburn on the E. & T. H. Railroad. It was inspected July 13. The ventilation was generally good. The air was moving a little slow in some parts of the mine, the volume of air being 10,100 cubic feet per minute. No gas was discovered in any part of the mine at the time of my visit.

A special visit was made on September 6 on account of a gas explosion which occurred on September 5, in which eleven men were injured, the injuries proving fatal to three.

SUPERIOR MINE.

Operated by the Island Coal Co., located one mile and a half west of Dugger, on a branch of the I. & V. R. R. This mine was abandoned about the first of June on account of the tipple being burned.

LYONTON MINE.

Operated by Magill & Raines, located at Lyonton, two miles west of Dugger. It was inspected on February 20. Some parts of the mine were in bad condition on account of the air-ways being closed. The men in two entries went out until they could be put in fit condition to work. I made another visit in a short time and found the men all at work, and the air good.

BRIAR HILL MINE.

Located just north of Dugger, operated by the Dugger Coöperative Coal Co. This is a new mine, and is yet being worked on a small scale.

ACCIDENTS—FATAL.

Oliver C. Blevens, killed by shot of coal on May 26, 1893, in Alum-Cave mine, in Sullivan County. Operated by the New Pittsburgh Coal and Coke Co.

Willis Powell, killed by fall of slate, in Jumbo mine, operated by the Jackson Hill Coal and Coke Co., on June 17, in Sullivan County.

Michael Haney, killed by shot of coal on July 21, 1893, in Frisco Mine, operated by Robert Lander, in Gibson County.

Pid or Gallant Hays, died on September 9, 1893, from injuries received from gas explosion in Shelburn Mine, on September 5, 1893, operated by the Shelburn Coal Co., in Sullivan County.

Simpson Elwick, died September 11, 1893, from injuries received in gas explosion in Shelburn Mine, on September 5, 1893, operated by Shelburn Coal Co., in Sullivan County.

Henry Hodges, died from injuries received in gas explosion in Shelburn Mine, on September 5, 1893, operated by the Shelburn Coal Co., in Sullivan County.

ACCIDENTS—NON-FATAL.

George Yates, Levi Bardsley, George Brown, Ransom Kempt, Thomas Mills and Albert Norton were injured by a gas explosion which occurred in Shelburn Mine on September 5, 1893, operated by Shelburn Coal Co., in Sullivan County.

George Farris, hand broken by fall of slate January 18, 1893, in Sunnyside Mine, operated by Sunnyside Coal and Coke Co., in Vanderburgh County.

Henry O'Loughlin, collar bone broken by being caught between car and cross timber while driving on February 24, 1893, in First Avenue Mine, operated by First Avenue Coal Mining Co., in Vanderburgh County.

Alvin Dudley, ribs broken by falling coal on March 7, 1893, in Lyon-ton Mine, operated by Magill & Raines, in Sullivan County.

Table Giving Name of Mine, Also Kind of Mine, Power Used, Kind of Coal, Thickness of Vein, Depth From Surface and How Ventilated.

MINES IN DAVIESS COUNTY.

NAME OF MINE.	Kind of Mine.	Power Used.	KIND OF COAL.	Seam Worked.	Coal, Thickness.	Depth from Surface.	How Ventilated.
Maple Valley	Shaft.	Steam.	Bituminous	L	Ft. In.	Ft.	Fan.
No. 4	Shaft.	Steam.	Bituminous	L	5	74	Fan.
No. 7	Shaft.	Steam.	Bituminous	L	4	49	Fan.
No. 9	Shaft.	Steam.	Bituminous	L	7	66	Fan.
Wilson No. 1	Shaft.	Steam.	Bituminous	L	5	86	Fan.
Wilson No. 2	Shaft.	Steam.	Bituminous	M	3	100	Fan.
Murray	Shaft.	Steam.	Cannel and bitum's	I	5	100	Fan.
			Bituminous	K	6	50	Fan.

MINES IN GREEN COUNTY.

NAME OF MINE.	Kind of Mine.	Power Used.	KIND OF COAL.	Seam Worked.	Coal, Thickness.	Depth from Surface.	How Ventilated.
Island No. 2	Shaft.	Steam.	Bituminous	L.	Ft. In.	Ft.	Fan.
Summit	Shaft.	Steam.	Bituminous	L.	5	70	Fan.
Fluehart	Shaft.	Steam.	Bituminous	L.	5 6	76	Fan.
				L.	5	72	Fan.

MINES IN PIKE COUNTY.

NAME OF MINE.	Kind of Mine.	Power Used.	KIND OF COAL.	Seam Worked.	Coal, Thickness.	Depth from Surface.	How Ventilated.
Ayrshire	Shaft.	Steam.	Bituminous	K.	Ft. In.	Ft.	Fan.
Blackburn	Slope.	Steam.	Bituminous	K.	5	30	Furnace.
Littles	Shaft.	Steam.	Bituminous	K.	7	80	Fan.
				K.	7	89	Fan.

MINES IN KNOX COUNTY.

NAME OF MINE.	Kind of Mine.	Power Used.	KIND OF COAL.	Seam Worked.	Coal, Thickness.	Depth from Surface.	How Ventilated.
Bicknell	Shaft.	Steam.	Bituminous	K	Ft. In.	Ft.	Fan.
Prospect Hill	Shaft.	Steam.	Bituminous	M	4	98	Fan.
				M	3	340	Fan.

MINES IN GIBSON COUNTY.

NAME OF MINE.	Kind of Mine.	Power Used.	KIND OF COAL.	Seam Worked.	Coal, Thickness.	Depth from Surface.	How Ventilated.
Frisco	Shaft.	Steam.	Bituminous	K	Ft. In.	Ft.	Fan.
				K	4	130	Fan.

MINES IN PERRY COUNTY.

NAME OF MINE.	Kind of Mine.	Power Used.	KIND OF COAL.	Seam Worked.	Coal, Thickness.	Depth from Surface.	How Ventilated.
Troy	Shaft.	Steam.	Bituminous	G	Ft. In.	Ft.	Furnace.
Cannelton	Dritt.	Horse.	Semi-block	F	3	80	Furnace.
				F	3	150	Furnace.

MINES IN VANDERBURGH COUNTY.

NAME OF MINE.	Kind of Mine.	Power Used.	KIND OF COAL.	Seam Worked.	Coal, Thickness.	Depth from Surface.	How Ventilated.
Engleside	Shaft.	Steam.	Bituminous	K	Ft. In.	Ft.	Fan.
Sunnyside	Shaft.	Steam.	Bituminous	K	4	265	Fan.
Sunnyside, No. 2	Shaft.	Steam.	Bituminous	K	4	265	Fan.
First Avenue	Shaft.	Steam.	Bituminous	K	4	257	Fan.
Diamond	Shaft.	Steam.	Bituminous	K	4	260	Fan.
Coöperative	Shaft.	Steam.	Bituminous	K	4	260	Fan.
					4	255	Fan.

MINES IN WARRICK COUNTY.

					Ft. In.	Ft.	
Lawder	Slope.	Steam.	Bituminous	K	7	30	Fan.
Gough	Shaft.	Steam.	Bituminous	K	7	50	Furnace.
Chandler	Shaft.	Steam.	Bituminous	K	4	128	Furnace.
Star	Shaft.	Steam.	Bituminous	K	3 6	50	Fan.

MINES IN SULLIVAN COUNTY.

					Ft. In.	Ft.	
Curryville	Shaft.	Steam.	Bituminous	L.	5	248	Fan.
Sheburn	Shaft.	Steam.	Bituminous	L.	5	248	Fan.
Hancock	Shaft.	Steam.	Bituminous	L.	5	70	Fan.
Lynton	Shaft.	Steam.	Bituminous	L.	5	50	Fan.
Dugger	Shaft.	Steam.	Bituminous	L.	5	100	Fan.
Alum Cave	Shaft.	Steam.	Bituminous	K.	6 6	40	Fan-Fur.
Old Pittsburgh	Shaft.	Steam.	Bituminous	L.	5	50	Fan.
Stark	Shaft.	Horse.	Bituminous	L.	5	40	Furnace.
Jumbo	Shaft.	Steam.	Bituminous	L.	5	30	Fan.
Briar Hill	Shaft.	Steam.	Bituminous	L.	5	100	Fan.

MINES IN SPENCER COUNTY.

					Ft. In.	Ft.	
Lincoln	Shaft.	Steam.	Bituminous	G.	3	23	Furnace.

REPORT OF ASSISTANT MINE INSPECTOR.

MR. THOS. MCQUADE, Brazil, Indiana,

Inspector of Mines, State of Indiana:

SIR—In conformity with section 5 of the Revised Statutes of the State of Indiana, defining the duties of the State Inspector of Mines, I herewith submit my report for the fourth quarter of the year ending December 31, 1893, and for the time I was filling said office in the year 1893.

Respectfully,

M. COMMESKY,

Assistant Inspector of Mines for the State of Indiana.

PERRY COUNTY.

CANNELTON MINES.

Owned by the American Cannel Coal Company, of Cannelton, Ind. The mine is located three miles northeast of the city of Cannelton, and is operated by drift. The coal is from two to four feet in thickness and of a good quality. This mine was inspected on October 23, 1893, and found in good condition.

TROY MINE.

Owned and operated by Burgenroth Bros., of Troy, Ind. The mine is located one-half mile east of Troy, and is operated by shaft. The mine was inspected on October 24, 1893. The ventilation in some parts of the mine was found to be bad, owing to no fire in the furnace. I had the promise of the mine foreman that the furnace would be put in order at once and the same would not be neglected hereafter.

SPENCER COUNTY.

LINCOLN CITY MINE.

Owned and operated by Henry Schafer, of Lincoln City, Ind. The mine was not inspected, as I found they were only working six men, therefore not coming under the mining law.

WARRICK COUNTY.

STAR MINE.

Operated by John Archibald, of Newburg, Ind. The mine is operated by shaft one hundred feet in depth. The coal is four feet in thickness. This mine, when inspected, was found in good condition, as to ventilation, but I found no stairway in the second outlet. I requested that a stairway be put in, and the company agreed to comply with my request.

CHANDLER MINE.

Operated by Clement Vogt Coal Company, of Chandler. The mine is operated by a shaft, one hundred and ten feet in depth, the thickness of the coal is four and one-half feet. When inspected the condition of this mine was good.

DE FOREST MINE.

Operated by Thomas Hall & Co., of De Forest, Ind. This mine was not in operation, therefore I can not say what condition the mine was in at that time.

LAWDER MINE.

Owned and operated by the R. Lawder & Woolly Coal Mining Co., of Boonville, Ind. The mine was not in operation when visited.

GOUGH MINE.

Owned and operated by R. Gough, Boonville, Ind. This mine was working less than ten men, therefore was not inspected.

VANDERBURGH COUNTY.

INGLESIDE MINE.

Owned and operated by John Ingle & Co., Evansville, Ind. This mine took fire on the 27th of September, in the bottom timbers. No one was injured, but eleven mules were suffocated by the fire. The damages were reported at \$4,000. The mine was not in operation, therefore was not inspected.

CO-OPERATIVE MINE.

Owned and operated by the Evansville Coal and Mining Company, of Evansville, Ind. This mine is operated by a shaft 232 feet in depth. The coal is four feet in thickness. This mine was inspected on the 20th of October, and I found it in bad condition. I called the attention of the management to what was necessary to put the mine in compliance with the law, and the company made the changes that were necessary.

VANDERBURGH COUNTY.

SUNNYSIDE MINE.

Operated by the Sunnyside Coal and Coke Co., of Evansville, Ind. This mine is operated by a shaft 260 feet in depth. The coal is 4 feet in thickness. The coal in this mine is mined by machines. This mine was inspected on the 25th of October, and found in fair condition.

UNITY MINE.

Operated by the Sunnyside Coal and Coke Co., of Evansville, Ind. This mine was not inspected, owing to the fact that they were operating with less than ten persons at that time.

FIRST AVENUE MINE.

Operated by C. Thomas. This mine is operated by a shaft 265 feet in depth. The coal is 4 feet in thickness. The mine was inspected October 21, and found in fair condition, but I found the company was not complying with the law in regard to the stairway in the second outlet. I asked that a stairway be placed in the outlet at once.

DIAMOND MINE.

Operated by the Diamond Coal and Mining Co., of Evansville, Ind. This mine is operated by a shaft 240 feet in depth. The coal is 4 feet in thickness. It was inspected October 21, and found in good condition below, but I found no stairway in the second outlet, which I ordered put in. I also found they were not using the lawful signals for hoisting and lowering the cages in the mine. This I asked to be changed to the right signal.

PIKE COUNTY.

AYRSHIRE MINE.

Owned and operated by D. Ingle, Oakland City, Ind. This mine is located at Ayrshire, Pike County, six miles east of Oakland City, on the Air Line Railroad. It was inspected on the 21st of November. The condition of the mine was good. This is a new mine, with all the latest improved machinery to handle coal on top with.

LITTLE'S MINE.

Owned by S. W. Little, at Little Station, Pike County. This mine is on the Evansville & Indianapolis Railroad. It was inspected on the 22d of November. I found it in good condition. The mine is operated by a shaft 86 feet in depth. The coal is 6 and 7 feet in thickness.

POSEY MINE

Operated by the Posey Co-operative Coal Co. It was not in operation when visited, and has since been sold to S. W. Little, of Blackburn, Pike County.

GIBSON COUNTY.

FRANCISCO MINE.

Operated by R. Lawder, of Francisco, Ind. This mine is operated by a shaft 128 feet in depth. The coal is 4 feet in thickness. The condition of mine when inspected was good. The company had put down the second shaft, but it was not complete as to stairways.

KNOX COUNTY.

PROSPECT HILL MINE.

Operated by F. Clark, of Vincennes, Ind. It was inspected on the 27th of November, and found in bad condition. Many changes were ordered made to place the mine in compliance with the law. This is the deepest shaft in the State. The coal is three feet in thickness.

BICKNELL MINE

Operated by the Bicknell Coal and Mining Co., of Bicknell, Ind. This mine is operated by a shaft 92 feet in depth. It was not in operation when I was there to inspect it.

DAVIESS COUNTY.

WILSON MINE.

Owned and operated by John Wilson & Sons, of Washington, Ind. This mine is located one-half mile northwest of Washington and is operated by a shaft. The coal is six feet in thickness and of excellent quality.

CABLE MINE NO. 7.

Owned by Cable & Co., of Washington, Ind. Mine No. 7 is operated by a shaft sixty-two feet in depth. The thickness of the coal is six and one-half feet. This mine is about worked out.

CABLE MINE NO. 4.

Owned by Cable & Co.

CABLE MINE NO. 9.

Owned by Cable & Co., and is operated by a shaft. This is the largest mine now in operation in Daviess County. When inspected they were working sixty-six persons and six mules.

MAPLE VALLEY MINES.

Owned by Cable & Company. This mine is located two miles southwest of Washington. When inspected it was found in parts very warm. Some changes were ordered made to better ventilate the mine.

MONTGOMERY MINE.

Operated by the Wilson Coal Company of Montgomery, Ind. This mine is operated by a shaft. The coal is four feet in thickness.

MUTUAL MINE.

Operated by the Mutual Mining Company, of Cannelburg, Ind. This mine is operated by a shaft. The coal mined in this mine is cannel and bituminous cannel, three and three and one-half feet in thickness. The bituminous is one and one-half feet in thickness.

WHITE RIVER VALLEY MINE.

Owned by S. Rogers, of Washington, Ind. This mine has not been in operation for some time.

GREENE COUNTY.

ISLAND MINE No. 2.

Owned by the Island Coal Company, at Linton, Ind. Island Mine No. 2 is one of the largest mines in the State. It is a machine mine, equipped with all the latest improved machinery for mining and handling coal. The Harrison machine is used in the mine. The coal is excellent steam and domestic coal. The mine is operated by a shaft ninety-five feet in depth. The coal is five feet in thickness.

SUMMIT MINE.

Located one and one-half miles west of Linton, Ind., and owned by the Summit Coal and Mining Company, of Dugger, Ind. This mine was inspected November 7. As the doors conducting the air were in bad condition, I ordered the management to repair them, which was done at once.

BUCKEYE MINE.

Operated by the Linton Coal and Mining Company, of Linton., Ind. This mine is located southwest of Linton, and is operated by a shaft. The coal is five feet in thickness, of a good quality for steam or domestic purposes.

ISLAND VALLEY MINE.

Operated by the Island Valley Coal Company, of Linton, Ind. This mine is located two miles southeast of Linton, on the branch of the I. & V. R. R. The mine is very complete, and produces an excellent quality of coal for steam and domestic use. This mine is operated by a shaft.

SULLIVAN COUNTY.

DUGGER MINE.

Operated by the Dugger and Neal Coal Company, of Dugger, Ind. This mine is operated by a shaft. The worked coal is five feet in thickness. When inspected one hundred and forty-two men were at work.

DUGGER CO-OPERATIVE MINE.

Operated by the J. Freeman Coal and Mining Company, of Dugger, Ind. This is a new mine and is operated by a shaft.

LYONTON MINE.

Operated by the Lyonton Coal Company, of Lyonton, Ind. This mine is worked on a small scale. It was inspected on December 13. This mine is operated by a shaft forty-five feet in depth. The coal is five feet in thickness.

SULLIVAN COUNTY.

BUNKER HILL MINE.

Operated by Hancock & Conkle, of Farnsworth, Ind. Bunker Hill Mine is operated by shaft, seventy-two feet in depth. The coal mined is four feet in thickness. Lately the mine has been repaired, and is now in good condition.

SHELburn MINE.

Operated by the Shelburn Coal Company, of Shelburn, Ind. The mine is operated by shaft, two hundred and forty feet in depth. The coal is five and one-half feet in thickness.

CURRYVILLE MINE.

Operated by the Curryville Coal and Coke Company, of Shelburn, Ind. This mine is operated by a shaft, two hundred and forty feet in depth. It was inspected on the 8th of December and found in bad condition. Many changes were ordered made.

OLD PITTSBURG MINE.

Operated by the Old Pittsburg Coal Company, of Hymera, Ind. The mine is operated by shaft, fifty feet in depth. The coal is five and one-half feet in thickness. The coal is mined by electric machines, and is hauled to the bottom of the shaft by electric motors.

LITTLE PITTSBURG MINE.

Operated by Starks & Son, of Hymera. It is worked by a shaft. The coal is hoisted out of the shaft by horse-power. The mine is worked on a small scale.

NEW PITTSBURG MINE.

Operated by the New Pittsburg Coal and Coke Company, of Alum Cave, Ind. The mine, located in the northeastern part of Sullivan County, is among the largest in the State. The coal is from six to eight feet in thickness, and is mined by machinery.

JACKSON HILL MINE.

Operated by the Jackson Hill Coal and Coke Company, at Eagle, Ind. This mine is operated by a shaft. The coal is five feet in thickness. The mine is located in the northeastern part of Sullivan County, and is a machine mine.

SMALL MINES.

SULLIVAN COUNTY.

Number of mines employing less than ten men in Sullivan County, 8; number of men in the eight mines, 27.

GREENE COUNTY.

Number of mines employing less than ten men, 4; number of men employed, 11.

DAVISS COUNTY.

Number of mines employing less than ten men, 5; number of men, 16.

KNOX COUNTY.

Number of mines employing less than ten men, 2; number of men, 5.

PIKE COUNTY.

Number of mines employing less than ten men, 9; number of men employed, 17.

DUBOIS COUNTY.

Number of mines employing less than ten men, 4; men employed, 9.

WARRICK COUNTY.

Number of mines employing less than ten men, 3; men employed, 7.

SPENCER COUNTY.

Number of mines employing less than ten men, 7; men employed, 15.

PERRY COUNTY.

Number of mines employing less than ten men, 9; number of men employed, 24.

NON-FATAL ACCIDENTS.

Patrick O'Maley, leg broken by fall of slate in Prospect Hill Mine, November 18, 1893. Prospect Hill Mine is located at Vincennes, Knox County.

William Bewger had a finger taken off while riding on the cars in Sunnyside Mine, December 29, 1893, at Evansville, Vanderburgh County.

William Gray and George Williams, both slightly injured by blast at Evansville, Vanderburgh County.

James Skull, slightly injured on the 9th of October, 1893, by a fall of slate in the Jackson Hill Mine, Sullivan County.

Ora Huff, slightly injured on the 16th of November, 1893, by blast at the Lyonton Mine, Sullivan County.

John Bredeway, leg broken by a fall of coal in Island City Mine No. 2 on the 2d of December, 1893, in Greene County.

Joseph Easley was slightly injured by a fall of slate in Cable No. 4 Mine, December 23, 1893, near Washington, Daviess County.

Jesse Gibner was injured in the Buckeye Mine, October, 1893, by a fall of slate at Cannelburg, Daviess County.

The total number of mines employing more than ten persons each, and reporting to this office, for the quarter ending December 31, 1893, I find as follows:

Sullivan County	10
Greene County	4
Daviess County	8
Knox County	2
Pike County	2
Gibson County	2
Vanderburgh County	6
Warrick County	4
Spencer County	1
Perry County	2

Total number of such mines reporting for the above quarter . 41

There will be eleven new mines to add to the above number in the next report.

REPORT OF STATE SUPERVISOR OF OILS.

INDIANAPOLIS, IND., January 1, 1894.

To HON. S. S. GORBY,

State Geologist of Indiana:

SIR—In accordance with the statutes providing for the appointment of a State Supervisor of Oil Inspection and Deputy Supervisors of Mineral Oils and other substances, and to regulate the sale of the same for illuminating purposes, I herewith submit my third annual report for the inspection of illuminating oils, for the period commencing November 1, 1892, and including October 31, 1893.

N. J. HYDE,

State Supervisor of Oil Inspection.

REPORT OF STATE SUPERVISORS OF OILS.

The total number of barrels of oil inspected from November 1, 1892, to and including October 31, 1893, amounted to two hundred and forty-five thousand five hundred and thirty-four (245,534). Of this number two hundred and forty-four thousand six hundred and fifty-two (244,652) barrels were approved, and eight hundred and eighty-two (882) were rejected. After deducting the number of barrels rejected there remained two hundred and forty-four thousand six hundred and fifty-two (244,652) for consumption in Indiana, showing an increase of over ten thousand (10,000) barrels over the preceding year, and a decrease of more than twelve hundred (1,200) barrels of rejected oil, which speaks well for the vigilance and efficiency of the Supervisors.

The following tables will show the number of barrels approved, number rejected, with total number of barrels inspected during the year; as well as the inspection by months, by stations, and place of manufacture; together with other information pertaining to the inspections, etc. :

TABLE SHOWING NUMBER BARRELS APPROVED AND REJECTED.

Number of barrels approved	244,652	
Number of barrels rejected	882	
Total number of barrels inspected for year		245,534

TOTAL INSPECTIONS BY MONTHS.

	<i>Approved.</i>	<i>Rejected.</i>	<i>Total.</i>
November	26,667	430	27,097
December	34,667	92	34,759
January	27,849	120	27,969
February	25,350	240	25,590
March	20,753	. . .	20,753
April	17,379	. . .	17,379
May	13,893	. . .	13,893
June	10,469	. . .	10,469
July	9,771	. . .	9,771
August	12,656	. . .	12,656
September	19,361	. . .	19,361
October	25,837	. . .	25,837
Total	244,652	882	245,534

NUMBER BARRELS INSPECTED BY STATIONS.

	<i>Approved.</i>	<i>Rejected.</i>	<i>Total.</i>
Evansville.	18,594	360	18,954
Vincennes.	8,269	. . .	8,269
New Albany.	11,374	. . .	11,374
Jeffersonville	1,600	. . .	1,600
Madison.	2,758	. . .	2,758
Aurora	2,205	. . .	2,205
Greensburg	495	. . .	495
Columbus	1,887	. . .	1,887
Muncie	2,920	. . .	2,920
Richmond.	5,850	. . .	5,850
Indianapolis.	65,608	522	66,130
Crawfordsville.	3,411	. . .	3,411
Terre Haute.	8,996	. . .	8,996
Lafayette	12,970	. . .	12,970
Kokomo	1,610	. . .	1,610
Logansport	10,161	. . .	10,161
Rochester	915	. . .	915
Whiting	5,233	. . .	5,233
Delphi	230	. . .	230
Valparaiso	1,239	. . .	1,239
Hammond.	3,106	. . .	3,106
Peru	5,517	. . .	5,517
Marion	4,023	. . .	4,023
Huntington	2,214	. . .	2,214
Fort Wayne	14,158	. . .	14,158
South Bend	8,180	. . .	8,180
Goshen	2,572	. . .	2,572
Michigan City	2,258	. . .	2,258
Elkhart.	9,880	. . .	9,880
Laporte.	2,339	. . .	2,339
Cincinnati.	7,518	. . .	7,518
Mansfield	3,672	. . .	3,672
Lima	8,315	. . .	8,315
Toledo	1,524	. . .	1,524
Cleveland.	3,051	. . .	3,051
Total	244,652	882	245,534

TABLE SHOWING PLACE OF MANUFACTURE AND NUMBER OF BARRELS.

Whiting, Ind	65,365
Cleveland, Ohio	22,717
Lima, Ohio	123,395
Findlay, Ohio	2,183
Cincinnati, Ohio	670
Marietta, Ohio	420
Toledo, Ohio	4,034
Oil City, Pa	9,017
Pittsburgh, Pa	7,272
Bear Creek, Pa	2,640
Franklin, Pa	610
Freedom, Pa	2,051
Titusville, Pa	310
Rossville, Pa	193
Reno, Pa	845
Washington, Pa	758
Carrapolis, Pa	126
Allegheny, Pa	449
Bradford, Pa	262
St. Louis, Mo	92
Parkersburgh, W. Va	2,125
Total	245,534
Indiana	65,365
Ohio	153,419
Pennsylvania	24,533
West Virginia	2,125
Missouri	92
Total	245,534

A careful enforcement of the law by a corps of competent deputies again enables a report of immunity from loss of life or property. Occasionally you will see in the papers reports of lamp explosions, but, upon investigating the matter, that investigation proves it to be caused by gross negligence or carelessness. It does not seem as if any legal restrictions would prevent such accidents, until people learn by experience to be more careful in handling and filling their lamps, keeping them clean, and stop using oil to light their fires with.

As to the general working of the law, it is gratifying to be able to report that there have been no deliberate and intended violations of it. The country merchants in some portions of the State have bought oil from manufacturers and attempted to sell the same without first having it inspected. In every instance the offenders have invariably pleaded ignorance of the law, and upon a thorough investigation of the case, I have

requested the deputies to allow it to weigh in mitigation, where there was no reasonable doubt of their sincerity. It has been my chief object to secure the fullest compliance with the law by all persons interested either in the sale or use of all illuminating oils, with as little litigation as possible. I have been led to adopt this policy by early learning that in almost all cases of attempted violations of the law, the offenders were imposed upon by representatives of manufactories and jobbers, who, so long as they sold their oil, cared nothing for the consequences to the unsuspecting merchant. The usual form of deception is to assure the merchant that they sold nothing but strictly Indiana Legal Test Oil, leaving him to assume that the oil would, in all respects, come within the legal requirements of the State law; and in most cases the merchant, having never read or heard of the inspection law, would proceed to sell the oil without hesitation, and in good faith, when, in fact, the oil had never been inspected or branded by an Indiana inspector, and was, in no wise, legal oil. To prevent, as much as possible, the further continuance of such acts upon the part of unscrupulous dealers, I have had printed ten thousand (10,000) of the following circulars and mailed them to all merchants that handle petroleum oils, with the belief that it would be the means of placing such merchants on their guard against such dealers, as well as instructing them in regard to portions of the law pertaining to their business.

NOTICE.

To Dealers in Petroleum Oils:

Having been appointed State Supervisor of Oil Inspection for Indiana, I wish to call your attention to the following sections of law pertaining to the trade:

SEC. 5155. SELLING UNINSPECTED OIL. If any person or persons, or agent for any person, shall sell, or attempt to sell, to any person in this State any such oils, to be consumed within this State for illuminating purposes, whether manufactured in this State or not, before having the same inspected as provided in this act, he shall be deemed guilty of a misdemeanor, and shall be subject to a penalty, and, upon conviction thereof, shall be fined in any sum not less than fifty nor more than three hundred dollars, or be imprisoned in the county jail not exceeding six months, or both, at the discretion of the Court.

SEC. 5157. SELLING EMPTY BRANDED BARRELS. Any person or persons selling, or in any way disposing of, an empty, or partly empty, barrel, cask, or package which has been branded by the Inspector or Deputy Inspector, before thoroughly cancelling, removing and effacing the inspection brand on the same, shall be guilty of a misdemeanor, and, upon conviction, shall be fined, for each offense, the sum of fifty dollars, and be imprisoned in the county jail for any period not more than sixty days.

SEC. 5158. INJURY FROM UNINSPECTED OIL. Any person or persons who shall sell, or keep for sale, to be consumed within this State for illuminating or combusive purposes, any oil or oils whatever, not duly inspected and approved, according to the provisions of this act, shall be liable in damages to the amount

of any injury resulting from the use of such oil or oils to the person or persons injured in person or property; and such damages may be recovered by proceedings in the several Circuit Courts of this State, the same as damages may be recovered in other civil cases.

It shall be the duty of the inspector who shall know of the violation of any of the provisions of this act, to enter complaint before any Court of competent jurisdiction against any person so offending.

SEC. 5162. FALSE BRANDING. Any person, not a duly authorized Inspector or Deputy Inspector, who shall brand with an Inspector's brand any barrel, cask or package, or other vessel containing oil for illuminating or combusive purposes, or any person who shall fill, or cause to be filled for use, any package, cask, barrel or other vessel having an Inspector's brand thereon, without first having the oil inspected and approved as this act provides, shall be deemed guilty of a misdemeanor, and, upon conviction, shall be fined in any sum not less than forty dollars nor more than three hundred dollars.

The law must be enforced impartially and honestly, without fear or favor.

Acting upon instructions received from you last March to this department, requesting me to make an exhibit of the petroleum products gathered from the Indiana oil fields, I at once set to work to carry out said instructions to the best of my ability with the limited time at my disposal and the small space allotted for this exhibit by the managers of the Mines and Mining Department of the World's Columbian Exposition at Chicago. And I take pleasure in reporting the said exhibit as being favorably received by the managers and awards made favorable to said exhibit. Fifty samples of oil were shown in quart jars arranged in a pyramid, the whole surmounted by a five-gallon jar of paraffine wax. The samples of crude oil were obtained from different sections of the State, as follows: Vigo, Jay, Blackford, Wells, Huntington, Grant, Howard, Randolph and Pulaski Counties.

After reserving a portion of the crude oil, I caused the rest to be refined into different samples of lubricating and illuminating oils, which refining was done by the Standard Oil Company, at Whiting, Ind., the largest refinery in the world, and I wish to herewith extend my thanks to Mr. J. A. Moffette, Vice-President of the Standard Oil Company, and Mr. G. P. France, superintendent of the works at Whiting, for their kindness in assisting me in making the exhibit. Below will be found a table and complete description of the exhibit.

14 samples labeled	Indiana crude.
2 samples labeled	Crude distillate.
2 samples labeled	Crude naptha.
2 samples labeled	Refined oil distillate.
2 samples labeled	Refined naptha distillate.
2 samples labeled	300° fire test distillate.
1 sample labeled.	Stove naptha.
1 sample labeled.	Oleum spirits.
1 sample labeled.	Eldorado engine.
1 sample labeled.	Eldorado castor.

1 sample labeled.	30° cold test engine oil.
1 sample labeled.	Atlantic red oil.
1 sample labeled.	Zone paraffine oil.
1 sample labeled.	Diamond paraffine oil.
1 sample labeled.	Straw paraffine oil.
1 sample labeled.	Renown engine oil.
1 sample labeled.	Filtered cylinder oil.
1 sample labeled.	Red neutral oil.
1 sample labeled.	White neutral oil.
1 sample labeled.	Capital cylinder oil.
1 sample labeled.	Zero cold test black oil.
1 sample labeled.	Summer cold test black oil.
1 sample labeled.	Crude paraffine wax.
1 sample labeled.	Railroad signal oil.
1 sample labeled.	Eocene.
1 sample labeled.	Water white Indiana test.
1 sample labeled.	Water white California test.
1 sample labeled.	Standard white Indiana test.
1 sample labeled.	Standard white 112° test.
1 sample labeled.	Headlight 175° test.
1 sample labeled.	Indiana legal test.

All of which was carefully packed and shipped to destination, and placed in proper position, to so remain until the final close of the Exposition, after which they will be shipped to the State Museum of the Geological Department of Indiana, and left as an exhibit of Indiana's oil product.

As Indiana is now coming to the front very fast as an oil producing State a few facts at this time may be of great interest to the general public. By referring back to the table showing place of manufacture, you will find that sixty-five thousand three hundred and sixty-five (65,365) barrels of illuminating oil were used in this State alone, manufactured from Indiana crude; not including gasoline, lubricating oils or other products, which, no doubt, will more than double the illuminating oils in number of barrels shipped into all sections of the State. But this is only a small portion of Indiana's product that is being refined. It is shipped in large quantities to the southwestern and western States, and wherever it is being used, I am reliably informed, is giving universal satisfaction; and I know that in this State no other oils show any better qualities than that manufactured from Indiana crude. During the beginning of the year 1893 one of the daily papers of this city sent a correspondent over the entire oil producing section of this State, who made a very complete and exhaustive report, which was afterwards published, creating a great deal of favorable comment and surprise, as very few persons had any idea of the vast amount of wealth concealed under Indiana's soil, and causing hundreds of people to flock to the oil fields to see and investigate its truthfulness. While at the present time the oil

industry is only in its infancy, it is the general opinion of those best informed that Indiana will soon be in the foremost rank in point of production. Following are a few statistics, which up to the present time are, I am reliably informed, correct. Up to January 1, 1893, there were one hundred and fifty-one (151) producing wells in this State. During the year 1893 there were completed six hundred and fifty-seven (657) wells; of this number fifty-six (56) were dry wells, and seventy (70) wells were abandoned during the year, leaving six hundred and eighty-two (682) producing wells at the end of the year, December 31, 1893, while there were at the close of the year forty-three wells being drilled. The total output of the six hundred and eighty-two (682) wells was two millions three hundred and thirty-five thousand, two hundred and eighty-eight (2,335,288) barrels, which is all refined in this State. Of the six hundred and eighty-two (682) wells about two hundred and twenty-five (225) are flowing wells, and the balance, four hundred and fifty-seven (457), are being pumped.

There is an average of five men employed on each drilling well during the time it is being sunk. As it requires labor that is skilled in such work the wages paid are from three (3) to four (4) dollars per day. After completion a well is usually operated by one man, commonly called a pumper. However, two men are frequently required to run one pumping well, but often one man will run two flowing wells, so the average is about one pumper to each well. Fifty dollars (\$50) per month is the usual salary paid pumpers. The pipe line companies employ on the average about one hundred (100) men, who receive a salary of from fifty (50) to ninety (90) dollars per month, which does not include the superintendents and other officers of the company.

One can hardly conceive the vast amount of money and labor it takes to handle this product of Indiana's oil fields when you consider the refineries, storage tanks, pumping stations, pipe lines, tank cars, cooper shops for the manufacturing of the barrels, boxes and such necessary things as are required for the handling of this product, but all must concede that a very valuable industry has been added to the manufacturing interests of the State as a result of the oil discoveries. The wells mentioned and included in this report are distributed through the counties of Jay, Wells, Adams, Blackford and Grant. While other portions of the State have shown indications that oil may be found, the above mentioned counties have shown the greatest yield up to the present time, and comprise what is commonly called the oil fields of the State.

Below I give a recapitulation of the number of wells, location and daily average production for 1893.

Number of producing wells Jan. 1, 1893	151	
Number completed during year 1893.	657	
Total		808
Number of dry wells	56	
Number of wells abandoned during 1893.	70	
Total		126
Leaving number of producing wells Jan. 1, 1894		682

Divided as follows:

Jay County	279
Wells County	270
Blackford County	45
Adams County.	85
Grant County . . . . .	.3
Making a total of	682

Wells now in use:

Number of flowing wells	225
Number of pumping wells	457
Total	682

Daily average production by months for the year 1893, is as follows:

Months.	Bbls. per Day.
January.	3,607.24
February	3,429.48
March	4,340.29
April	4,883.10
May	6,030.28
June	6,987.21
July	7,150.53
August	8,011.40
September.	8,187.15
October	8,147.35
November.	8,186.89
December	7,614.13

Making a total output from these wells of 2,335,288 barrels for the year 1893.

Showing the number of wells completed for oil during the year by months:

MONTH.	Wells Completed.	New Production Bbls.	Dry Wells.	Drilling.	Rigs Up.	Abandoned Wells.
January	20	1,206	7	23	13	4
February	30	911	10	19	15	..
March	28	2,805	7	24	15	9
April	40	5,600	9	17	14	4
May	52	2,925	17	24	22	4
June	53	5,060	7	44	28	..
July	62	3,550	11	39	38	6
August	62	3,790	12	50	42	..
September	77	3,620	17	54	35	3
October	81	3,000	14	67	44	4
November	83	2,395	19	62	47	11
December	83	2,318	12	67	51	6
In Grant County	4	..	4	..	..	..

WELLS COMPLETED IN JAY COUNTY, IND., IN 1893, BY MONTHS.

MONTH.	Wells Completed.	New Production Bbls.	Dry Wells.	Drilling.	Rigs Up.
January	5	525	2	14	12
February	14	620	2	7	9
March	14	1,770	3	15	9
April	23	4,600	5	10	9
May	31	1,750	10	11	10
June	24	2,960	5	44	28
July	22	2,150	3	26	20
August	30	2,250	5	31	23
September	45	2,390	11	30	10
October	28	850	8	12	5
November	13	320	4	10	5
December	8	95	5	11	11

WELLS COMPLETED IN WELLS COUNTY, IND., IN 1893, BY MONTHS.

MONTH.	Completed Wells.	New Production - Barrels.	Dry Wells.	Drilling.	Rigs Up.
January	8	605	..	5	2
February	7	176	2	8	1
March	10	1,000	2	6	4
April	9	680	..	4	4
May	13	865	3	18	10
June	19	1,490	..	16	8
July	17	1,010	2	6	8
August	18	830	3	8	12
September	15	320	2	12	10
October	32	1,235	4	38	24
November	52	1,500	10	34	34
December	54	1,583	5	41	29

WELLS COMPLETED IN ADAMS COUNTY, INDIANA, IN 1893, BY MONTHS.

MONTH.	Com- pleted Wells.	New Pro- d'ction Bbls.	Dry Wells.	Drill- ing.	Rigs Up.
January.	7	70	5	5	5
February.	7	115	4	4	5
March.	3	30	2	3	2
April.	5	320	1	3	1
May.	8	310	4	5	2
June.	10	610	2	6	5
July.	12	390	5	3	2
August.	7	390	1	4	5
September.	9	300	2	5	6
October.	9	465	1	9	4
November.	7	240	2	6	3
December.	11	395	1	8	7

WELLS COMPLETED IN BLACKFORD COUNTY, INDIANA, IN 1893, BY MONTHS.

MONTH.	Com- pleted Wells.	New Pro- d'ction Bbls.	Dry Wells.	Drill- ings.	Rigs Up.
January.	2	.....	2	2	.....
February.	1	5	.....	.....	.....
March.	3	.....	3	.....	.....
April.	.....	.....	.....	.....	.....
May.	.....	.....	.....	2	4
June.	1	.....	1	4	8
July.	7	320	1	6	3
August.	8	320	2	7	9
September.	12	450	1	8	6
October.	11	335	2	12	5
November.	10	245	1	7	4
December.	.....	.....	.....	.....	.....

The probabilities are that a greater number of wells will be drilled during the ensuing year than have been sunk altogether in the past, and I hope to be able to make in my next report a complete account of every-thing pertaining to this industry.

In conclusion, it affords me great pleasure to repeat that I have every reason to believe that the law is being enforced impartially and honestly. There have been no deliberate violations of the law, and I am gratified to know that the law is accomplishing all that was intended by its enactment, and the consumer is more than compensated by its existence and enforcement in the saving of life and property.

To my deputies I extend an expression of my sense of appreciation of their efficiency and willingness at all times to aid and assist me in enforcing the law.

Respectfully submitted,

N. J. HYDE,

State Supervisor of Oil Inspection.

REPORT OF STATE SUPERVISOR OF NATURAL GAS.

OFFICE OF SUPERVISOR OF NATURAL GAS, }
INDIANAPOLIS, IND , January 1, 1894. }

To HON. S. S. GORBY,
State Geologist, Indianapolis, Ind.:

SIR—In accordance with the laws of the State of Indiana, relating to the supervision of natural gas and the inspection of gas wells and gas plants, I have the honor to submit to you the following report on the conditions of the gas fields of the State, and the transactions of this department for the year 1893.

In the inspection of plants furnishing gas to private consumers, I have, in most instances, found the machinery in a fair to good condition and comparatively safe. But few accidents have occurred, and these resulted from defective house plumbing and were not the fault of the machinery of the plant.

The owners and managers of gas plants have met me in a fair spirit, and directions that have been given for repairs and improvements, in order to throw additional safe-guards around the consumer, have been cheerfully and readily followed. The men who have direct charge of the plants are becoming more competent by experience, and the most of them are beginning to appreciate the dangerous character of the powerful agent under their control.

A great deal of reckless and unnecessary waste of gas is yet practiced in some parts of the field, which I have been unable to stop, for the reason that the local officers who are charged with the prosecution of the laws neglect or refuse to act. Public sentiment in those localities is of such a character as to render it impossible to enforce any law looking to the preservation of this fuel.

The laws regulating the tubing and packing of wells and the plugging of abandoned wells are very generally obeyed.

In the large oil field that is being developed in the counties of Blackford, Jay, Wells and Grant, I regret to say that a great waste of gas is practiced. The methods used for obtaining oil are such that it is practically impossible to prevent waste of gas. It would be a fortunate

thing if some method could be devised whereby the production of oil, or gas either, could be had without destruction to the other products. With the present method the production of oil is bound to destroy the gas field. Another great waste of gas is practiced by the domestic consumers. The devices for burning, which are in use, are such that at least fifty per cent. more gas is consumed than is necessary. The present method of selling gas by the month, instead of by measure, is responsible for the continuation of this waste. I would recommend that a law be passed compelling all gas to be sold by meter measurements.

In the prosecution of my work I have everywhere met with kind and courteous treatment, and every assistance possible has been rendered me. I take this method of tendering my sincere thanks for the same.

Respectfully,

E. T. J. JORDAN,

Supervisor of Natural Gas.

AREA OF THE GAS FIELD.

While natural gas has been prospected for by the drilling of wells in nearly every county in the State of Indiana, yet outside of the areas mapped out and published with former reports from this department, no developments have been made of any scientific or commercial importance. The boundaries of the "belt," as it is called, have been very clearly defined. No discoveries have been made that would necessitate any change. Therefore the maps that accompany this report may be relied upon as accurate. Vast sums of money have been expended within this State in prospecting for this fuel, without any returns. Much of this could have been saved if the prospectors had understood the conditions necessary for the production of natural gas. These conditions have been fully set forth in former reports from this office, and are worthy the careful study of all who are interested in the production of this fuel. It would be a superfluity to repeat them here.

The perpetuation of the natural gas fields is a question of vital interest to Indiana, as this State has been benefited to the extent of millions of dollars within the past few years by the discovery of this valuable fuel.

THE HISTORY OF GAS.

The history of natural gas fields shows that they are of but temporary duration. Indeed, it is but natural that the accumulations of centuries should be exhausted in time by the constant and immense drains to which all the fields have been subjected. Nature can not manufacture it as fast as it is being consumed, and the natural flow of the wells must soon become exhausted. Gas in the great fields of Pennsylvania and Ohio is a thing of the past, if the natural flow of the wells is to be relied upon for the supply. Matters are in a distressing condition in those States, and especially in northwestern Ohio, as all the towns are left burdened with debt, and with no other resources at their command. Their era of prosperity is at an end, so far as it depended upon natural gas. In many of these towns, as a natural result of the criminal waste of nature's most valuable fuel and the unnatural business excitement and wild speculation that obtained for years, it may be truthfully said that "their last days shall be worse than their first." It remains to be seen whether the same disastrous conditions will mark the end of natural gas in Indiana.

About the time that natural gas began to fail in Ohio and Pennsylvania, the great fields of Indiana were discovered, and their vast extent, as well as the apparent stability of the supply of the wells, seemed to warrant the belief that at last a permanent supply had been found. As a result of this discovery and the failure of the Ohio fields, the factories accepted the offer of the cities and towns in the Indiana gas field and removed their plants to this State. The loss of these factories to north-western Ohio caused a terrible panic and collapse throughout that gas belt, and fortunes sank from sight as values declined to their normal condition. Over \$300,000,000 has been invested in this State in manufactories, and others are now being erected throughout the gas belt. Pipe lines were run to the gas field from Chicago, and from many of the principal cities and towns in the State, and every effort has been made to control as much of the territory as possible. Slowly the ends of these pipe lines have been converging to a given point until now but little of the gas territory remains to be developed. There is no question but the time will eventually come, although a long way off as yet, on account of the vast extent of the fields, when every inch of Indiana gas territory will have been developed, and then the supply will rapidly diminish.

THE FAILURE HAS BEGUN.

Indeed the failure has already begun. Already wells are being abandoned every month, and the rock pressure in many parts of the field is rapidly diminishing. The average field pressure has slowly but surely fallen off, and now stands reduced from 320 pounds, original pressure, to 240 pounds average pressure over the field.

To preserve a full supply of fuel gas to their patrons the different companies and the manufactories have been obliged every year to reach out to remoter fields, drilling many new wells and extending great pipe line plants at very heavy cost.

The limit of extension is nearly reached. Many wells are wet; nearly all show moisture when heavily drawn upon, and must be held back or risk the danger of being flooded out.

At the rate of pressure reduction that is now going on, and by a continuance of the present extravagant and wasteful method of consumption it is only a question of a very short time when artificial pressure will have to be used to force the gas through the pipe lines. The use of pumps for artificial pressure is fraught with most serious risk of reducing the gas pressure below the water pressure, and so destroy the wells.

The question of perpetuating or husbanding the supply of the field becomes a vital one. Indiana has the largest and best gas field ever discovered, and as no new fields are in prospect, it seems that these are the last fields that will ever be brought into requisition for manufacturing purposes.

With these gloomy conditions of the supply staring us in the face, we should awake to a realization of the fact that natural gas is a temporary blessing. It is the plain duty of every good citizen to cooperate to the fullest extent to preserve the supply of gas so long as it is possible to do so. It is the plain duty of managers of companies, or those engaged in furnishing supplies of this fuel, to sound the note of alarm, and to point out the way by which the flow of gas can be prolonged, and this great source of comfort and convenience continued over the longest possible period. A system of the strictest economy should be enforced and the remainder of the precious fluid should be distributed to the consumers as ordered by special acts of the Legislature.

AN ERA OF PROSPERITY.

Immediately upon the discovery of natural gas in Indiana an era of prosperity began that has been unparalleled. Immense manufacturing establishments were located, and, in time, when these were started and their fires, fed by Nature's best fuel, started, great train loads of their products were sent out from the gas belt every day. Villages became prosperous towns, and towns grew in a few months into thriving cities, and lots were sold at high prices many miles from their centers. Much wild speculation has prevailed. A great deal of unnatural and unhealthy excitement in business has marked the history of some of these towns since the discovery of this fuel. However this has not been carried to that extent that it was in the towns of Ohio. The business men in these towns, profiting by the fate of the towns in the State above mentioned, have been more conservative. One of the worst features of the excitement that prevailed, was the belief in the ideas that natural gas was to be perpetual. This belief fostered extravagance and waste. It can be shown from facts obtained and recorded in this department that the waste of gas, during the first four years after its discovery in the fields of Indiana, amounted to more than twenty millions of dollars. And this estimate, too, is made on the extremely low prices at which gas has been sold throughout the State.

This condition of affairs continued, as I say, for four years before the people, who were vitally interested, were willing to admit the fact that natural gas was failing, and failing rapidly, too. The pressure began to go down in all the principal centers, and, in fact, nearly all over the field. The supply in many places began to fall short, and there was much suffering during the hard winter of 1892-3. A great many factories, in the towns deriving their supplies from this gas field, were shut off from the lines and asked to burn coal.

These stern conditions have at last aroused the people to view the situation in its true light. Much of the extravagance and waste has been stopped. Men are seeking to find out the best means for husbanding

what remains of this valuable fuel. Some wholesome laws were passed by the Legislature for the preservation of gas. In regard to these laws, I regret to say that in some localities they have not been enforced as rigidly as they should be, and the fault has been with the local officers charged with enforcing the laws. Many of these officers are aspirants, and are afraid of their popularity.

One of the wastes of gas that still prevails is in the domestic consumptions. With the appliances for burning gas, that are almost universally used, at least 50 per cent. more gas is used than is necessary to produce the required amount of heat.

CUBIC FEET OF GAS BURNED IN ONE HOUR.

The following table is given to show the amount of gas that is consumed through different sized mixers, and at different pressures. The tests which produced these results were made with a Westinghouse meter, and may be relied upon as correct:

This table was given in my last report, and published in the eighteenth Geological Report of Indiana, but by a mistake of the printer, an error was made which rendered it valueless.

SIZE OF MIXER.

PRESSURE.	No. 3— $\frac{3}{8}$ -inch.	No. 5— $\frac{3}{8}$ -inch.	No. 7— $\frac{3}{8}$ -inch.	No. 9— $\frac{3}{8}$ -inch.	
$\frac{3}{8}$ -pounds. . .	36 cu. ft.	66 cu. ft.	96 cu. ft.	156 cu. ft.	The fractions of an inch given in the size of the mixers denote the diameters of the orifice through which the gas passes at the point of admixture with the air.
$\frac{4}{8}$ " . . .	41 " "	76 " "	108 " "	164 " "	
$\frac{5}{8}$ " . . .	45 " "	84 " "	116 " "	178 " "	
$\frac{6}{8}$ " . . .	48 " "	96 " "	134 " "	196 " "	
$\frac{7}{8}$ " . . .	55 " "	100 " "	144 " "	208 " "	
" . . .	60 " "	108 " "	156 " "	228 " "	
" . . .	64 " "	114 " "	168 " "	240 " "	
" . . .	68 " "	120 " "	179 " "	256 " "	
" . . .					
" . . .					

It will be seen from the above table that the greater the pressure in a mixer, the greater number of cubic feet of gas is consumed with only a fixed amount of air. Natural gas, like any other fuel, requires a certain amount of air, in order to have a perfect combustion. It follows, then, that the higher the pressure the greater the amount of gas that passes through the mixer and the more imperfect is the combustion. With the imperfect appliances now in use, the greatest amount of heat is not obtained. This is not only wasteful, but it is dangerous from the fact that this half burned gas is liable to escape into houses and cause suffocation or explosion.

With the mixers now in general use, a pressure of from six to ten ounces in the low pressure mains, will furnish as much, if not more gas, than can be perfectly consumed. Under the conditions existing in most, if not all, of the towns and smaller cities of the Indiana gas field, a pressure of from one to five pounds is carried.

IMPROVED MIXERS AND BURNERS.

On this branch of the subject I am willing to risk criticism by repeating what I have said in my former reports. Too much can not be said on this question. All who are interested in the perpetuity of this fuel should be taught to know what extravagances and waste are being practiced and the causes. Consumers have been slow to adopt improved mixers and burners. In many of the towns the gas plants are not arranged for the proper and equal distribution of the gas. Improved appliances and devices cost money, and so long as the present method of paying for the gas by the month or year is permitted, just so long will the present waste continue.

The remedy is to compel, by legislation if necessary, consumers to pay for the gas used by meter measurement. When this method shall become the rule, consumers will find it to their interest to adopt the improved methods for burning this fuel, and will economize its use in every way possible. Until this is done I can see but little hope for economy in the consumption of this precious fuel. The waste will continue, and the end will be correspondingly hastened. The supply of gas is certainly failing. It may not be possible to tell just how long it will last, but the final exhaustion is inevitable. The period of exhaustion has been entered upon in the Indiana field, and the end is close at hand. The theory of the generation of this fluid in commercial quantities is not now believed or advocated by any person who has studied the conditions as they exist. Indeed, it is more than probable that this generation ceased many ages ago. There is a given amount stored within the areas of the gas-bearing rocks. This storehouse is tapped in Indiana by many hundreds of wells, and millions of cubic feet are drawn out every day. As the gas is withdrawn water or oil comes in and takes its place. Turn whichever way we may in our explorations and theorizing, the fact of the final exhaustion of this fuel stares us in the face.

THE INITIAL PRESSURE.

The following is the pressure found in named localities during the year 1893. At many of the places, however, the pressure given was only obtained from new wells at a distance of from two to four miles from the towns, the wells in the towns and immediate vicinity showing a much less pressure, many wells being practically exhausted:

<i>Town.</i>	<i>County.</i>	<i>Pressure, Pounds.</i>
Greenfield	Hancock	250
Carthage	Rush	120
Noblesville	Hamilton	240
Sheridan	Hamilton	240
Kokomo	Howard	250
Marion	Grant	250
Gas City	Grant	300
Fairmount	Grant	300
Elwood	Madison	300
Frankton	Madison	300
Anderson	Madison	240
Alexander	Madison	300
Summitville	Madison	300
Chesterfield	Madison	290
Muncie	Delaware	240
Albany	Delaware	280
Eaton	Delaware	290
Hartford City	Blackford	260
Montpelier	Blackford	250
Camden	Jay	225
Dunkirk	Jay	275
Greensburg	Decatur	175
Fountaintown	Shelby	210
Waldron	Shelby	225

These pressures were found in the most instances in new wells. In their immediate neighborhood are found older wells showing a much less pressure, some even below 100 pounds.

The wells connected with the pipe lines conveying gas to Indianapolis, Crawfordsville, Frankfort, Lafayette, Logansport, Peru, Wabash, Huntington, Bluffton, Fort Wayne, Decatur, Portland and Shelbyville show pressures from 225 to 260 pounds

The wells and the pipe lines leading to Chicago and Richmond are better, showing 280 and 290 pounds pressure. These companies, in order to keep up the necessary supply of gas, are compelled to drill many new wells each year to take the place of those that have become exhausted. Each year these companies have been compelled to acquire new leases and extend their lines, until there is but very little territory to be obtained. If, in drilling these new wells, the pressure of the original wells could be obtained, there might be some hope of the perpetuity of the gas. But such is not the case. The new wells are coming in with a constantly decreasing pressure, and of necessity will be much shorter lived than the original wells. All this goes to prove that the field is slowly but surely becoming exhausted. This exhaustion will be in an accelerated ratio as we approach the final end.

The gravity of the situation can only be understood when it is known that from 225 to 250 pounds pressure at the head of the main lines is

absolutely necessary to force the gas to the different cities that lie outside, but are obtaining their fuel from the gas field, with sufficient pressure to distribute it through the low pressure city lines to the consumers. And this pressure, too, is needed when all the reducing stations and district valves are wide open and every facility afforded for free circulation.

There remains now but a small average margin above the limit of low pressure. At the annual rate of pressure reduction, and by a continuance of the present extravagant and wasteful method of consumption, this small margin will be spent or exhausted in a very short time. When this shall have happened, artificial pressure by means of pumps will be resorted to for the purpose of distribution. It has been the experience of the gas areas of other States, that when the initial pressure must be supplemented by artificial means, that the end is very near at hand. A careful study of the conditions of the field in Indiana as they exist to-day will show that we have almost reached that point.

What must we do? Are we willing to go back to the use of wood and coal? After having enjoyed the conveniences and luxuries of natural gas for so long a time to do so would be a great hardship. In order to avoid doing so, or at least to put off the evil day as long as possible, consumers should be willing to adopt any method that would preserve this fuel, and perpetuate its use for the longest possible period of time.

THE REMEDY FOR PRESENT EVILS.

In order to do this, I have the following suggestions:

First. All gas should be sold by meter measurements, and this should be enforced by law.

Second. Natural gas should not be used in the manufacture of bricks, tiles, nor in the rolling mills or melting furnaces of glass factories. In these factories a coarser and less valuable fuel can be used.

The highest and best purpose to which natural gas can be applied is the domestic use. It is in this use that it does the greatest good to the greatest number, and it is for this use that it should be preserved.

The present consumption in the domestic use of gas, as I have said, is, without doubt, fully fifty per cent. greater than is actually necessary. This profligate waste of such valuable fuel is inexcusable. Now, if it is possible to check this extravagance, I believe the supply can be made to last several years. There is but one way to stop this reckless and criminal wastefulness, and that is to require each consumer to pay for just what the consumer uses—no more and no less. This can be done only by the use of a meter. Natural gas is a commodity, and a very valuable commodity, and every other commodity in the commercial world is sold by weight or measure. Experience has shown that this is the only just and equitable way of selling natural gas. The price per thousand feet should be approximately the same as charged in cities where conditions

are similar. The following are the net meter rates per thousand feet charged in other cities: Detroit, Piqua, Lima, Dayton, Springfield, Toledo, Buffalo and Columbus, 25 cents; Pittsburgh, Allegheny and Erie, 22½ cents; Jamestown and Corry, 21 $\frac{6}{10}$ cents; Fostoria and Logansport, 20 cents; Indianapolis, Richmond and Fort Wayne, when sold to manufacturers by meter, 10 cents.

When the time comes that consumers will be compelled to pay for what they use, then, and not till then, will economy be practiced. Then it will be that the consumer will provide himself with the most approved appliances for the economical use of this fuel. There is a growing disposition to introduce meters into all the distributing systems of the natural gas companies. When this fuel was first brought into use, the supply was so abundant, that the reckless wastes, of which I have spoken, were tolerated. When it was taught, and generally believed by consumers that the supply was inexhaustible, the necessity for economy was not felt. When it cost the same by the month or year, whether much or little was consumed, there was no inducement to economize.

Under that condition of things the low prices for gas that have since prevailed, and the method of payment was fixed. No inducement was offered to the uses of gas to adopt economical methods. The prices in most places have been merely nominal. The extremely small cost at which this fuel could be procured was one of the causes that led to the reckless extravagance and waste that has been practiced. Whatever costs but little is not apt to be highly valued. Meters are now constructed so as to be adapted to this fuel. The objection that was at first urged against the use of meters, viz.: that the meters were very imperfect, will no longer hold good.

The day has passed away when any nice regard for economy in the use of natural gas is deemed foolish and futile. The warnings that the supply of this precious stock of heat and power is limited and that it is fast becoming exhausted, are so plain that no one can any longer fail to recognize them.

GAS FORMATION HAS CEASED.

I have before stated that it is held by all scientists and others who have given the matter any thought, that gas is not being generated at the present time in any appreciable quantities, and certainly not in quantities sufficient to meet the enormous drain that is being made on the different fields to-day. This being true, the necessity for husbanding the supply in every conceivable way becomes apparent. The highest interest of every consumer is to make the product last as long as possible. Any waste or prodigality in the use of this most valuable fuel becomes at once a crime against the public good. "The greatest good

to the greatest number" should be kept in view in the use and management of this fuel.

By prodigality and mismanagement the final failure of the product has been hastened all too rapidly. This failure can not be overlooked. It is shown by the diminished initial pressure and by the presence of salt water.

An advance in price on the part of all municipal corporations for all the uses they undertake to supply is now the proper policy. The prices at which this fuel has hitherto been furnished has led to the undervaluing and wasting of gas. The supply will do towns more good by serving them longer if they are required to pay a higher price for the gas.

Natural gas is merely a transient phase of the stored power of the earth. It is folly to talk of its taking anything like a permanent place in the work of the world. The claim that it can do so springs only from enthusiasm and is unsupported by the facts. There is in reality but little of it, and this is found in but limited regions and can not last long whenever its utilization is undertaken by the eager and masterful activities of our day.

If proper management of the field by the enforcement of wholesome laws, and if economy in the use of gas is everywhere insisted upon and practiced, that portion of gas that yet remains stored in the Trenton limestone of Indiana may be made to last several years. It is to this end that all should work. It is to the highest interest of every one to prolong the use of this luxury. It is in our power to make the last days of natural gas in Indiana its best days. If, on the other hand, the wasteful practices in consumption shall be maintained, if improper and ruinous management of wells in the field shall still prevail, there is sure to be, and at a no very distant day, an entire failure and a great disappointment. When this day comes our disappointment will be the greater and our regret the more bitter when we realize that our condition is the result of our short sighted management and profligacy.

TO PERPETUATE THE FIELDS.

Now that the final exhaustion of the supply of natural gas is an admitted fact, many persons are directing their attention to the finding of a substitute that shall combine all of its luxury and convenience. Plants for the manufacture of fuel gas have been built in many cities, and are in operation with some degree of success. However, none, as far as I have been able to learn, have succeeded in manufacturing a fuel that is equal to natural gas. The inventive genius of the American people is unlimited, and I predict their success in this direction. Natural gas has been a great object lesson to great communities as to the advantage of gaseous fuel, and it can hardly be that this lesson will be given in vain.

It has prepared the world for something much better than itself. Natural gas has done a very important work.

I may be permitted while on this subject to repeat from a former report from this Department, and say that "the exemption from the soot and dust is inseparable from the burning of bituminous coal in our cities, and the positive addition that gaseous fuel makes to the comfort and convenience of the entire community when used as a domestic fuel and as a source of steam power, are results in themselves too valuable to be abandoned when these small and treacherous stocks of buried power are exhausted. The conversion of the coal now burned in a large city into gas before being used would result in an immense economy in fuel, besides affording the incidental advantages alluded to above, and this economy of stored power is an object to which the civilized world will soon be obliged to address itself in good earnest."

Progress is the order of this age, and no backward step will be taken in the matter of fuel. That portion of the human race that has experienced the comfort and convenience of natural gas will never be content to go back to wood and coal, burned in the old way, as a source of heat and power.

In many of the gas fields, as has been before stated, when the gas is exhausted in the porous rock, oil takes its place. A theory has been advanced by some that the gas fields can be perpetuated by forcing air down the wells into the rock by means of powerful pumps. Some of the cities and towns of northwestern Ohio, I have been informed, are now engaged in very expensive experiments in order to test this theory. The Trenton rock in those fields being oil-bearing, is porous and saturated with oil deposits. It is thought that by forcing the air through this rock it becomes carbonated, and after being thus filtered, returns to the surface of the earth where it is piped and consumed. A large plant to test this theory is being put in at Findlay, Ohio, and its promoters are very sanguine of success.

THE PROCESS EXPLAINED.

A late newspaper, published at Findlay, Ohio, has this to say in explanation of the process: "By the new process the pressure at all times would be governed to suit the changes of temperature, and so avoid shortage of gas at the time when most wanted.

"These sanguine anticipations are not in line with the old croakers who never developed an original thought, or lost an opportunity to obstruct every progressive step suggested. The fact still remains (notwithstanding every obstruction) that at no time since the introduction of practical science in general business have we been required to take a backward step in anything essential to the comfort, convenience and higher development of the human race. In keeping with such universal progress,

we must find some way to utilize this boundless supply of fuel which nature has stored in a reservoir below us, and which present methods fail to reach.

“The fact is now demonstrated in thousands of places that air forced through a reservoir of oil is carbonated, and becomes a better illuminating gas than any natural gas. Who will give an intelligent reason why air, forced through nature’s oil reservoir, should not produce gas equally good and in proportionately larger quantities than is produced from artificial tanks of oil? Within the last few months interesting illustrations have been given at different places in Ohio and Indiana. Gas from a high pressure field was conveyed through a long pipe line, and permitted to return to the porous rock through a few wells connected with said pipe line in a low-pressure field, and from which surrounding wells within a half to a mile radius were supplied with gas. Every proposition on which this enterprise depends is already proved in various similar operations, and the promoters of the enterprise have every reason to anticipate in the near future a general revolution from the old to the new method of producing gas.”

In regard to this theory the facts at hand are not sufficient to warrant me in hazarding an opinion of its practicability in the production of fuel. That air can be forced through the porous portions of the Trenton rock is undoubtedly true. Demonstrations of this have been shown in the Indiana field. A high pressure pipe line passing through low pressure locality, and having low pressure wells connected with it, will cause an increase, in the well pressure in the immediate territory surrounding such wells. This has been experienced at Noblesville, in Hamilton County, and at Kempton, in Tipton County. In fact this condition may be observed on any pipe line that has wells connected therewith whose initial pressure is lower than the line pressure. This fact is so well known that many gas companies disconnect their low pressure wells that lie in the immediate neighborhood of wells belonging to rival companies. Without doing this they know that by this means they would be furnishing gas to their rivals without compensation. In regard to the air becoming sufficiently carbonated in its passage through the oil deposits contained in the pores of the Trenton limestone to make it a fuel equal to natural gas I have no means of knowing. I shall await with a great deal of interest the outcome of the experiments that are now being made. In partial support of what is expected to be accomplished by the supporters of this theory, it may be said, first, that within the greater portions of the gas fields of Ohio and Indiana large oil deposits are found in the porous rock, and second, that the forcing of air through this porous rock by artificial means is practical.

In view of the fact that the natural gas supply of Indiana will soon be exhausted experiments like the one above mentioned are looked to

with a great deal of interest. Should they be successful a vast amount of valuable fuel will be made available, and the wonderful era of prosperity that was inaugurated by the discovery of natural gas within the State of Indiana will be continued indefinitely. In that event, and with the supply of fuel regulated at pleasure, the gas belt of Indiana would become the greatest manufacturing center the world has ever seen.

TRANSPORTATION OF GAS.

One of the great wastes of natural gas that exists in the Indiana gas field is the leakage from pipe lines. During the early days of this fuel, when most of the pipe lines were laid, experience had not then taught the necessity of using the best pipes and fittings. Cheap pipes and cheap connections was the rule. Especially is this true in what is known as "farmer lines," that is, lines that supply people who live in the country. These lines, as well as many that supply the towns and cities, were laid by persons of no experience, and were not tested as to their capacity to withstand high pressures. The result was that leaks were at almost every connection in many of those lines, and great wastage of gas. Much improvement, however, has been made in many of these plants. Better material and better work has been substituted. Especially is this true of the plants that have been put in more recently. Good material is now used, and lines are thoroughly tested before being subjected to the pressure from the gas wells. A fair estimate of the results of these improvements would be that the loss from leakage from the pipe lines has been reduced more than one-half. Not only was there a great loss of valuable fuel from this cause, but there was a great danger to life and property. Many accidents have occurred that has resulted in the loss of life and the destruction of much valuable property that can be directly traced to leakage in pipe lines and mains.

All pipes used for the conveyance of natural gas should be tested by hydrostatic pressure up to at least 300 pounds to the square inch, and the pipe should be rapped with a hammer while under pressure.

The weight in pounds of one foot of cast-iron pipe may be calculated by the following formula:

$$W = (D^2 - d^2) \times 2.45.$$

When D = outside diameter of pipe in inches.

d = inside diameter of pipe in inches.

W = weight of a lineal foot of pipe in pounds.

Example: Required, the weight of one foot of six-inch pipe, metal half inch thick; square of outside diameter (6 inches \times 6 inches) = 36 inches, less square of inside diameter (5 inches \times 5 inches) = 25 inches, = $11 \times$ constant, 2.45 = 26.95, or weight in pounds of one foot of six-inch pipe.

Cast iron pipe may be generally used for low pressure, but it should

not be used for high pressure mains. In conveying gas under a pressure of fifty to two hundred and fifty pounds to the square inch, only the best of lap-welded wrought iron or steel pipes should be used. And on this kind of pipe where the threads are cut the metal should be made thick, so that the pipe shall not be reduced in strength at that point. One source of great weakness is in the special fittings. They should all be made of the best malleable iron or steel. Many companies are now having their fittings made to order, much heavier than those generally found in the market. Even the best wrought iron and steel pipes should be subjected to a hydrostatic pressure of at least three times as great as any pressure that it will be subjected to in use.

By a special act of the General Assembly of Indiana of 1891, the pressure in high pressure pipe lines is limited to three hundred pounds. In the putting in of gas plants, or in their extension or improvement, every means should be adopted in order to make them absolutely safe. Human lives, as well as property, are too valuable to be endangered by the insecure handling of this powerful agent, through mistakes and criminal notions of economy.

By the way of suggestions as to what should be observed in the laying of gas plants, or in the improvement of the same, I quote some recommendations from a report to the court of a commission at Pittsburgh, Penn., appointed to investigate the safety of the plants in that city during the earlier years of the use of gas. They say:

“There should be stop-valves located not over three thousand feet apart on all high pressure mains, so that a line can be shut off in sections in case of accidents.

“A uniform pressure should be kept on each line.

“Each high pressure feeder to a low main should have an efficient pressure regulator, and in addition thereto not less than two blow-off valves, each of sufficient capacity to relieve the line of any excess of pressure.

“All low pressure lines should be connected with each other, and to the high pressure mains in such a manner as to form a circuit. If the lines are connected in this manner, with sufficient feeders from the high pressure mains, and all dead ends avoided, the pressure we designate in the next finding as low pressure will, in our opinion, be adequate to supply all possible consumers of gas except the large manufactories, which are provided for direct from high pressure mains.

“A greater pressure than ten pounds should not be allowed on low pressure lines.”

“In each public building located near a low-pressure main or mains, a mercury gauge should be placed, connected with the main or mains, and open at all reasonable hours to the inspection of citizens.”

“All tees, angles, gates, etc., should be of the best in the market, and

they and all sleeves should be covered with suitable boxes with perforated covers."

I wish to add the above recommendations in addition to, and partly as a repetition of what I have always urged in person and in my former reports on this subject. It may be urged that these recommendations are coming rather late, as most of the plants have already been laid. This is only partly true, for the reason why, that the above suggestions are on a condensed form of what I have already advocated. And, then again, plants are to be improved, and they must be extended in order to furnish supply to the increasing demand and for extension of lines to remoter fields.

SUBSTITUTES FOR NATURAL GAS.

That the supply of natural gas will last but a very short time longer is conceded by all persons who have given the matter careful and serious consideration. That a gaseous fuel from some source will continue to be extensively used is also generally conceded. Natural gas will have prepared the way for the use of gaseous fuel. The failure of natural gas will, doubtless, bring heavy losses to many individuals, firms and corporations. Still, it will have accomplished much good, in that the knowledge gained by the experience during the years of its existence will greatly benefit the public in general.

The use of a gaseous fuel generated in producer furnaces is now largely used in the operations in metallurgy. The great saving in this method of firing over that of the direct utilization of the combustion of coal is probably due, in a measure, to the utilization of the waste heat in the regenerative chambers. Fuel gas of this character, however—that is, made by the admission of air to the incandescent fuel—can not be conducted long distances except at an expense greater than its value as a heat producer.

In the manufacture of water gas, coke or anthracite coal has to be used. No process has been invented yet whereby soft or raw bituminous coal can be used successfully for this purpose. So long as this is true this gas can not be made cheap enough to come in competition with direct firing with the soft coals of Ohio and Indiana.

It is probable that a mixture of coal gas, water gas and producer gas will be the fuel gas of the future for domestic purposes.

COMPARATIVE VALUE OF GASES.

Without attempting to describe the processes whereby different fuel gases are manufactured, the following tables will show the comparative values of the four gases—natural gas, coal gas, water gas and gases from a producer furnace.

Assuming that producer gas is made from the slack coal that is found

in such vast quantities lying about our coal mines, an approximate analysis of this slack would show it to be composed as follows:

Fixed carbon	55 per cent.
Permanent gas	15 per cent.
Condensable matter, tar and soot	10 per cent.
Water	10 per cent.
Ash	10 per cent.

Deducting the ash, the proportions are, by weight:

Fixed carbon	61.11 per cent.
Volatile combustible matter	16.67 per cent.
Water	11.11 per cent.
Tar	11.11 per cent.

After excluding all of the excesses of deleterious matter, the gas from the producer will then have this composition:

Carbon monoxide	32.69 per cent.
Carbon dioxide	7.93 per cent.
Nitrogen	51.82 per cent.
Illuminating gas (H., CH ₄ , C ₂ , etc.)	3.24 per cent.
Watery vapor	2.16 per cent.
Tarry vapor and soot	2.16 per cent.

The value of each of the four gases that are now used being compared will be in heat units per pound of gas:

Natural gas	24.195
Common coal gas	22.968
Water gas	7.069
Siemen's furnace gas	1.957

The above calculation is based upon the following composition of the several gases:

COMPOSITION OF NATURAL GAS.

	<i>Per Cent. By Volume.</i>	<i>Per Cent. By Weight.</i>
Hydrogen (H)	2.18	0.268
Marsh gas (C H ₄)	92.60	90.383
Carbonic Oxide (C O)	0.50	0.857
Olefiant gas (C ₂ H ₄)	0.31	0.531
Carbonic acid (C O ₂)	0.26	0.700
Nitrogen (N)	3.61	6.178
Oxygen (O)	0.34	0.666
Hydrogen sulphite (H ₂ S)	0.20	0.417
Total	100	100

COMPOSITION OF COAL GAS.

	<i>Per Cent. By Volume.</i>	<i>Per Cent. By Weight.</i>
Hydrogen	46.00	8.21
Marsh gas.	40.00	57.20
Carbonic oxide	6.00	15.02
Olefiant gas	4.00	10.01
Water	1.50	2.41
Carbonic acid	0.50	1.97
Nitrogen	1.50	3.75
Oxygen	0.50	1.43
Total	100	100

COMPOSITION OF WATER GAS.

	<i>Per Cent. By Volume.</i>	<i>Per Cent. By Weight.</i>
Hydrogen	45.00	5.431
Carbonic oxide	45.00	76.041
Marsh gas.	2.00	1.931
Water vapor	1.50	1.630
Carbonic acid	4.00	10.622
Nitrogen	2.00	3.380
Oxygen	0.50	0.985
Total	100	100

COMPOSITION OF PRODUCER GAS.

	<i>Per Cent. By Volume.</i>	<i>Per Cent. By Weight.</i>
Hydrogen	6.00	0.458
Marsh gas.	3.00	1.831
Carbonic oxide	23.50	25.095
Water vapor.	1.00	0.686
Carbonic acid	1.50	2.517
Nitrogen	65.00	69.413
Total	100.	100

The specific gravity of the several gases is as follows :

Natural gas . . . . .	.570
Coal gas. . . . .	.400
Water gas . . . . .	.570
Producer gas.	1.000
Air.	1.000

Making a comparison on the basis that natural gas has a temperature of about 40° Fahr., we have the following:

One thousand feet of air at 40° Fahr., will weigh	80	pounds.
Then, 1,000 feet of natural gas, specific gravity,	.570	$\times 80 = 45.6$ pounds.
“ “ “ coal “ “	.400	$\times 80 = 32.0$ “
“ “ “ water “ “	.570	$\times 80 = 45.6$ “
“ “ “ producer “ “	1.000	$\times 80 = 80.0$ “

Then, natural gas,	45.6	pounds	$\times 24,195$	heat units	=	1,033,292	units.
“ coal “	32.0	“	$\times 22,968$	“	=	734,976	“
“ water “	45.6	“	$\times 7,069$	“	=	322,346	“
“ producer “	80.0	“	$\times 1,957$	“	=	156,560	“

Another showing of the comparative value of these four gases is in the evaporating of water.

One thousand feet of natural gas will evaporate	893	pounds.
“ “ coal “ “	591	“
“ “ water “ “	262	“
“ “ producer “ “	115	“

It has been found in practice that coal gas possesses advantages over either of the other gases in a way that does not appear in a theoretical calculation. It will ignite at a lower temperature. This is due to the fact that it possesses more free hydrogen.

A large portion of the black smoke that is seen pouring out of smoke stacks attached to the furnaces of steam boilers is due to the fact that, when the gases generated from the coal comes in contact with the steam boiler, they (the gases) are cooled below their point of ignition, and therefore escape unconsumed.

As this is well known, then the fact becomes apparent that the gas that ignites at a low temperature will produce better results, other things being equal, than a gas that ignites at a higher temperature.

Many people are looking anxiously to some of these fuel gases, or to a combination of them, as their source of fuel when natural gas shall have failed. No doubt, that before that time arrives the manufacture of these gases will have been brought to such a state of perfection as to cheapen them so as to bring them within the reach of all the uses to which this fuel is applied. The vast sums of money invested in conducting mains will not be lost, as the public in many localities will have become so accustomed to a gaseous fuel that will never return to the use of solid fuel. Then it will be that the slack and waste at our coal mines will be converted into fuel gas, and be conveyed through the mains laid for conveying natural gas to manufacturing places and for domestic use.

MEASUREMENTS OF GAS WELLS.

By request, I herewith give a method for measuring the volume of the supply from gas wells. The Pilot tube is now generally used in measuring the velocity flow. This tube may be of any size, as the observed pressure will indicate an absolute independence of size of tube mouth. One-eighth to one-fourth inch are the sizes generally used, and the mouth should be made sharp, or very nearly so.

The tube may be clamped to the tubing of the well in order to hold it in place. Care should be taken to place the mouth of the tube exactly in the center of the stream of flowing gas, and not more than one diameter of the tube mouth above the mouth of the well tubing. The mouth of the well tubing where test is made should be not less than fifteen inches from any collar or valve, or fitting of any kind. This is done for the purpose of having a free flow, as a collar or fitting of any kind would cause an eddying of the gas. From the observed pressure on the gauge, by the use of the tables given below, the volume can be ascertained. I have taken this table from Prof. S. W. Robinson's report to the State Geologist of Ohio on the measurements of gas.

Cubic feet of gas, reckoned at 32° F., discharged by well per day of twenty-four hours of continuous flow, by Pilot tube measurement; the specific gravity of the gas being taken at 0.6 (air = 1), and the temperature of the flowing gas at well mouth being taken at 32° F. :

PRESSURE BY WATER GAUGE—INCHES.	PRESSURE BY PRESSURE GAUGE—LBS. PER SQ. INCH.	DIAMETER OF ORIFICE, OR OF WELL MOUTH.									
		1 Inch.	1½ In.	2 In.	2½ In.	3 In.	3½ In.	4 In.	4½ In.	5 In.	5½ In.
.1	.0036	12,390	27,880	49,556	77,440	111,510	151,780	198,220	250,890	309,750	392,000
.2	.0073	17,560	39,510	70,360	109,750	158,040	215,110	281,040	355,590	439,000	555,910
.3	.0109	21,480	48,330	89,940	139,250	198,320	263,130	343,760	434,870	537,000	679,630
.5	.0182	27,720	62,370	110,880	173,250	249,480	339,570	443,520	561,330	693,000	877,080
.7	.0254	32,820	73,840	131,260	205,100	286,380	402,000	525,050	664,610	820,400	1,035,500
1.0	.0364	39,210	88,230	156,830	245,100	352,890	480,400	627,310	794,030	980,400	1,240,700
1.5	.0545	48,030	108,070	192,120	300,200	432,270	588,400	768,480	972,600	1,200,800	1,517,900
2.0	.0727	55,340	124,520	221,360	345,900	498,060	677,960	885,440	1,120,500	1,383,600	1,751,000
3.0	.109	67,910	152,800	271,630	424,500	611,190	832,020	1,086,510	1,375,200	1,698,000	2,145,800
4.0	.145	78,410	178,420	313,680	490,100	705,690	960,600	1,254,620	1,587,800	1,960,400	2,480,900
5.0	.182	87,670	197,260	350,670	518,400	739,030	1,074,860	1,402,670	1,775,310	2,193,600	2,733,900
7.0	.254	103,500	232,880	414,000	646,900	931,500	1,267,900	1,656,000	2,096,900	2,587,600	3,274,800
10.0	.3636	123,000	276,750	492,000	768,800	1,107,000	1,506,750	1,968,000	2,490,800	3,075,000	3,890,900
13.75	.50	146,220	328,990	484,880	913,880	1,316,000	1,791,200	2,339,500	2,76,900	3,655,500	4,636,500
20.62	.75	175,350	394,540	701,400	1,096,000	1,578,150	2,148,160	2,805,600	3,550,900	4,384,000	5,548,200
27.5	1	201,800	454,010	807,200	1,261,200	1,816,050	2,471,800	3,218,500	4,066,100	5,044,600	6,384,600
	1.5	247,840	557,650	991,370	1,549,000	2,231,000	3,036,000	3,965,000	5,019,000	6,196,000	7,842,000
	2	285,130	641,540	1,140,500	1,782,000	2,566,200	3,493,400	4,562,000	5,774,000	7,128,000	9,021,000
	2.5	316,500	712,130	1,266,000	1,978,000	2,848,500	3,887,000	5,064,000	6,409,000	7,913,000	10,014,000
	3	344,350	774,780	1,377,400	2,152,000	3,069,100	4,218,000	5,510,000	6,973,000	8,609,000	10,895,000
	3.5	370,000	832,500	1,480,000	2,313,000	3,330,000	4,582,500	5,920,000	7,493,000	9,250,000	11,707,000
	4	393,000	884,250	1,572,000	2,456,000	3,537,000	4,814,200	6,288,000	7,958,000	9,825,000	12,435,000
	4.5	415,270	934,350	1,661,100	2,595,000	3,737,400	5,087,000	6,644,000	8,409,000	10,382,000	13,139,000
	5	436,200	981,450	1,744,800	2,726,000	3,925,800	5,343,000	6,973,000	8,833,000	10,905,000	13,802,000
	5.5	456,200	1,026,500	1,824,800	2,851,300	4,105,900	5,589,000	7,299,000	9,288,000	11,405,000	14,435,000
	6	473,750	1,065,900	1,895,000	2,961,000	4,264,000	5,803,000	7,580,000	9,593,000	11,844,000	14,990,000
	6.5	489,840	1,102,100	1,959,400	3,062,000	4,409,000	6,001,000	7,837,000	9,919,000	12,246,000	15,499,000
	7	505,920	1,138,300	2,023,700	3,162,000	4,553,300	6,198,000	8,095,000	10,245,000	12,648,000	16,008,000
	7.5	522,010	1,174,500	2,088,000	3,263,000	4,698,000	6,395,000	8,353,000	10,571,000	13,050,000	16,517,000
	8	538,500	1,211,600	2,154,000	3,366,000	4,846,000	6,597,000	8,616,000	10,905,000	13,462,000	17,038,000
	9	565,570	1,273,200	2,263,000	3,537,000	5,093,000	6,930,000	9,054,000	11,459,000	14,147,000	17,905,000
	10	589,270	1,325,900	2,357,100	3,683,000	5,303,000	7,219,000	9,428,000	11,933,000	14,372,000	18,645,000
	12	633,340	1,425,000	2,533,300	3,958,000	5,700,000	7,758,000	10,133,000	12,825,000	15,833,000	20,040,000
	14	675,000	1,518,000	2,700,000	4,219,000	6,075,000	8,289,000	10,800,000	13,669,000	16,875,000	21,357,000
	16	713,556	1,605,500	2,854,200	4,459,700	6,422,000	8,741,000	11,415,000	14,449,000	17,800,000	22,500,000
	18	748,650	1,684,500	2,994,600	4,679,000	6,738,000	9,151,000	11,978,000	15,160,000	18,700,000	23,500,000
	20	779,350	1,753,500	3,117,400	4,871,000	7,014,000	9,548,000	12,470,000	15,762,000	19,500,000	24,500,000

PRESSURE BY WATER GAUGE— INCHES.	PRESSURE BY PRESSURE GAUGE— LBS. PER SQ. INCH.	DIAMETER OF ORIFICE, OR OF WELL MOUTH.									
		1 Inch.	1½ In.	2 In.	2½ In.	3 In.	3½ In.	4 In.	4½ In.	5 In.	5½ In.
25	845,150	1,901,600	3,381,000	5,282,000	7,606,000	10,353,000	13,522,000				
30	902,180	2,148,300	3,609,000	5,639,000	8,120,000	11,054,000	14,435,000				
35	954,370	2,448,300	3,819,000	5,968,000	8,593,000	11,697,000					
40	996,660	2,747,000	3,995,000	6,242,000	8,968,000	12,231,000					
45	1,036,700	2,932,600	4,147,000	6,479,000	9,230,000	12,700,000					
50	1,072,000	2,412,000	4,288,000	6,700,000	9,648,000	13,132,000					
55	1,106,880	2,436,000	4,428,000	6,918,000	9,962,000	13,539,000					
60	1,137,600	1,137,600	4,550,000	7,110,000	10,238,000	13,935,000					

INSPECTION OF PLANTS.

There has been but very little complaint during the year of plants furnishing gas to consumers. I have found in my inspection that the gas machinery is being kept in a much better condition than formerly. This is the result of the managers having acquired more experience and of their having a greater appreciation of the dangerous agent which they are required to handle. This condition is largely due to the fact that plants are subject to inspection. In making my inspections I have tried at all times to impress upon the minds of those in charge of plants and gas machinery the extremely dangerous character of this fuel, and the great necessity of careful attention, also that none but the best regulators, pipes, fittings and other machinery should be used, and that this should at all times receive their best attention and be kept in the best possible condition. I condemned but one regulator during the year. This one belonged to the Fountainton Gas Company and was located at New Palestine in Hancock County.

I have found owners and managers of plants, as a general thing, very ready to accept my suggestions as to changes and repairs that may be necessary in order to give good and safe service. By so doing plants have been kept in good condition and the necessity for condemnation has been avoided.

PROF. S. S. GORBY,
Indianapolis, Ind. :

DEAR SIR—I hereby lay before you my report on the Fishes of the State of Indiana. In the following pages I have endeavored to present a complete catalogue of the fish-like animals known to inhabit Indiana waters, and to furnish with each species a description which will make its identification as easy as possible. I have also given under each species a list of the localities in the State where it has, so far as I have been able to learn, been taken by any competent ichthyologist; and there will be found with each locality a citation in brackets to the work which has been my authority. Also, so far as information on the subject and available space have permitted, I have dealt with the habits of our fishes. So far as their food-habits are concerned, I have, for the most part, relied on the extended observations of Dr. S. A. Forbes, of the State University of Illinois, the results of whose investigations have been published in the various volumes of the "Bulletins of the Illinois State Laboratory of Natural History." As regards the breeding habits of our fishes, something, but far too little, is known concerning the larger species which serve as food, while little or nothing is known about the numerous small fishes which swarm in our streams, lakes and ponds. Nevertheless, investigations on this subject would yield results of great interest and value.

The number of known species of Indiana fishes may be put at one hundred and fifty. Besides these, a considerable number of species has been found in territory contiguous to the State, and some of these will undoubtedly yet be found within our limits. Of such species I have given descriptions in foot-notes.

For our present knowledge of our fishes we are indebted to the labors of LeSueur and Rafinesque at the beginning of the century, and to those of a number of naturalists within recent years, chief among whom are Profs. Gilbert, Jordan, Jenkins, Evermann, and Eigenmann. I have endeavored to give due credit to these and all others by referring to their writings.

I am under especial obligations to Dr. G. B. Goode and Dr. T. H. Bean for permission to examine the collection of fishes belonging to the United States National Museum.

O. P. HAY.

FIELD COLUMBIAN MUSEUM,
CHICAGO, December 1, 1894.

THE LAMPREYS AND FISHES OF INDIANA.

The word fish, as popularly employed, has a somewhat indefinite and variable meaning. Not to mention its application to such creatures as "shell-fish," the star-fish and the devil-fish, animals having only the remotest relationship to the pike or the bass of our streams, the word is still made to include vertebrated animals very different from one another. Nor are the zoölogists wholly agreed as to what constitutes a fish. Whether the lamprey eels and the sharks are or are not fishes is a matter of dispute. According to the views of many recent writers, a lamprey eel, a shark, and a catfish are as different from one another in their organization as are a frog, a lizard and a bird. That is, each of the so-called fishes named above belongs to a distinct and different class of the vertebrate sub-kingdom. The frog, the lizard, and the bird represent respectively three other classes. Others would include among the true fishes the sharks, but would exclude the lampreys. According to the views which I adopt, the lancelets constitute a class, the lampreys another, the sharks and the rays a third, while all other fish like animals compose a fourth class, the true fishes

Of these classes we have in Indiana representatives of two only, our waters supporting neither lancelets nor any form of shark-like animals. The classes represented are named and distinguished as follows:

- A. Body long and slender, eel-like; skin smooth and slippery, wholly devoid of scales; no paired fins; no lower jaw; the mouth placed in or near the center of a large, circular and sucker-like disc; no bony skeleton. *Cyclostomi*, p. 148.
- AA. Body short or long; usually, but not always, furnished with scales or bony plates; paired fins rarely entirely wanting; lower jaw always developed; a bony skeleton always more or less developed, thus comprising a considerable number of membrane bones. *Pisces*, p. 152.

Class 1. CYCLOSTOMI.

THE HAG-FISHES AND LAMPREYS.

Skeleton entirely cartilaginous, membranous and notochordal. Vertebral axis not divided into distinct vertebræ. No ribs. No paired fins. Anterior portion of the head containing large cartilages which support the suctorial disk. No lower jaw developed, nor any evident upper jaw. Mouth and suctorial disk of adults armed with horny teeth. Nasal organ single, opening in the midline of the upper surface of the head. Gills sac-like, six or more on each side, opening usually by as many holes in a line along the sides of the body, occasionally into a canal which opens far back on the ventral surface. Dorsal and anal fins with rays, and meeting around the end of the tail.

This class contains a number of very remarkable animals, some of which inhabit the ocean, others the waters of rivers and lakes. They are parasitic on other fishes, seizing them by means of the suctorial disk, then with the horny teeth, rasping away the flesh and sucking the blood of their victims. Some of the marine species even burrow into the bodies of the larger fishes.

The two succeeding orders of this class are recognized:

- A. Nostril close to the border of the disk; the nasal duct opening behind on the roof of the mouth. *Hyperotreta.*
- AA. Nostril opening just in front of the eyes; the duct terminating behind in a blind sac. *Hyperoartia*, p. 148.

All our species belong to the last-named order.

Order 1. HYPEROARTIA.

Nasal organ with its external opening placed on the top of the head, just in front of the eyes; the duct terminating behind in a flask-shaped sac, which lies at the base of the skull; eggs small.

This order contains only a single family, the *Petromyzontidæ*:

Family PETROMYZONTIDÆ.

THE LAMPREYS.

Body eel-like, scaleless and slippery; anteriorly cylindrical, compressed behind. Dorsal and anal meeting around the tail, the dorsal more or less notched. Sucking disk armed with horny teeth in the adults, unarmed in the larval stage; surrounded with a fringed border. Tongue with teeth. Gill openings seven in number along each side.

Eyes present in the adults, rudimentary in the young. Nasal organs in front opening just in front of the eyes, behind ending in a blind sac. Eggs small.

The lampreys probably do not burrow into the bodies of their prey as do the hag-fishes, but content themselves with tearing away bits of flesh from the surface. They are often taken while adhering to the bodies of the larger fishes. On the other hand, the fishes sometimes retaliate by swallowing the lampreys. The lampreys likewise employ the sucking disk to fasten themselves to stones and other bodies, thus obtaining resting places. While thus attached, the water for respiration must pass both in and out through the gill openings. Some of the larger lampreys, especially the Sea Lamprey, are used as food. It is not highly regarded, in this country at least, and is said to be difficult to digest. In England a fresh-water species is largely employed as bait in the cod fisheries. For interesting information on lampreys see 12, 1884, 677.

The lampreys undergo a marked change during their growth. For a time, until they reach a considerable size, they are worm-like, blind and toothless.

GENERA OF PETROMYZONTIDÆ

- A. Sucker relatively small and with few teeth; mouth overhung with a crescent-shaped horny plate, which terminates at each end in a distinct tooth; tongue armed in front with a crescentic, serrated, horny plate. *Ammocetes*, p. 149.
- AA. Sucker large in adults, and furnished with numerous teeth, which are in rows radiating from the mouth; horny plate above the mouth short and with but two or three teeth, which are placed close to one another. *Petromyzon*, p. 150.

Genus AMMOCETES Duméril.

Small freshwater lampreys. Suctorial disk relatively small and furnished with few teeth. Horny plate over the mouth elongated and terminating at each end in a distinct tooth. Anterior border of the tongue furnished with a crescent-shaped horny tooth, which is dentated, the middle denticle being largest. Dorsal fin continuous, but with a broad shallow notch.

A single species only is found with us, and this is regarded as identical with that found in Europe.

AMMOCETES BRANCHIALIS (Linn.).

Mud Lamprey; Brook Lamprey; Pride.

Jordan, 1888, 7, 10; *A. niger*, Jordan, 1882, 8, 9. *A. branchialis*. Jordan & Fordice, 1885, 1, 293

A small lamprey, not exceeding perhaps eight inches in length. Distance from the snout to the last gill-opening contained in the total length about four and three-fourth times. Dorsal fin beginning about the middle of the animal and continuing to the tail, but deeply notched a little in front of the middle. Anal fin deep just behind the vent, then low until reaching the caudal. Sucking disk rather small, surrounded with a fringe of long papillæ. Horny plate above the mouth expanded at each end into a distinct tooth. Below the mouth is a transverse row of blunt, horny teeth. On each side of the disk are about three teeth with double tips; the other discal teeth are simple, small and not numerous. Between the gills and the vent are about sixty-five transverse muscular grooves. The color is a bluish black, with the disk and the belly paler.

Distributed from Central New York to Minnesota and south to Kentucky. The European species is regarded as identical.

In Indiana this species has been taken at Indianapolis in White River (1, '77, 46), Falls of the Ohio, Wabash River, Bloomington, Ind. (1, '85, 410), Vernon, Jennings County. It is also given by Jordan in 14, No. 2, as an inhabitant of Lake Michigan.

Too little is known concerning the habits of this little lamprey. It is said to ascend small brooks in early spring for the purpose of depositing its spawn. Where it passes the remainder of the year appears to be unknown; it probably inhabits the waters of the deeper streams. They are often found clinging to stones and other bodies. They are of no economic importance, but they would make good bait.

Genus PETROMYZON Linn.

Lampreys with the horny plate above the mouth (*supraoral lamina*), short and with only two or three closely approximated teeth. Teeth of the disk numerous and arranged in arched rows radiating from the mouth. Lingual teeth divided by a median groove into lateral halves. Dorsal fin continuous, scarcely notched. The toothless young resemble *Ammocetes*.

Two teeth on the supraoral lamina; teeth of disk all simple.

concolor, p. 151.

Three teeth on the supraoral lamina; some of the lateral teeth of the disk with two cusps.

castaneus, p. 151.

PETROMYZON CONCOLOR (Kirtland).

Silvery Lamprey.

Jordan and Gilbert, 1882, 8, 867; Jordan and Fordice, 1885, 1, 282; *Ichthyomyzon argentatus*, Jordan and Gilbert, 1882, 8, 10.

Head (to first gill), in the total length seven to eight times. Dorsal fin continuous, scarcely notched. About fifty muscular grooves between the gills and the vent. Teeth of the supraoral lamina two. Transverse row below the mouth with seven or eight teeth. All the teeth of the disk simple. Color, silvery gray, darker on the upper surface. A blue spot over each gill opening, even in the larvæ. Length, about one foot.

Found from Lake Erie to Missouri and north. In Indiana they have been taken in White River at Indianapolis, and in the Ohio at New Albany (1, 1877, 46); Wabash River, at Delphi (23, 1888, 43); Blue River, at Wyandotte Cave (Jenkins); New Harmony (4, 1888, 162); Great Lakes (11, 1872-3, 36); Lake Michigan (14, No. 2); Eel River, Whitley County (Kirsch, 4, 1894, 36).

Dr. Jordan (2, 758), says that this lamprey is rather common both in Lake Erie and in the Ohio River. It appears to leave the deep waters on the approach of spring, and to ascend the smaller streams to deposit its spawn. Mr. Lewis H. McCormick (Fishes of Lorain County, Ohio), found ripe eggs in specimens on May 22. Dr. Jordan has known of their being taken from Lake Erie while they were adhering to perch. On the other hand, he states that they have been taken from the stomachs of the perch to which the lampreys have served as food. Prof. Milner (11, 1872-73, 74) states that this lamprey is parasitic on the lake sturgeon. It is also known to attack the paddle-fish. In the Great Lakes Prof. Milner states that it is found from shore to a depth of twenty fathoms.*

* PETROMYZON CASTANEUS (Girard).

Jordan and Gilbert, 1882, 8, 864; Jordan and Fordice, 1885, 1, 281; *Ichthyomyzon castaneus*, Jordan and Gilbert, op. cit., p. 10.

Supraoral plate with three cusps. Seven to twelve teeth in the transverse row below the mouth. Head with the gills contained in the total length four to five times. Muscular impressions between the gills and the vent, fifty-six. Color, chestnut or yellowish. Length, about 10 inches.

Distributed from Minnesota to Louisiana. Not yet known from Indiana.

This species may be distinguished from *P. concolor* by the three closely approximated teeth above the mouth, and by the different color.

Class 2. PISCES.

THE TRUE FISHES.

This class contains all our native so-called "fishes," except the lampreys described on the preceding pages. Before proceeding to the classification and description of our fishes it seems proper, for the benefit of those who are beginning their ichthyological studies, to call attention to the structural characters which we must employ, and to define certain terms.

The body of a fish, a bass, for instance, is recognized as consisting of three portions, *head*, *trunk* and *tail*, the hinder border of the gill-opening and the vent serving as points of division. The head bears the organs of special sense, the beginning of the alimentary canal, together with its weapons of offense and defense, and the organs of respiration. The trunk contains the organs of circulation, of digestion, excretion, and of reproduction. The tail is the principal organ of locomotion. On the body and tail are located the various fins; some of them occasionally extend even on to the head.

The brain-case and the skeleton of the tongue and of the gills of some fishes are composed, to a great extent, of cartilage; in others this cartilage is more or less converted into bone; in all true fishes this cartilage, ossified or not, is covered in by plates of bone laid down in membrane. In and about the mouth are several membrane bones which must receive our attention. Forming the front border of the upper jaw we find two bones, the *premaxillaries*, which meet in the middle line. Each usually sends backward a process to form the whole or a part of the upper margin of the mouth, and another process upward which lies upon the other bones of the snout. The latter processes move on their bed, so as to allow the premaxillaries to be pushed forward and withdrawn. However, we do not say that the upper jaw is *protractile* unless there is a distinct crease of the skin, separating the skin of the upper lip from that of the forehead. The bass and the sun-fishes furnish examples of fishes in which the premaxillaries form the whole of the upper margin of the mouth. In the pike but a small portion of the margin is occupied by the premaxillaries. These bones are likely to bear teeth, in case there are any teeth in the mouth.

The *maxillary* usually lies above and behind the premaxillary. It often forms the hinder portion of the margin of the mouth. It is usually flat at the hinder end. It seldom bears teeth, yet it does so in the gars and the mud-fish (*Amia*). In many fishes, as the bass and pike, there is found on the upper border of the maxillary a *supplementary* bone. In the fishes of the herring family the maxillary is composed of about three pieces. In the cat-fishes the maxillary is a rudiment lodged

in the base of the upper barbel. In front of the eye is found a flat bone, the *preorbital*, while a chain of *suborbitals* runs below the eye. In some fishes, as in the miller's thumb, these are converted into a firm *bony stay* underneath the eye.

The lower jaw is composed of a number of pieces, the most important of which is the *dentary*, so called because it usually supports teeth. In the roof of the mouth are several bones, important because they are often armed with teeth. In the middle line, just behind the premaxillaries, is the *vomer*. The teeth on the bones in the mouth can most easily be detected by gently scraping over them the head of a common pin. Immediately behind the vomer, on each side of the roof of the mouth, is the *palatine*, and further back the *pterygoid*. The palatines often bear teeth, as in the pike, the bass, etc. Teeth on the pterygoids are not so common, but they may be found in the goggle-eye and the warmouth. These teeth will serve to locate the positions of these bones.

The sides of the skull behind are occupied by the *opercles* or *gill-covers*, a sort of valves, which cover in the gill-chamber. The gill-cover almost always consists of four bones, the *preoperculum*, *operculum*, *interoperculum* and the *suboperculum*. The free border of the preopercle is often furnished with teeth, *serrated*, while the opercle may bear one or more spines. The yellow perch has both the serrations and an opercular spine. The gill-covering has a membranous border by means of which the gill-cavity may be more completely closed. Below the opercular apparatus is found the *gill-membrane*, a fold of skin supported by one or more ray-like bones, the *branchiostegals*. The anterior ends of these bones are attached to the *hyoid* bone. The gill-membranes may be joined along their lower borders to the *isthmus*, the space between the throat and the breast; or they may be free from the isthmus and from each other; or lastly, they may be free from the isthmus and grown together, so as to form a sort of flap—like a bib.

The gills of fishes consist of folds and slender processes of the mucous membrane, supported by the cartilaginous or bony gill-arches. These arches, four in number, consist each of several pieces of bone or cartilage, and the two of each pair encircle the pharynx. The mucous membrane forming the gills is produced into flat processes, which are arranged in one or two rows along the convex side of each arch. More commonly there are two rows, but in some cases only a single row of the gill-filaments on each arch. Along the concave side of the arches are often borne solid processes of bone or cartilage, the *gill-rakers*. These are sometimes short and weak, sometimes thick and stout, sometimes long and slender. In the paddle-fish and some others they are found on all the gill-arches; they are long and slender, and evidently act as a filtering apparatus. Commonly only the most anterior arch bears gill-rakers, as may be seen in the bass and some of the sun-fishes. The remains of a

fifth gill-arch are present in fishes, but they bear no gills. It consists on each side of a single enlarged bone, the *lower pharyngeal*, which nearly always carries teeth. The upper ends of some of the other arches form the *upper pharyngeals*, also tooth bearing, and these two sets of teeth work against each other in triturating the food. In the suckers and minnows the lower pharyngeals are scythe-shaped and carry a few large teeth.

Between the gills are the *gill-slits*, passages through which the water issues from the pharynx. Often the slit behind the fourth gill is reduced to a mere pore, and it may be wholly closed. The external gill opening is usually large, but may be reduced in size. In the eel the openings are small and close together. In the paddle-fish and the sturgeon there is found on the top of the head a pore, the *spiracle*. This is the external opening of a tube which internally communicates with the pharynx. In a large number of fishes there is a small, gill-like organ, the *pseudo-branchia*, to be found on the inner side of the gill-cover and near its upper border. It is present in the yellow-perch and the jack-salmon (*Stizostedion*). In the bass and the sun-fishes it is covered with the skin so as to be somewhat concealed.

As already stated, teeth may occur on the premaxillaries, maxillaries, vomers, palatines, pterygoids, dentaries and the pharyngeals. They may also be found sometimes on the bone at the base of the skull, on the tongue, and on the gill-arches. The teeth vary greatly in form and size. When fine and close-set and in bands, they are said to be *villiform*; when coarse and sharp they are termed *card-like* or *cardiform*. Teeth set on the jaws and larger than the teeth surrounding them are called *canines*. On the other hand, some fishes, as the sturgeons and the gizzard shad, are wholly without teeth of any kind. Other interesting organs connected with the head are the *barbels* or beards. They are usually situated near the mouth. Those of the cat-fishes are well known. In a few minnows (*Hybopsis semotilus*) a small barbel occurs near the corner of the mouth. The body of most fishes is clothed with some sort of firm structures. These are commonly thin, overlapping scales, but may be hard, bony scales or bony plates. The gars are furnished with a sort of coat-of-mail, composed of imbricated, hard, enameled scales. The sturgeons have five rows of large, bony bucklers. The paddle-fish, the cat-fishes and some others are entirely naked. The free borders of the scales of many fishes, as of those of the suckers, pikes and white-fishes, are smooth. Such scales are *cycloid*. Most of the higher fishes, as the bass and the greater number of the sun-fishes, have the free edge, and often a portion of the exposed surface of the scales provided with numerous sharp points. They are denominated *ctenoid* scales. In most cases the presence of ctenoid scales may be detected by drawing the tip of the finger lightly over the scales from the tail toward the head. A good lens.

will reveal the structural differences. The scales of fishes are arranged in more or less regular rows, transverse and longitudinal. The number of these furnish specific characters. In most fishes one of the rows which runs along the side is made up of scales which have each a small pore. This row of pores is called the *lateral line*. The number of transverse rows of scales may be determined by counting the number of scales along this lateral line, beginning just behind the gill-opening. The number of longitudinal rows may be determined by counting from the anterior of the dorsal fin to the lateral line and from the lateral line to the middle of the belly. The number of rows, both transverse and longitudinal, is somewhat variable, even in the same species. The formula, "scales, 6—45—12," means that there are forty-five rows of scales along the lateral line, six above it and twelve below it.

The fins of fishes are folds of membrane supported by firm cartilaginous or bony rays. They are classed as *vertical* or *unpaired* and *horizontal* or *paired*. The vertical fins stand in a vertical plane along the middle line of the trunk and tail. The rays are of two kinds, soft, or articulated, and spiny. The soft rays are distinguished by being cross-jointed, and often by being split toward their extremities. The spines are neither jointed nor do they divide. They may be strong and inflexible or they may be slender and weak. Close examination with a lens may sometimes be necessary in order to distinguish the weak spines from undivided or mutilated soft rays. The two kinds may be studied in the vertical fins of a bass or of a sun-fish. When both soft and spiny rays are present, the latter occupy the anterior portion of the fin. The fin may consist wholly of soft rays or wholly of spines.

The vertical fins are known as the *dorsal* (along the back), the *anal* (along the under side of the tail), and *caudal* (at the tip of the tail). In some cases, as in the eel, the dorsal and anal are confluent with the caudal. The dorsal may be undivided, or it may consist of two or three distinct portions. Occasionally the spinous portion of the fin may be represented by a few spines without membrane to connect them. The number of rays, soft and spinous, in any species is likely to be quite definite, especially when not great. In some fishes, as the cat-fishes, there is a fleshy, rayless fin located behind the proper dorsal. It is called the *adipose fin*.

The caudal fin varies greatly in form. Two modifications of it must be noticed. In a few, as the paddle-fish, the sturgeons, gars, and to somewhat less extent in *Amia*, the spinal column appears to run out along the upper border of the caudal. In adult gars and in *Amia* this is shown by the extension of the scales further back on the upper side of the tail than on the lower. The term *heterocercal* has been employed to express this condition. In most fishes the backbone appears to stop

short at the base of the caudal. Such tails are, outwardly at least, *homocercal*.

The paired fins are usually, four in number, two pectorals and two ventrals. The pectorals correspond with the anterior limbs of other vertebrates, the ventrals to the hinder limbs. In the lower fishes (cat-fishes, suckers) the ventrals are placed considerably behind the pectorals, that is, they are *abdominal*. In other forms, as in the bass, the ventrals are brought forward close to, and even immediately under, the pectorals. In such cases the ventrals are said to be *thoracic*. In a few species, as the ling (*Lota*), the ventrals are located even in front of the pectorals, and are then said to be *jugular*. The number of rays in the ventrals furnishes a useful character in the classification of the fishes. In many of the higher families of fishes the front of the ventral is occupied by a spine, and this is followed by five soft rays. In some families the spine is missing, while the number of soft rays is increased or diminished. The ventrals, and occasionally even the pectorals, may be entirely wanting. The pectorals are always placed immediately behind the head. The upper rays are the strongest. In the cat-fishes the anterior ray is a stout serrated spine. In the lower families of fishes the pectorals are inserted below the axis of the body; in the higher families they are usually placed higher up.

Some of the modifications of the alimentary canal may be briefly noticed. The stomach is sometimes little, if any, larger than the remainder of the canal. In some species it is bent like a horseshoe, and is then said to be *siphonal*. In other fishes, as our white fishes, the stomach forms a blind sac, the gullet entering at the same end as that from which the small intestine departs. The term *caecal* is applied to such stomachs. Into the beginning of the small intestine are often found opening a number of blind tubes, the *pyloric caeca*. The intestine terminates usually in front of the anal fin. In the pirate perch, however, the vent is situated in front of the ventral fins, just below the preopercle. The class which is composed of the bony fishes may be defined as follows:

Vertebrates breathing by means of gills, furnished with rayed fins and having the primitively cartilaginous skeleton supplemented by membrane bones.

Limbs, if present, one or two pairs; not terminating in recognizable digits. Median fins supported by rays. Shoulder girdle strengthened by a membrane bone, the clavicle. Brain-case, organs of sense, and the jaws, provided with membrane bones. Gill cavity enclosed by an operculum, which contains one or more membrane bones. Gills free along their outer border. Blood cold.

KEY TO THE SUB-CLASSES OF FISHES.

A. Tail heterocercal.

- * Skeleton mostly cartilaginous; skin naked or covered with large bony plates; mouth placed beneath a long projecting snout. *Chondrostei*, p. 157.
- ** Skeleton well ossified; skin covered with hard enameled scales or with cycloid scales; mouth terminal. *Holostei*, p. 163.

AA. Tail outwardly homocercal.

- * All the rays of the dorsal and pectoral fins (except sometimes the most anterior ray), soft and articulated. Ventrals, if present, abdominal and without a spine. *Physostomi*, p. 169.
- ** Usually with more than one ray of the dorsal, one or more rays of the anal, and the most anterior ray of the ventrals, spinous. Ventrals, when present, thoracic or jugular; or, if the ventrals are abdominal, then there is a spinous dorsal. *Physoclisti*, p. 244.

Sub-class 1. CHONDROSTEL.

PADDLE-FISHES AND STURGEONS.

Primitive skeleton mostly cartilaginous and notochordal. Head and shoulder girdle furnished with membrane bones. Opercular apparatus containing but one or two bones. Snout much produced beyond the mouth. Ventrals abdominal. Tail strongly heterocercal. Skin naked or furnished with bony plates, devoid of true scales. Air-bladder communicating with the œsophagus by means of a duct.

This sub-class contains two orders. Its members are the least specialized of the bony fishes.

- * Mouth large, overhung by the paddle-like snout. *Selachostomi*, p. 157.
- ** Mouth small, sucker like; snout moderate. *Glaniosstomi*, p. 159.

Order 1. SELACHOSTOMI.

THE PADDLE-FISHES.

Maxillary present; premaxillary absent. Opercular apparatus with only a single small bone. Head produced into an enormous snout. Mouth large, horizontal. Skin naked or with small, stellate, bony plates. This order contains but a single family.

Family POLYODONTIDÆ.

Body fusiform, little compressed. Mouth large; its margin formed by the maxillary, overhung by an enormous snout. Teeth small; on jaws and palatines; often wanting. Skin almost entirely naked. No barbels. Gill-rakers on all the gill-arches. Dorsal and anal far back. Caudal with many closely bound spines (fulcra) along its upper border.

This family contains two living genera, our *Polyodon* and the Chinese *Psephurus*.

Genus POLYODON Lacépède.

Snout broad and thin, resembling the blade of an oar. Mouth and gill-openings very large. Gill-rakers long and slender. Gill-membranes connected across the isthmus, free from the latter. Operculum large, produced into a long, skinny flap. Spiracles present.

POLYODON SPATHULA (Walb.).

Paddle-fish; Spoon-bill Cat; Duck-bill Cat.

Jordan and Gilbert, 1882, 8, 83; Jordan, 12, 660, pl. 242.

Snout long, thin and flexible; one-fourth to two-fifths the total length; strengthened by numerous stellate, anastomosing ossifications. The distance from the tip of the snout to the last gill is more than one-half the total length. Mouth more than one-half the length of the head. Maxillaries meeting in the middle line in front, forming the whole margin of the upper jaw. Minute teeth on the jaws, the short palatines and the vomer of the young, but these are wanting in the adults. Eyes small; placed near the base of the snout. Spiracles opening at the base of the suspensorium, not far behind the eyes. Gill-flap long, reaching nearly to the insertion of the ventral fins. Two rows of long, slender gill-rakers on each gill-arch; the rows of each arch separated by a broad membrane. Pectorals and ventrals of moderate size. Anal placed behind the dorsal. Caudal large, forked, the two lobes nearly equally developed. The prolongation of the spinal column into the upper lobe is covered with narrow, bony plates. Color olivaceous or bluish; paler below. Attains a length of 5 to 6 feet, and a weight of 30 pounds or more.

Mississippi and Missouri valleys, and rivers of the South.

In Indiana this fish will doubtless be found all along the Ohio River. I have taken it at Madison, where it seems to be abundant. It has been taken at Cincinnati, Ohio. New Harmony (4, '88, 162). Prof. Evermann has taken it at Brookville, in the Whitewater (5, No. 2, 3), and at Delphi, in the Wabash. Vigo County (16, '93). Prof. Jordan records the finding of five specimens in the White River at Indianapolis

(1, '77, 46). Mr. Lewis H. McCormick reports (15) a single specimen having been taken in Lake Erie. Eigenmann reports having taken it in Lake Manitou (24, '93, 78).

There is no danger of confounding this fish with anything else. It needs only to be seen that it may be recognized. It appears to be abundant in the larger streams of our State. Its large size and its freedom from bones should make it a desirable fish, but its flesh is said to be tough. Prof. Forbes states that it is quite generally dressed for market and sold at the same rate as cat-fish. The paddle of this fish appears to be employed in stirring up the vegetation of the streams in which it lives, in order that it may obtain its food. Prof. S. A. Forbes (14, No. 2, 82) has given us the results of his observations on its habits:

“The alimentary canal of each of the five specimens examined was found full of a brownish, half-fluid mass, which, when placed under the microscope, was seen to be made up chiefly (in one case almost wholly) of countless myriads of entomostraca, of nearly every form known to occur in our waters, including many that have been seen as yet nowhere but in the stomachs of these fishes. Mixed with these, in varying proportion, were several undetermined and probably undescribed species of water worms (*Annulata*), most of them belonging to the family *Naididae*. Sometimes as much as a fourth of the mass was composed of vegetable matter—largely algæ, but included fragments of all the aquatic plants known by me to occur in the waters of the Illinois, except *Ceratophyllum*. Occasionally leeches (*Clepsine*), water beetles, a few larvæ of *Diptera* and *Ephemera* and water bugs were noticed.”

Prof. Forbes found extremely little mud mixed with the stomach contents. He believes that the close set and slender gill-rakers form a filtering apparatus which permits the river silt to pass out, while it retains even the smallest crustaceans. Of the breeding habits of this remarkable fish nothing appears to be known.

Order 2. GLANIOSTOMI.

THE STURGEONS.

Maxillary present. Opercular apparatus with opercular and interopercular bones. Head produced forward into a flat or subconical snout. Body provided with rows of bony bucklers. Mouth underneath the snout and transverse; capable of being protruded downward; toothless. Includes a number of large fishes, some of which inhabit the northern seas and ascend rivers in order to spawn, while others reside permanently in European and American rivers.

Family ACIPENSERIDÆ.

Body elongate, fusiform. Skin with five rows of bony plates, between which are numerous small bony deposits. Mouth rather small, projectile, toothless. Gill-rakers present, not slender. Dorsal and anal fins far back. Vertical fins with fulcra.

This family contains two genera, both of which are represented in Indiana.

- * Snout depressed, shovel-shaped. *Scaphirhynchus*, p. 160.
 ** Snout nearly conic. *Acipenser*, p. 161.

Genus SCAPHIRHYNCHUS Heekel.

Head broad and flat. Snout long, flat and pointed. A row of barbels across the lower side of the snout. No spiracles. Gill-membranes connected with the isthmus. Gill-rakers two rows on each arch, short, broad, and flat. Caudal peduncle long, depressed and entirely covered with bony plates. Tail ending in a long filament.

Besides the single American species there are a few species found in Asia.

SCAPHIRHYNCHUS PLATORHYNCHUS (Raf.).

Shovel-nosed Sturgeon; White Sturgeon.

Scaphirhynchops platyrhynchus, Jordan and Gilbert, 1882, 8, 88; Jordan, 1882, 2, 768; 12, 1884, 663, pl. 244; *Scaphirhynchus platyrhynchus*, Jordan, 1888, 7, 34.

The body rather slender, the head rather broad, becoming suddenly broader just behind the eyes, then passing into the flat, pointed snout. From the head the body tapers gradually to the tail, the upper lobe of which ends in a long, slender filament. This filament covered with minute bony plates. Caudal, dorsal, and anal fins rather small. Body protected by five rows of bony bucklers; these separated in front of the dorsal fin by spaces roughened by small bony deposits. Each plate with a median ridge, which terminates behind in a sharp point. Behind the dorsal the rows become confluent, thus entirely covering the caudal peduncle. From the head to the dorsal fin there are about eighteen plates in the dorsal row, and about thirty in the lateral row. Between the pectorals and ventrals there are about twelve plates in the lowest row. Head with a few short, backwardly directed spines. Its length contained in distance from tip of snout to base of caudal about four times. Snout one-half the length of the head. Barbels four. Lips thin and soft; the inside of the upper with numerous papillae. Color, olive above; pale below. Reaches a length of five, possibly of eight, feet.

A very common fish in all the larger streams of the Mississippi Valley.

In Indiana it has been taken by Prof. Evermann at Delphi, in the Wabash (23, '88, 44). I have seen a specimen which was taken in the South Fork of White River at Columbus. I have also seen numerous specimens taken in nets in the Ohio River at Madison. Vigo County (16, '93). Wabash River (3, II, 271).

Not much is known concerning the habits of this fish. Considering the small size of its caudal fin it must be a slow-swimming fish, which spends the most of its life on the bottom. Having no teeth it must subsist on small prey. I found the stomach of a specimen, taken at Madison, filled with the larvæ of some phryganeid insect and with grains of clean white sand. This sand had probably formed the cases of the larvæ. The shovel-nosed sturgeon is stated to spawn in May, ascending for this purpose the smaller streams. Dr. Jordan says that it is used somewhat for food, but does not seem to be highly valued.

Genus ACIPENSER Linn.

Head rather high, descending to the narrowed, nearly conical snout. A transverse row of four barbels. A spiracle over each eye. Gill membranes united with the isthmus. Gill-rakers present, lanceolate in form. Caudal peduncle short, higher than wide; not wholly covered with bony plates, the rows not being confluent on the tail. Tail not terminating in a filament.

Species marine or fresh water. Our single species not descending to the sea.

ACIPENSER RUBICUNDUS Le Sueur.

Lake Sturgeon; Ohio Sturgeon; Black Sturgeon; Rock Sturgeon.

Jordan and Gilbert, 1882, 8, 87; Jordan, 1882, 10, 766; Jordan, 1884, 12, 661, pl. 244; Ryder, 1888, 4, 234; Smith, 1892, 4, 185, pl. 21.

Body elongate, terete, tapering towards snout and tail. Back arched. Profile of head concave. Snout pointed (at least until a considerable size is reached), at length becoming blunt; about as long as the rest of the head, or shorter. Space between the rows of large plates occupied by numerous small rough scales. Shields of young individuals with a distinct keel, which ends in a hooked point. In old age the plates become smooth and more or less imbedded in the epidermis. Dorsal rows of plates fifteen or sixteen; lateral rows thirty to thirty-nine. Plates between the pectorals and ventrals nine or ten. Dorsal rays, forty; anal about twenty-seven.

Attains a length of six to twelve feet, and a weight of 150 pounds or more. Specimens nine feet in length have been reported.

Inhabits the Great Lakes, the rivers of British America, and the large rivers of the Mississippi Valley.

In Indiana it has been taken in the Wabash River from Vigo County to New Harmony (3, II, 156; 23, 1888, 55); Lake Michigan and Ohio River (9, 1874, 228); New Harmony (4, 1888, 42). Milner reports it abundant in Lake Michigan. It also occurs in the Ohio River. The specimens taken there were formerly regarded as belonging to a distinct species, but authors now consider them as less mature individuals. Prof. Milner regards the sturgeon as occupying the zone in the Great Lakes extending from shore to a depth of twenty fathoms. Michigan City (1, 1889, 253).

Prof. Milner (11, 1872-73) says that at the southern end of Lake Michigan these fishes begin to congregate early in June, near the shores and mouths of rivers for the purpose of depositing their spawn. Some taken at the mouth of the Calumet River on the first of July were emaciated, and only one in twenty contained spawn.

The eggs, and probably the very young, are preyed upon by other fishes. Some sturgeons even have been found with sturgeons' eggs in their stomachs. Prof. Milner does not think that the sturgeons, except the youngest, are greatly exposed to the attacks of other fishes. When small, they are so well defended by the sharp spines of their bony shields that they would make an uncomfortable mouthful for any fish of the lakes; while, after the spines have disappeared, the sturgeon has become too large for any fish to attack. Lampreys, however, fasten on them and produce sores and ulcerations.

The food of the sturgeon consists of small mollusks. Those with thin shells have these broken up; the thicker ones remain unbroken. They are also extremely fond of cray-fishes. They are not to any great extent eaters of fish spawn. Prof. Milner says that the sturgeon as food is not popular. Many of the fishes are taken in nets along the lakes and then thrown out and allowed to decay, in order that they may not get into the nets again. The French Canadians make a kind of soup of the sturgeon, which is palatable, resembling chicken soup. A considerable quantity of smoked sturgeon is prepared. Caviare is made out of the eggs, while the skin is stated to be capable of being converted into a valuable leather.

Dr. H. M. Smith, writing later than Prof. Milner (4, 1892, 185), states that the value of the sturgeon is yearly becoming more fully appreciated, so that the fishermen now receive the same price for it as for white-fish and lake trout. The sturgeon is captured mainly by means of gill-nets.

Dr. Ryder (4, '88, 234) has studied the sturgeons. During their larval stage they possess teeth. When hatched, the young sturgeon is barely half an inch long. Their earliest food probably consists of microscopic organisms. Later *Daphnida* and *Cladocera* are preyed on. Then the larger crustacea are sought after, Amphipods and Isopods. A good deal

of mud is taken in with the food. Sturgeons have been observed digging up the soft bottom with their snouts.

Sub-class 2. HOLOSTEL.

Primitive skeleton extensively ossified. Head fully protected by membrane bones. Body clothed with enameled bony plates or with cycloid scales. Opercular apparatus well developed. Branchiostegals present. Tail heterocercal, but not so strongly so as in the *Chondrostei*.

Two orders are recognized; these include fishes which are the modern representatives of forms that were abundant during former geological periods.

* Snout long; dorsal fin short and far back. *Ginglymodi*, p. 163.

** Snout short and blunt; dorsal very long. *Halecomorphi*, p. 167.

Order 3. *GINGLYMODI.

This order is distinguished by many remarkable characters. The bodies of the vertebræ, instead of being concave at both ends, as in other fishes, are strongly convex in front and concave behind. Each side of the lower jaw is composed of five bones, as in many reptiles. The maxillary bone is transversely divided into several pieces.

The body is elongate. The short dorsal and anal fins are situated close to the caudal. The head is produced into a long snout, and the jaws are armed with teeth which contain a pulp cavity, and the walls of which are fluted or folded. The order contains the family *Lepisosteidæ*.

Family LEPISOSTEIDÆ.

THE GAR-FISHES.

Form elongated and subcylindrical. Head long, terminating in a depressed snout; covered with enameled bones. Mixillary, premaxillary, and lower jaw furnished with sharp conical, fluted teeth. Dorsal and anal fins small, set near the caudal. Body covered with hard, enameled, rhomboidal scales.

A single genus, containing fishes which are of great interest to the student of biology, but which are of no economic value.

Genus LEPISOSTEUS Lacépède.

Upper jaw longest. Both jaws with large teeth set among numerous smaller ones, the larger teeth fitting into pits in the opposite jaw. Palatines with small, sometimes also with large, teeth. No teeth on tongue. Gill-rakers present, short. Gill-membranes broadly attached across the isthmus and free from it. Lateral line present. Ventrals situated about the middle of the body. Young with the tail ending in a filament.

A genus containing three species, all of which are represented in Indiana.

- * Snout more than twice the length of the remainder of the head ; at least fifteen times as long as its least width. *osseus*, p. 164.
- ** Snout not twice as long as the rest of head ; its medium width in its length about three and one-fourths times or more.
platostomus, p. 165.
- *** Snout usually, but not always, shorter than rest of head ; its medium width in its length three times or less.
tristæchus, p. 166.

LEPISOSTEUS OSSEUS (Linn.).

Long-nosed Gar.

Jordan and Gilbert, 1882, 8, 91 ; Jordan, 1882, 2, 770 ; Jordan, 1884, 12, 663.

Body nearly cylindrical, with a long, pointed head ; snout long and slender, its length more than twice that of the rest of the head, its least width contained in its length fifteen to twenty times ; whole head in length to caudal fin three times ; dorsal rays, eight ; anal rays, nine ; scales, about sixty horizontal rows ; color, olivaceous, paler below ; fins with black spots ; young with a lateral dark band, or row of dark spots ; may attain a length of five or six feet ; usually much smaller.

New York, New Jersey, to Florida ; west to Mexico ; north to the Great Lakes. Occurs mainly in lakes and the larger streams, but not often in the smaller streams.

In Indiana, this fish probably is to be found in every considerable body of water. In the larger rivers it is entirely too common. It was taken in the Wabash River by LeSueur (3, II, 329). Messrs. Jenkins and Evermann report it as occurring in the Upper Wabash and Tippecanoe Rivers (23, '88, 44). Dr. Jenkins also found it at Lake Maxinkuckee. Messrs. Evermann and Quick found it at Brookville, Franklin County (5, No. 2, 3). Dr. Jordan captured specimens at Indianapolis, in White River (1, '77, 377). I have seen it taken in numbers at Madison, from the Ohio River. The species appeared to be common at Rockford, in Jackson County. In the Great Lakes, Professor Milner found this fish occupying the zone from the shore to a depth of twenty fathoms. Vigo County (16, 93) ; New Harmony (4, '88, 162) ; Whitley County (Kirsch, 4, '94, 36) ; Owen and Spencer Counties (Eigenmann, 24, '93, 79).

As is true in the case of many of our aquatic animals, the habits of the long-nosed gar are not well known. It is at least a free swimmer and prefers abundant space, since it seldom visits small streams. They are usually regarded by the fishermen as strong and

vigorous fishes, and are greatly disliked by them on account of the injuries which the fishes do to the nets. They appear, however, capable of laying aside cares of life and enjoying themselves. Dr. Kirtland says: "It may be seen, apparently sleeping, on the surface, and gently carried around on an eddy for an hour at a time." The formidable array of extremely sharp teeth in the long jaws would impress one with the idea that the gar is capable of capturing the most active and most slippery of fishes. Dr. Jordan, however, states (2, 771) that he has never known it to attempt to take food, although he has frequently seen them basking in a school of minnows, and had kept them in aquaria. He has never found any fish in their stomachs, and out of eight examined by Prof. Forbes, the stomachs of all but one were empty; that one containing a single cray-fish. These observations really tend to prove that the gars very rarely eat anything. In a later publication Prof. Forbes (14, II, 478) places the gars among the principal fish-eaters among our species, those which make fish at least 75 per cent. of their diet. I have been told that one was found to have eaten a snake.

Gars are not regarded as having any value as food, although I have heard of their being eaten. Their flesh is said to be rank and tough. Considerable difficulty might be experienced in removing their armour of hard, imbricated scales, although scalding might have some effect on it.

The gar deposits its eggs in the early spring. From the studies of Profs. Alex. Agassiz, E. L. Mark, and S. Garman it has been learned that in the St. Lawrence River the eggs are laid at night about May 20. In our region this may occur still earlier. The eggs are large, looking much like those of toads, and having a large outer membrane and a small yolk. They are very viscous, and stick to whatever they come into contact. The young were found to begin hatching in six days. They are not greatly different from the young of other fishes. Their food consists of the larvæ of mosquitos, great numbers of which are devoured. They have, at the tip of the snout a suctorial disk, by means of which they can fasten themselves to objects. The vertebral column of the fish, until a considerable size is reached, is prolonged into a filament along the upper edge of the tail.

Lepisosteus platostomus Raf.

Short-Nosed Gar.

Jordan and Gilbert, 1882, 8, 91; Jordan, 1882, 2, 773; Jordan, 1884, 12, 664, pl. 241.

Resembles the preceding, but has a shorter head, and a shorter, broader snout. The latter is from one to one and three-fourth times as long as the rest of the head; its median width is contained in its length about three and one-fourth times. Length of whole head in length of fish to base

of caudal about three times. Dorsal, eight; anal, eight. Scales about sixty along lateral line. Color of adults, dark olive above, paler below; some silvery on sides of head and body. Vertical fins and sometimes sides of body with dark blotches. May reach a length of five feet, but specimens of this size must be extremely rare. They are usually about two feet. The species has about the same range as the preceding, but is more common in the Southern States than farther north.

In Indiana this species seems to be quite rare. Prof. Jordan states that he has seen specimens from Lake Michigan (10, '74, 227), and Prof. Jenkins reports (16, 93; 23, '88, 55) having taken specimens from the Wabash in Vigo County. Vincennes and New Harmony (4, '88, 162). It was also taken in the Wabash River by the French naturalist, LeSueur (3, II, 329). Lake Manitou (Eigenmann, 24, '93, 79).

Less is known about the habits of this gar than about those of the long-nosed gar. Their habits are probably quite similar. While both species frequent the larger streams, the short-nosed gar, at least, can live in very impure waters. Along the Lower Mississippi I have seen large numbers of them in a small, shallow, and muddy pond, having been left there by the retiring of the high waters. In the Great Lakes this gar appears to live from shore to a depth of twenty fathoms (11, '72-3, 36). Prof. Forbes (14, '88, 464) states that such individuals as were examined by himself had eaten nothing but fishes.

LEPISOSTEUS TRISTÆCHUS (Bloch and Schneider).

Alligator Gar.

Jordan, 1888, 7, 36; *Litholepis tristæchus*, Jordan and Gilbert, 1882, 8, 92; *Litholepis spatula*, Jordan, 1882, 2, 774; *Lepidosteus spatula*, 1884, 12, 664.

Resembles the two preceding, but attains a larger size and has a shorter head and a shorter, wider snout. Head in the length to base of caudal, three and one-half times. Snout usually not quite so long as the rest of the head, but sometimes a third longer; its median width contained in its length three times or less. There is also a second row of large teeth present in the upper jaw, situated along the outer edge of the palatine bone. However, the smaller individuals of *L. platostomus* have similarly placed teeth, and hence care must be observed. In *platostomus* the teeth referred to are shed later in life. Dorsal rays, eight; anal rays, eight. Scales along the lateral lines about sixty. Color similar to the others. Length sometimes ten feet. This species is distributed from the Ohio River through the Southern States to Cuba and Central America. It is undoubtedly rare in the rivers of Indiana. Rafinesque and Kirtland have recorded it from the Ohio River. Dr. Jordan reports it from New Harmony (4, '88, 162).

This is undoubtedly the most formidable fish of our rivers. Rafinesque says that the length is from four to ten feet, and that one was caught which weighed 400 pounds. He further says that it sometimes lies asleep or motionless on the surface of the water, and may be mistaken for a log or a snag. It must, according to the same writer, be taken with a net or a strong cord, since neither the prongs of the gig nor rifle balls will penetrate its scales. Like the other gars, it is not regarded as fit for food. As regards the food-habits of the fish, Mr. Stearns writes that it will eat anything. It preys largely upon all the fishes smaller than itself, and its young are believed to be destructive to the eggs and young of other species. Dr. Jordan (11, '85, 801) states that it is difficult to distinguish this gar specifically from *L. platostomus*. I do not think that satisfactory characters separating them have been proposed. Dr. A. S. Packard, in his text-book on Zoölogy, states that the eggs are laid in rope-like masses and hung on the snags of sunken logs.

Order 4. HALECOMORPHI.

This order, more closely than any of the preceding, approaches the members of the *Physostomi*. The vertebrae are biconcave, the mandible consists of fewer bones than it does in *Lepisosteus*, the maxillary is not transversely segmented, and the tail is not strongly heterocercal.

Body rather elongate; the snout not long. Dorsal fin long. Teeth not fluted. This order takes its name from its affinities with the shads.

Family AMIIDÆ.

THE BOW-FINS.

Form elongated. Head short, terminating in a rounded snout; covered with hard, corrugated bones. Teeth not fluted; on most of the bones of the mouth, including the maxillaries. Body clothed with firm cycloid scales. Tail not strongly heterocercal.

Genus AMIA Linn.

Mouth horizontal. Maxillary furnished with a supplementary bone. Teeth on maxillaries, premaxillaries, vomers, palatines and pterygoids. A bony plate between the rami of the jaws. No spiracles. Cheeks covered with a bony plate. Gill-membranes free from isthmus and from each other. Lateral line present. Dorsal fin long; anal fin short. Contains only a single known living species.

AMIA CALVA Linn.

Bow-fin; Grindle; Mud-fish; Dog-fish.

Jordan and Gilbert, 1882, 8, 94; Jordan, 1882, 2, 777; 1884, 12, 659, pl. 241; Smith, H. M., 1892, 4, pl. 22.

Body compressed behind, the caudal peduncle deep. Head somewhat depressed, descending to the snout. Head in the length nearly four times; snout in the whole length of the head about four; rounded. Jaws even. Large teeth on the jaws and palatines; bands of smaller teeth on the vomers and pterygoids. Branchiostegals twelve. Gill-rakers short, stout. Eye rather small. Depth of body in the length four to five times. Ventrals about the middle of the body. Dorsal fin long and low, occupying more than one-half the length of the back; its rays about fifty. Anal short; its rays ten to twelve. Caudal rounded. Scales 8-67-11. Color in life green above, with a bronzy luster and with spots and anastomosing bands of black; paler below. Often some spots on the lower jaw. Fins dark. Tail of the male with a round, dark spot, surrounded with an orange border. This spot wanting in the female. Length of male reaching about eighteen inches; that of female about twenty-four to thirty inches.

Great Lakes and streams of the Mississippi Valley; Lake Champlain to Texas.

In Indiana Dr. Jordan records this fish from Lake Michigan (10, '74, 226); Maumee River (1, '77, 46); Ohio River. It was taken in the Wabash River by Le Sueur, the French naturalist (17, XIX, 432). Prof. Jenkins has taken it in Lake Maxinkuckee (23, '88, 55) and in the Wabash River in Vigo County (16, 93). Prof. Gilbert reports having found it abundant in the lowlands of Greene County (23, '84, 206); Posey County (4, '88, 162). It is common in the lakes in northwestern Indiana, near Chicago. Eel River basin (4, '94, 36).

Prof. Milner gives the Bow-fin as one of the fishes which inhabit the Great Lakes and occupy a zone extending from the surface to a depth of about twenty fathoms. In the rivers it is regarded as preferring the more sluggish portions of the stream. It is extremely tenacious of life and can remain out of the water for a long time. It is said to make excellent bait, and may be kept for a long period in crowded aquaria without change of water. It lives long on the hook. These fishes are very voracious, and probably prey on all animals of suitable size. They have been known to bite a two-pound fish clean in two at a snap. Dr. Forbes found in their stomachs the remains of various kinds of fish, uni-valve and bivalve mollusks, insects and insect larvæ, crayfishes and the smaller crustaceans. As food they are generally regarded as worthless. The flesh is pasty, as any one knows who has attempted to clean a

skeleton; and Dr. Jordan says that it almost all disappears in the process of frying. On the other hand, Prof. Forbes states (14, No. 2, 68) that it is generally eaten in southern Illinois. While of no value as food, they are quick to bite and full of pluck. They thus furnish sport to the fisherman who fishes for sport and not for filling the frying-pan.

Dr. Fülleborn, of Berlin, Germany, has most recently investigated the breeding habits of this fish. In the region about Madison, Wisconsin, the eggs are deposited during the months of April and May. In the center of a mass of aquatic vegetation a clear space some two feet across and nearly three feet deep would be found, the bottom of which was formed of a fine network of roots and delicate branches. This "nest" had the appearance of having been made by the fish, and in them was frequently found the male. On the bottom and sides of this nest the eggs were laid in thousands. Each egg has a diameter of about one-twelfth of an inch. The male remains about the nest until the brood is hatched and the young have reached a length of a little more than one-half inch. The brood then follows the male, who remains near shore. About June 1 the adult fishes and the young suddenly disappear, having apparently betaken themselves to deep water. The eggs appear to hatch in from six to fourteen days after deposition. When the young are first hatched they are only about one fifth inch long.

Sub class 3. PHYSOSTOMI.

Primitive skeleton thoroughly ossified. Membrane bones well developed. Body naked, or covered with scales, which, except in rare cases, are cycloid. Tail, at least to external view, not heterocercal. Fin-rays soft and articulated, except occasionally one or two of the most anterior of the dorsal and pectoral. Ventrals, if present, abdominal. Air-bladder, if present, with a duct opening into the alimentary canal.

The members of this sub-class are, in the last resort, distinguished from the *Physoclisti* only by the possession of a duct from the air-bladder to the alimentary canal. The *Physoclisti* have, in the great majority of cases, the ventrals either thoracic or jugular; a portion or the whole of the dorsal and anal made up of spines; and the scales are very often ctenoid. Or, if the fins all consist of soft rays, the ventrals are thoracic or jugular. Even the test just given fails in the *Scomberesocidæ*; but these do not concern us, they being marine. Any of our fishes which have the dorsal and anal fins composed wholly of soft rays (except occasionally the most anterior one or two) and with the ventrals abdominal belong to the *Physostomi*. The *Physostomi* and the *Physoclisti* form two great bodies of

fishes, for the most part now widely separated, but between which, like intercurrent strings, there yet remain a few somewhat anomalous families.

Orders of PHYSOSTOMI.

- * Body of normal, fish-like form; ventrals rarely wanting.
 - a. Skin naked, devoid of scales; barbels about mouth; pectorals and dorsal each with spine. (Cat-fishes.)
Nematognathi, p. 170.
 - aa. Skin usually furnished with scales; barbels rarely present.
 - b. Lower pharyngeals falciform, armed with a few teeth in from one to three rows; no teeth in the mouth. (Suckers and minnows.)
Eventognathi, p. 181.
 - bb. Lower pharyngeals not falciform, and without enlarged teeth. (Moon-eyes, herrings, shad, white-fish, etc.)*
Isospondyli, p. 223.
 - c. Shoulder girdle furnished with a precoracoid arch.
 - cc. Shoulder-girdle without precoracoid arch; jaws with teeth. (Blind-fishes, toothed minnows, mud minnows and pikes.)
Haplomi, p. 233.
- ** Body greatly elongated and snake-like; ventrals wanting. Eels.
Apodes, p. 243.

Order 5. NEMATOGNATHI.

THE CAT-FISHES.

Body possessing the normal, fish-like form. The skin is naked, without scales, but some exotic forms possess bony scutes. The maxillaries are rudimentary, forming the base of the two longest barbels. Suboperculum absent. The four anterior vertebræ are coalesced and connected with the organs of hearing. It contains with us only the following family:

* The following remarks concerning fishes belonging to the two orders, *Isospondyli* and *Haplomi*, may be of assistance to students in identifying our Indiana species, but these statements, it must be understood, do not apply to all *extra-limital* species.

Our isospondylous fishes are more or less compressed, both as to head and body. In all, the head is devoid of scales. All possess an adipose fin, except the gizzard-shad (*Dorosoma*), the shads (*Clupea*), which have no teeth, or very feeble ones, and the moon-eye (*Hiodon*), which has a very complete dentition, including teeth on the tongue. The dorsal fin is usually medium in position (well behind in *Hiodon*, however). The gill-rakers are often, but not always, long. The lateral line of pores is usually present, but wanting in the shads and the gizzard-shad.

The *Haplomi*, on the other hand, have the body compressed behind, but rather wide and depressed in front, and the head is rather flat. The head always has scales on some part, except in the case of the blind cave-fishes (*Amblyopsidæ*). There is never an adipose fin present, while the dorsal is far back in the region of the anal. The lateral line is wanting, or nearly so, except in the pikes.

Family SILURIDÆ.

THE CAT-FISHES.

Maxillary bones rudimentary, found at the base of the lateral barbels. Margin of the upper jaw formed by the premaxillaries. Two or more pairs of barbels. In all our species the rayed dorsal is present and preceded by a spine; there is an adipose fin present; and the pectorals are preceded by a stout spine. All our Indiana species are included under the following four genera:

- A. Supraoccipital bone not reaching back to insertion of dorsal spine, leaving in the middle line an interval filled with soft tissues.
- a. Head broad and flat. Ventral rays, nine. Supraoccipital bone not extending backward beyond a line joining the upper ends of the gill-openings.
- b. Adipose fins not free behind, running into the caudal; branchiostegals, nine on each side. *Noturus*, p. 171.
- bb. Adipose fin free behind; branchiostegals twelve on each side. *Leptops*, p. 175.
- aa. Head not so broad and flat. Ventral rays, eight. Supraoccipital extending further back than the gill-slits. *Ameiurus*, p. 176.
- AA. Supraoccipital bone reaching back to insertion of the dorsal spine; no soft interval. Tail forked. *Ictalurus*, p. 180.

Genus NOTURUS Rafinesque.

Body elongated, compressed behind, depressed in front of the dorsal fin. Head broad and flat. Supraoccipital not reaching backward beyond a line joining the upper ends of the gill-slits, and not reaching the base of the dorsal fin. Caudal rounded and inserted on a rounded base. Dorsal not free behind, but running into the anal. Ventral rays, nine; branchiostegals, nine.

Most of the species of *Noturus* are small, the largest not exceeding a foot in length. They are of no importance economically. In the axil of the pectoral fin is found a poison-pore, out of which, Cope says, may be drawn a long gelatinous style, which is branched at the inner end.

ANALYSIS OF THE SPECIES.

- A. Premaxillary band of teeth not narrowing to a point behind, but ceasing abruptly.
- a. Upper jaw projecting beyond the lower.
- b. Pectoral spines with the teeth on the hinder border stronger than those in front. *cleutherus*, p. 172.

- bb. Pectoral spine rough in front, grooved behind.
nocturnus, p. 172.
- aa. Jaws nearly equal.
- c. Pectoral spine smooth in front, grooved behind.
gyrinus, p. 173.
- cc. Pectoral spine with small teeth in front, stronger, recurved ones behind.
miurus, p. 173.
- ccc. Pectoral spine with the teeth in front short and recurved, the hinder ones weak.
exilis, p. 174.
- AA. Premaxillary band of teeth narrowed abruptly behind, then extending back to a point.
flavus, p. 174.

NOTURUS ELEUTHERUS Jordan.

Jordan and Gilbert, 1882, 8, 99; *Schilbeodes eleutherus*, Eigenmann and Beeson, 24, '93, 81.

Body, stout; head, broad and flat, contained in the length of body three and seventy-five one-hundredth times; eye, small, in length of head, five and one-half times; snout projecting considerably beyond the lower jaw; anal rays, thirteen; pectoral spine about half the length of head, its front with small recurved teeth, its hinder border with strong recurved teeth. The color is brownish, with two or three darker bands across the back. In 7, 42, the color is stated to be nearly plain brownish, with numerous small dots above.

This species resembles *N. miurus* so closely that there is much doubt of its distinctness. (11, '85, 802.) White River, Indianapolis.

The length is given at four inches. Professor Kirsch reports (4, '94, 36) that he has taken a number of specimens in Eel River, in North-eastern Indiana. Eigenmann has found it at Gosport, in Owen County. (24, '93, 81.)

NOTURUS NOCTURNUS Jordan and Gilbert.

Jordan and Gilbert, 1886, 23, 6; 1891, 4, 138.

Body rather elongated and slender; depth in length, about five and one-half times; head moderate, flat; its width in length of body, five times; tapering from the opercles to the rounded and projecting snout; snout, in the head, three to three and five-tenths times; dorsal rays, I, 6; anal rays, 15 or 16; its base about equal to the length of the head; pectoral spine weak; its length in the head close to two and one-fourth times; rough in front, grooved behind; adipose fin passing into the caudal almost without notch; color almost uniform brown, paler below; no stripes. Length, two to three inches.

Originally described from the rivers of Arkansas, where it appears to be abundant. More recently it has been taken at Evansville, Ind. (4, 1891, 138.)

NOTURUS GYRINUS (Mitchill).

Tad-pole Cat-fish.

Jordan and Gilbert, 1882, 8, 98; *Schilbeodes gyrinus*, Eigenmann and Beeson, 1893, 24, 81.

Body moderately elongated; head broad and flat; the snout rounded, not projecting beyond the lower jaw; head widest at the pectoral spine, where the width is equal to the length. Three and one-half to four in length of body. Depth of body in its length four to five times. Distance from snout to dorsal contained in length not quite three times. Adipose fin continuous with the rudimentary caudal rays, with more or less of a notch. Anal rays, fifteen or sixteen. Pectoral spines about one-half the length of the head; almost devoid of serrations and grooved behind. A conspicuous poison pore behind the pectoral. Color yellowish, with the upper surface in front of the dorsal brownish; sides usually with one or more dark streaks. Length five inches.

Found from New England to Minnesota and south to Louisiana.

In Indiana it has been captured at the following points: Posey County (4, '88, 162), Monroe County (1, '85, 410), Indianapolis (1, '77, 377), Lake Maxinkuckee (4, '88, 158), Carroll County (23, '88, 44), Whitley County (4, '94, 36), Kankakee River at Riverside and in creek near Michigan City (24, '93, 82). It is moderately abundant. It is accustomed to hide about under stones and logs. According to Prof. S. A. Forbes (14, '88, 462), its food consists of the larvæ of aquatic insects, minute crustaceans, and a few worms. Some filamentous algæ were also found in the stomachs of two specimens. I have found no account of the breeding habits of the species.

NOTURUS MIURUS Jordan.

Cross-barred Stone Cat.

Jordan and Gilbert, 1882, 8, 99. *Schilbeodes miurus*, Eigenmann, 1893, 24, 81.

Body rather stout; depth in length about five; width at the shoulders in the length, four and one-fourth; head in length, three and three-fourths to four. Outlines of head curving toward the snout, which is rounded, and somewhat overhangs the lower jaw. Eye in length of head, four. Adipose fin partially separated from the caudal rays by a shallow notch. Anal with twelve or thirteen rays; its basis in length of body nearly six times. Pectoral spines strong, curved, the front border with small teeth which are turned toward the base, the hinder border with strong recurved teeth; the spines a little more than half the length of the head. Body olive or grayish, with blotches of brown. Top of

head, a streak on the opercle, another over each pectoral, a band across the adipose fin, and the base of the caudal brown. Pectorals, dorsal and anal each with a brown cross-band. Length four or five inches.

Distributed from Minnesota south to North Carolina and Louisiana.

In Indiana it appears to be quite common, about as abundant as *N. flavus*, and has been taken at the same localities. Vincennes, New Harmony and Patoka, in Gibson County (4, '88, 162); White River, Owen County (4, '88, 166); Monroe County (1, '85, 410); White River, Lawrence County (23, '84, 197); White River, Indianapolis (1, '77, 377); Fourteen Mile Creek, Clark County (23, '88, 56); Ohio County (23, '88, 56); Tippecanoe River and Deer Creek (4, '88, 158); streams of Carroll County (23, '88, 44); Vigo County (16, '94); Eel River, in northeastern Indiana (4, '94, 36).

This species has much the same habits, probably, as its relatives, hiding away under stones and logs. It is said to form an attractive species for the aquarium.

NOTURUS EXILIS Nelson.

Slender Stone Cat.

Jordan and Gilbert, 1882, 8, 100; *Schilbeodes exilis*, Eigenmann and Beeson, 1893, 24, '81.

Body moderately elongate, the depth in the length nearly six times. Head in length four; flat, narrow, its width in length of body over five times; its width at the shoulder maintained nearly to the eyes, the outlines then rounding to the snout. Jaws nearly equal. Pectoral spines weak; their length in head three times; weak, retrorse teeth on both borders. Anal rays, fourteen to seventeen; anal basis in length of body about four and one-half times. Caudal peduncle deep and compressed.

Color much and irregularly mottled with brown. Pectorals brown; tips of dorsal and caudal, as well as base of caudal rays, brown. Length, about four inches.

Distributed from Indiana to Kansas. Apparently everywhere rare. In Indiana it has been taken in Carroll County (23, '88, 44), Monroe County (1, '85, 410.)

Nothing distinctive is known concerning the habits of this species.

NOTURUS FLAVUS Raf.

Yellow Stone Cat.

Body rather elongated; the depth in the length about six times. Head flat; its width just in front of the pectoral spine in length of body four and one-half times; the lateral outlines curving gently to the angle

of the mouth, then rounding into the broad snout. Upper jaw projecting beyond the lower. Premaxillary band of teeth with a narrow process running back on each side. Pectoral spine in length of head two and two-thirds times; with retrorse teeth in front, nearly smooth and grooved behind. Adipose fin with a notch where it joins the caudal. Dorsal rays, I, 6; anal, 16. Length, twelve inches. Yellow, tinged more or less with brown. Pectorals and caudals, brownish yellow.

Virginia and Tennessee north to Canada. In Indiana it has been found at many points. Vincennes and New Harmony (4, '88, 162); White River at Spencer and in Eel River, Owen County (4, '88, 166); East Fork White River, Lawrence County (23, '84, 199); White River at Indianapolis (1, '77, 377); Ohio County (23, '88, 56); Brookville, Franklin County (5, No. 2, 3); Kankakee River at Plymouth (4, '88, 155); Lakes of Laporte County and St. Joseph's River (1, '7, 46); Carroll County (23, '88, 44); Monroe County (1, '85, 410); Great Lakes, from shore to twenty fathoms, (11, '72, 36); Eel River basin (4, '94, 36).

Dr. Jordan (2, 800) states that it is a sluggish fish, lurking under stones and logs. It is of no use as food. It seems strange that so little is known concerning the habits of so abundant and so large a member of this interesting genus. Dr. T. H. Bean states (25, 19) that this and the other stone cat-fishes make excellent bait in fishing for the black bass.

Genus LEPTOPS Raf.

Body elongated, depressed in front, compressed behind; head broad and flat; mouth large, the lower jaw projecting; supraoccipital not reaching base of dorsal fin; branchiostegals, twelve on each side; adipose fin free behind, not running into the caudal; ventral rays, nine; size attained, large.

LEPTOPS OLIVARIS (Raf.).

Mud Cat; Yellow Cat.

Pilodictis olivaris, Jordan and Gilbert, 1882, 8, 102; *Pelodichthys olivaris*, Jordan, 1882, 2, 797; *Leptops olivaris*, Jordan, 1884, 12, 628.

Body long and slender, depressed in front, compressed behind; head broad and flat, its length in length of body about three and five tenths, its breadth in the same distance about five; lower jaw projecting decidedly beyond the upper; premaxillary band of teeth, with a narrow process projecting behind; eyes small, about nine in head; dorsal with a stiff spine and six or seven rays; adipose dorsal with its hinder edge free from the back, as in *Ameiurus*; caudal cut off nearly square, with numerous rudimentary rays above and below; anal with twelve to fifteen rays. Pectorals with a curved spine, which is serrated in front and behind.

Color above yellowish, mottled with brown; sometimes with a brown

band across the back through the dorsal and another through the adipose. Each of the paired fins crossed by a dusky band. Reaches a length of three feet or more and a weight of fifty to seventy-five pounds.

Indiana to the Gulf of Mexico. In our State it appears to have been taken only in the southern portion. Ohio River (17, XV., 136); Vigo County (23, '88, 55; 16, 93); Ohio County (23, '88, 56); Brookville, Franklin County (5, No. 2, 4); Monroe County (1, '85, 410); Lower Wabash (1, '88, 46); East White River, Lawrence County (23, '84, 165); Patoka Creek in Gibson County (4, '88, 162); Evansville (4, '88, 165); White River at Indianapolis (Jordan).

This appears to be a mud-loving fish. It is usually found only in the larger streams. Its appearance is not prepossessing, but it is esteemed one of the best of the cat-fishes as an article of food. Forbes states that so far as known it feeds on animal food, chiefly fishes, such as sun-fishes, minnows and other cat-fishes. I have found in the axil of the pectoral fins of this fish a poison pore similar to that found in several or all of the species of *Noturus*, but apparently somewhat rudimentary. The two genera are closely related.

Genus AMEIURUS Raf.

Body moderately elongated; heavy in front; compressed behind. Supraoccipital bone extending backward behind a line joining the gill-slits, but not reaching the base of the dorsal spine. Caudal fin truncated or forked. Ventral rays eight, the first not divided.

A genus containing a considerable number of species, the members of which are familiar to all. Prof. S. A. Forbes found that the young of most of the species live almost wholly on entomostraca. For an interesting account of the breeding habits and development of the members of this genus see that of Dr. J. A. Ryder in "Bulletin U. S. Fish Commission, vol. III, 1883, page 225. Some of the species of *Ameiurus* lead their young about in schools near the shore and care for them as a hen does for her chickens.

A. Caudal fin not forked, at most slightly notched.

a. Anal fin long, its base more than one-fourth the length of the body; anal rays, twenty-four to twenty-seven.

natalis, p. 177.

aa. Anal basis short, four to five times in body; its rays eighteen to twenty-two.

b Lower jaw projecting beyond the upper; anal rays, twenty.

vulgaris, p. 177.

bb. Lower jaw not projecting; anal rays usually twenty-one or twenty-two.

nebulosus, p. 178.

aaa. Anal short, its basis nearly five in body; its rays, seventeen to nineteen.

melas, p. 178.

AA. Caudal fin deeply forked.

nigricans, p. 179.

AMEIURUS NATALIS (LeSueur).*Yellow Cat-fish.*

Amiurus natalis, Jordan and Gilbert, 1882, 8, 105; Jordan, 1882, 2, 790.

Body moderately long; compressed behind. Depth in length, four and one-half. Head broad and flat; widest through the opercles; the outlines then rounding in the broad snout; width of head in length of body, four; length of head in body, three and two-thirds. Upper jaw somewhat projecting. Length of pectoral spine in head, two and one-half. Anal fin long, its basis in length of body three and one-half times; its rays, twenty-four to twenty-seven. Caudal slightly or not at all notched. Color brownish, in life yellowish, paler below. Fins dusky. Length, a foot or a little more.

Distributed from Canada to Texas. In Indiana it has been taken at the following localities: Posey County (4, '88, 162); Brown and Monroe counties (1, '85, 410 and 23, '84, 200); Lower Wabash River (1, '77; 45); Ohio County (23, '88, 56); Brookville (5, No 2, 4); lakes of LaPorte County, St. Joseph's and Tippecanoe rivers (1, '77, 45); White River at Indianapolis (1, '77, 377); Lake Maxinkuckee (23, '88, 55); Carroll County (23, '88, 44); Eel River basin (4, '94, 36); Decatur County (Shannon).

Forbes, who has investigated the food-habits of this fish (14, II, '88, 459) says that it lives for the most part in small streams. The food is almost wholly animal. One had been eating a dead cat. A large proportion of fishes enters into the diet; conspicuous among them were cat-fishes. A considerable part of the diet consists of insects.

The larger specimens of this fish may do for food, but it is usually too small to pay for the dressing. The capture of this and other cat-fishes furnishes amusement to boys.*

**AMEIURUS VULGARIS* (Thompson).

Long-jawed Catfish.

Amiurus vulgaris, Jordan and Gilbert, 1882, 8, 105; Jordan, 1882, 2, 791.

Body rather stout and heavy; depth in length four and one-fourth to five times; rather high at the front of the dorsal and sloping in a nearly straight line to the snout, which is narrow. Head longer than wide, its length in body usually less than four times; high and convex above. Lower jaw heavy and projecting beyond the upper. Anal base short, contained in length of body five times; its rays nineteen or twenty. Color dark brown to black, paler below. Maximum length about eighteen inches.

Distributed from the region of the Great Lakes into British America. In "The Fishes of Ohio," Dr. Jordan states that it is sometimes found in the Ohio River. I find no record of its having been taken in Indiana streams, but Dr. Jordan (14, No. 2, 66) says that it is found in Lake Michigan. Eigenmann and Beeson include it in their list of Indiana fishes (24, '93, 80).

AMEIURUS NEBULOSUS (LeSueur).

Bull-head; Horned Pout.

Jordan, 1885, *12*, 628, pl. 233; *Amiurus catus*, Jordan and Gilbert, 1882, *8*, 104; Jordan, 1882, *2*, 793.

Body short and heavy; depth in the length four to four and one-half. Profile a nearly straight and rapid slope from the dorsal to the snout. Head longer than wide, the length in length of body about three and one-half. Jaws about equal, or the upper slightly the longer. Snout broad and rounded. Anal base in length of body four times; its rays usually twenty-one or twenty-two, occasionally only twenty. Caudal slightly notched. Color a livid brown, yellow below. The variety *marmoratus* is recognized, differing in having the body mottled with brown, greenish and whitish. The length probably never exceeds a foot and a half.

Habitat from Wisconsin to New England and Texas. Lake Michigan (*14*, No. 2, 66); Vigo County (*16*, 94); Tippecanoe River (*1*, '77, 46 and *23*, '88, 44); lakes of Laporte County, St. Joseph's and Maumee Rivers (*1*, '77, 46); Greene County (*23*, '84, 205); Eel River (*4*, '94, 36); Laporte County (*24*, '93, 80). The variety *marmoratus* has hitherto been known from Southern Illinois to Florida, but Dr Gilbert reports (*23*, '84, 205) finding numerous specimens of it in Greene County. *A. nebulosus* appears to be not so common in Indiana as *A. melas*. Prof. Forbes thinks that the form *marmoratus* inhabits only the deeper and larger streams, while the typical *nebulosus* prefers muddy ponds and streams. Forbes found that the food of this species was, to the extent of one-fourth, vegetable matter. Fishes constituted a fifth of the food, mollusks more than a fifth, insects nearly a fourth, and crustaceans about one-eighth.

AMEIURUS MELAS (Raf.).

Bull-head.

Amiurus melas and *xanthocephalus*, Jordan and Gilbert, 1882, *8*, 104; Jordan, 1882, *2*, 793, 796; 1884, *12*, pl. 233.

A short and heavy-bodied species; depth in length about four times. The profile rather steep and nearly straight. Head about as broad as long, its length in length of body three and one-half to four times. Snout broad and rounded; jaws about equal. Anal base short, about five times in body; its rays seventeen to nineteen. Color usually quite dark. Sometimes on being drawn from the water the fish is yellow, but this changes in spirits to brown. Length not exceeding a foot.

Distributed from New York to Western Kansas. It is doubtless found in every stream and considerable pond in the State. Vigo County (16, '94); Carroll County (23, '88, 44); Lake Maxinkuckee (23, '88, 55); Monroe County (1, '85, 410); Indianapolis (1, '77, 377); Brown County (23, '84, 199); Greene County (23, 84, 206); New Harmony (4, '88, 162); Eel River at Cataract (4, '88, 167); Laporte County (24, '93, 80); Tippecanoe River at Winamac.

This species, like most of its relatives, is a lover of muddy streams and ponds. Concealed in such places, it lies in wait for its prey, which is probably anything that can be swallowed. Forbes (14, No. 2, 82) found the stomach of one specimen to be filled with vegetable matter, mostly confervoid algæ. Another contained insects and young crayfishes. A specimen taken by myself at Winamac on June 30 was much distended with spawn. Probably it was about ready to be deposited. I recommend to all a reading of the remarks of the editor of the Milwaukee Sun on the bullhead, which were reprinted in Dr. Jordan's "Fishes of Ohio," page 794.

AMEIURUS NIGRICANS (LeS.).

Mississippi Cat-fish; Great Cat-fish.

Jordan, 1888, 7, 39; *Ictalurus lacustris*, Jordan and Gilbert, 1882, 3, 108; *I. nigricans* and *I. ponderosus*, Jordan, 1884, 12, 627, 628.

Body rather elongated; depth in length about five times. Tail deeply forked. Head with the lateral outlines gradually curving to the snout; the width across the opercles in length of head and body five and one-half times. Length of head in the length of head and body, four. Snout nearly three times in head. The upper jaw considerably projecting beyond the lower. Diameter of eye in head seven or eight times. Anal large; its rays twenty-five to thirty-five; its base in length of head and body about four. May attain a maximum length of five feet and a weight of one hundred and fifty pounds.

Distributed in the larger bodies of water from the region of the Great Lakes to the Gulf of Mexico. Lake Michigan (Jordan, 14, No. 2, 66). Dr. B. W. Evermann (23, '88, 44), reports having frequently seen it in the upper Wabash River. Prof. Milner states that in the Great Lakes it occupies the zone from shore to twenty fathoms. I have seen the species for sale at market in Madison, on the Ohio. LeSueur appears to have seen it in the Ohio and Wabash rivers (17, XV, 138). On account of its great size and abundance, it takes rank as one of our important food-fishes. Its flesh, however, is said to be rather coarse and somewhat devoid of flavor. It lives to some extent at least on other fishes.

Genus ICTALURUS (C. and V.).

Body elongated and compressed; the head not so broad and flat as in *Ameiurus*. Supraoccipital bone extending backward to join the second interspinal, a continuous bridge thus formed from the head to the front of the dorsal fin. Head narrow and rather high; upper jaw projecting beyond the lower. Anal fin long, of from twenty to thirty five rays. Ventrals of eight rays. Tail forked.

Anal fin of thirty-two to thirty-four rays. *furcatus* p. 180.

Anal fin of twenty-four to thirty rays. *punctatus* p. 180.

ICTALURUS FURCATUS (C. and V.)

Chuckle-headed Cat-fish.

Jordan and Gilbert, 1882, 8, 109; Jordan, 1882, 2, 785.

Slender, with the body much compressed from behind the head. Head narrow, its width four-fifths its length. Head in length of fish a little over four times. Profile steep and somewhat concave. Eye small, one-sixth of head; situated entirely in front of the middle of the head. Depth of body in its length about four and one-half times. Anal fin long, of from thirty-two to thirty-four rays; its base one-third the length of the fish. Color olive above, silvery on the sides and belly. Sides sometimes slightly spotted. Fins all dark edged. Length said to reach two feet. Ohio and Mississippi rivers. Apparently not common. I have a specimen which I obtained at Madison, on the Ohio River. It is eleven inches from tip to tip. Drs. Jordan and Evermann appear to have taken it in the Ohio River in 1887 (24, '93, 79).

ICTALURUS PUNCTATUS (Raf.).

Channel Cat-fish; White Cat-fish.

Jordan and Gilbert, 1882, 8, 108; *Ichthaelurus punctatus*, Jordan, 1882, 2, 786.

Body rather more slender than in *I. furcatus*; the depth in the length about five times. Head in length four times. Profile from the snout to the dorsal fin convex. Eye larger than in the preceding species, about five in head; situated so that the middle of the head strikes the posterior border. Anal fin rather short; of twenty-four to thirty rays; its base in length of fish three and one-half to four. Color olive, the sides silvery, and often with round dusky spots. It is said to reach a maximum size of three feet, but it is usually smaller.

Distributed from Vermont to Montana and south to Georgia and Mexico. It is very common in Indiana. Ohio River (LeSueur, Mem.

du Mus. V, 152); large streams of Carroll County (23, '88, 44); Ohio County (23, '88, 56); Brookville, Franklin County (5, No. 2, 4); White River, at Indianapolis (1, '77, 377); Lower Wabash (1, '77, 45); Lawrence County (23, '84, 200); Vincennes, Patoka, Posey County, Evansville, and White River at Spencer (4, '88, 162-166). Milner (11, '77, 3, 36) says that it is found in the Great Lakes. Vigo County (16, 94).

The habits of this species are in many respects different from those of the members of the genus *Ameiurus*. The latter are lovers of sluggish and muddy streams, in the silt and dirt of which they seek their living. The Channel Cat, on the contrary, delights in clear, flowing rivers and brooks, and the vicinity of water falls. They are apparently more active fishes. According to Prof. Forbes, who has studied the food of fishes with diligence and success, this species eats both animal and vegetable matters. One fourth of the food was of vegetable origin, chiefly algae. An important element consisted of mollusks, both univalve and bivalve. These had usually, by some unknown means, been torn from their shells before being eaten (14, '88, 457). One fish was found to have eaten one hundred and twenty mollusks. A considerable part of the food consists of insects and their larvæ. Leeches and crustaceans are also eaten. A dead rat was found in the alimentary canal of one individual. Other fishes are also eaten by the channel cat.

Order 6. EVENTOGNATHI.

Body possessing the normal fish-like form. The skin is, except in rare cases, clothed with cycloid scales. Maxillary bone normal. Opercular bones all present. Mouth toothless. Lower pharyngeal bones falciform and furnished with teeth in from one to three rows. The four anterior vertebrae coalesced and connected with the organs of hearing. No adipose fin.

Includes our suckers, carp, and toothless minnows.

From all other soft-rayed fishes the members of this order may be distinguished by the character of the lower pharyngeal bones and their teeth. These bones are relatively strong, usually curved into the form of a hand-sickle, and are provided with strong teeth, which are sometimes arranged in three, more commonly in one or two rows. These bones may be extracted for examination of the teeth by raising the gill-cover and thrusting in some hooked instrument, or even the head of a pin, just in front of the clavicle, the bone which bounds the gill-slit behind. The adhering flesh may then be removed. Care must be taken not to injure the teeth.

From the toothless herrings (*Clupea*) and the gizzard shad (*Dorosoma*) and the white-fishes (*Coregonus*) the Eventognathi may be distinguished by the fact that the maxillary bone is composed of a single slender bone,

and has no supplemental bone. From the white-fishes, again they may be distinguished by the absence of an adipose fin.

Pharyngeal bones with a single row of numerous teeth, which are arranged like the teeth of a comb. Maxillaries forming the hinder part of the margin of the upper jaw. Suckers and river carps.

Catostomidae, p. 182.

Pharyngeal bones with one to three rows of teeth, of which not more than seven are found in the main row, and fewer in the others, if present; margin of the upper jaw formed wholly by the premaxillaries. Toothless minnows and pond carps.

Cyprinidae, p. 197.

Family CATOSTOMIDÆ.

SUCKERS, CARPS, AND BUFFALO-FISHES.

Body usually somewhat compressed. Mouth moderate or small; tooth, less; its upper margin formed by the premaxillaries in front, by the maxillaries behind. Teeth of the pharyngeals numerous, in a single row, resembling the teeth of a comb. Gill membranes united to the isthmus. Ventral fins with about ten rays. Pectorals placed low on the body.

In many of the genera of this family there is present a fontanelle in the upper surface of the head. It may be discovered by thrusting into it the point of some sharp instrument.

ANALYSIS OF THE GENERA OF CATOSTOMIDÆ.

- A. Air-bladder in three parts. Fontanelle present.
- a. Upper lip protractile; lower lip not split into two distinct lobes.
 - b. Mouth of usual sucker-like form.
 - c. Lower teeth of the pharyngeals compressed.
Moxostoma, p. 183.
 - cc. Lower teeth of the pharyngeals much enlarged, nearly cylindrical, and truncated. *Placopharynx*, p. 186.
 - bb. Mouth modified. Lower lip split into two depending lateral lobes. *Lagochila*, p. 186.
- AA. Air bladder in two parts.
- d. Fontanelle present; the body considerably compressed.
 - e. Dorsal fin short; its rays ten to eighteen.
Catostomus, p. 187.
 - ee. Dorsal rays from twenty-three to thirty. Scales forty-five, or fewer.
Ictiobus, p. 192.
 - dd. Fontanelle not present. Body elongate, little compressed. Dorsal rays about thirty. Scales about fifty-five.
Cycleptus, p. 196.

Genus MOXOSTOMA Raf.

RED-HORSES.

Mouth inferior, the lower jaw horizontal, not split into two lobes, the upper jaw protractile, not especially enlarged; pharyngeal bones rather weak, the teeth compressed, the lower five or six largest; dorsal of eleven to seventeen rays; scales along the lateral line, forty to fifty-six.

A genus of some twelve to fifteen species living east of the Rocky Mountains. Of these the following belong to Indiana:

ANALYSIS OF INDIANA SPECIES OF MOXOSTOMA.

- * Dorsal fin of fifteen to eighteen rays; upper lobe of caudal longest. *anisurum*, p. 183.
- ** Dorsal of from twelve to fourteen rays.
 - † Lobes of caudal nearly equal, or upper shortest.
 - ‡ Head large, four to four and five-tenths in length; mouth large. *duquesnei*, p. 184.
 - ‡‡ Head short and small, four and five-tenths to five in head; mouth small. *aureolum*, p. 185.
 - †† Upper lobe of the caudal longest; anterior ray of the dorsal a third or more longer than the base of the fin; the upper border of the fin deeply concave. *breviceps*, p. 185.

MOXOSTOMA ANISURUM (RAF.).

White-nosed Sucker.

M. velatum, Jordan and Gilbert, 1882, 8, 138; *M. anisurum*, Jordan, 1888, 7, 47; Smith, H. M., 1892, 4 pl. 25.

Body deep and compressed, the depth in the length about three and one-half, heavy in front of the dorsal; the profile arched to the snout, the latter projecting beyond the upper lip, its length in that of the head a little more than twice; mouth inferior, of medium size n-shaped, the upper lip thin, the lower broad, fleshy and plicate; head, in length, three and three-fourths to four; the space between the eyes flat; dorsal fin with fifteen to eighteen developed rays, the most anterior one reaching back to the hindmost; the free border of the fin straight; upper lobe of the caudal longer and narrower than the lower; anal I, 7, the free edge rounded; scales, 6-44-5; color of upper parts light gray, of lower white; free border of dorsal fin dusky, also the central rays of the caudal, lower fins white; length about eighteen to twenty inches.

Distributed from the Ohio River to British America. Dr. Jordan says (4, '88, 162) that it is not rare at New Harmony, in Posey County.

Dr. Gilbert (23, '84, 200) records it from the East White River, in Lawrence County. To what extent it occurs in Lake Michigan I do not know. Dr. H. M. Smith (4, '92, 213) says that this species may be distinguished from *M. duquesnei* by the much larger and white fins, those of *M. duquesnei* being orange and red.

MOXOSTONA DUQUESNEI (Les.).

Red-horse; White Sucker.

M. macrolepidotum var. *duquesnei*, Jordan and Gilbert, 1882, 8, 140; *M. duquesnei*, Jordan, 1888, 7, 173; 1885, 12 pl., 222 A.

Body from stoutish to elongate, the depth varying from three and one-half to four in length; head rather long, its length in that of body from four to five times; profile arched to the snout, then descending abruptly to the large, inferior mouth; dorsal fin with twelve to fourteen rays, its free edge nearly straight; upper lobe of the caudal about the length of the lower or shorter; anal I, 7; scales, 5-45-6; color of upper parts olive or gray, of the lower parts silvery; the lower and tail fins are usually red or orange, at least in adult age; maximum length about two feet. Distributed from New York to Georgia and Dakota. It is not certain that the form described above is different from that found in the Chesapeake region, *M. macrolepidotum*. In Indiana the red-horse is one of the commonest fishes. Evansville (4, '88, 166); Lawrence County (23, '84, 200); Clark and Ohio counties (23, '88, 56); Franklin County (5, No. 2, 5); Monroe County (1, '85, 410); Vigo County (16, 94); Marion County (1, '77, 377); Kankakee River, Plymouth, (4, '88, 155); Cass and Carroll counties (4, '88, 155); Knox, Gibson and Owen counties (4, '88, 162, 166); Winamac, in Tippecanoe River. Eel River basin, (4, '94, 36). Other localities are given by Eigenmann and Beeson (24, '93, 84). This species is used as food, and its size and abundance give it some importance, but its flesh is not of very good quality, and is full of small bones. It inclines to clear streams. Its spawn is deposited in the month of May, and to accomplish this the fish ascends the smaller streams. The food of the red-horse, as determined by Forbes (14, '88, 442), consists almost wholly of mollusks, principally of univalves. Crustaceans were absent, while insects were present in small amounts. The young eat entomostraca. In some cases nearly the whole of the food of the young was found to consist of protozoa of different genera and species (14, No. 3, 72).

MOXOSTOMA AUREOLUM (Les.).

Lake Red-horse.

Jordan and Gilbert, 1882, 8, 140.

Body moderately compressed; depth in length, three and one-half to four and one-half; head short and small; its length in length of head and body, about five times; the outline of the head turned abruptly downward at the snout, which overhangs the mouth; length of snout in length of head, nearly three times; mouth small, semi-circular, the lips full and coarsely plicated; the angle of the mouth not extending back to a perpendicular from the nostril; dorsal, thirteen; anal, seven; the whole fin low: the free edge slightly concave or nearly straight; front of dorsal considerably nearer the snout than to the base of the caudal; the two lobes of the caudal about equal; scales, 6-45-5; color olive or grayish, with the lower fins and tail red. Distributed from Southern Indiana and Arkansas northward; quite abundant in some of the Great Lakes. It is recorded from the following places in Indiana: St. Joseph's River (4, '88, 154); New Harmony (4, '88, 162). It is by no means certain that this species is distinct from *M. duquesnei*. In Lorain County, Ohio, Mr. L. M. McCormick found this species considerably more abundant than *M. duquesnei*. Milner (11, '72, 3, 66) says that in the Great Lakes it is found from shore to a depth of twenty fathoms. Dr. Kirtland states that on the first approach of spring this fish resorts to the mouths of rivers and smaller streams for the purpose of spawning. The eggs are deposited on ripples, and McCormick states that ovoposition occurs at night. Professor Forbes found the food of this species to consist almost wholly of animal matter—about one-half of it of mollusks, the remainder of insects. As a food fish it is probably of about the same quality as *M. duquesnei*.

MOXOSTOMA BREVICEPS (Cope).

M. anisurum, Jordan and Gilbert, 1882, 8, 141; *M. crassilabre*, Jordan, 1888, 7, 48; *M. breviceps*, Jordan, 4, '88, 128.

Body short and deep; the depth in the length about three and one-half times. Head small, about five times in the length of the fish. The snout is pointed and overhangs the very small mouth. The anterior rays of the dorsal are longer than the base of the fin, while the free border is deeply concave. Upper lobe of the caudal considerably longer than the lower. The anal extends back beyond the base of the caudal. The lateral line has about forty-five transverse rows of scales crossing it. The dorsal and caudal fins are described as being red. Ohio River north to the Great

Lakes (4, '88, 167), where it is said to be abundant; Carroll County (23, '88, 45); White River, at Spencer, in Owen County (4, '88, 166). It is recorded from Cincinnati.

This species appears to have been confounded with a number of others. I know nothing distinctive regarding its habits.

Genus PLACOPHARYNX Cope.

Like *Moxostoma* in most respects. Lower pharyngeal bones enlarged and the number of teeth reduced. The lower six to ten teeth enlarged, cylindrical in form, and provided with a broad grinding surface. Mouth somewhat larger and more oblique than in most species of *Moxostoma*.

PLACOPHARYNX CARINATUS Cope.

Jordan and Gilbert, 1882, 8, 143.

Form sucker-like, the body heaviest forward and compressed. Depth in length about four times. Head in the length four to four and two-thirds. The upper line of the head nearly straight to the tip of the snout, then turned abruptly down to the upper lip. The snout little or not at all, overhanging the upper lip. Head broad and flat, or somewhat rounded above; the distance between the eyes in length of head twice. Mouth large, n-shaped, the lips thick and closely plicate. Eye in head five. Dorsal rays, twelve to fourteen; anal, eight; ventrals, nine. Lateral line complete. Scales, 7-44-6. Color in alcohol metallic gray above, white below. Said to be in life brassy green above, with the lower fins red. The length may reach thirty inches. Distributed from Georgia and Arkansas to Michigan and the Upper Missouri region. The following Indiana localities are on record: Terre Haute and Louisville (2, 832); Lower Wabash (1, '77, 45); Tippecanoe River, in Carroll County (23, '88, '45); Lafayette, Ind., where Prof. Cope obtained the type (6, '70, 467).

This fish is said to be abundant in the lower portions of the Wabash River. On account of its resemblance to the common red-horse, it is generally overlooked. Prof. Forbes (14, II, 441) found the food of this fish to consist principally of univalve mollusks and of the larvæ of insects. The character of the teeth, strong and with worn grinding surfaces, may be explained by referring to the nature of their food.

Genus LAGOCHILA Jordan and Brayton.

Resembles *Moxostoma* except in the structure of the mouth; upper lip not protractile, the lower lip divided by a longitudinal crease into two large depending lobes.

LAGOCHILA LACERA Jordan and Brayton.

Hare-lip Sucker.

Jordan, 1884, 12, 614; *Quassilabia lacera*, Jordan and Gilbert, 1882, 8, 144

Moderately elongated, the body heavy in front of the dorsal. The profile from the dorsal forms a regular and rapid curve to the upper lip. The lower outline from the mouth back is nearly straight. Mouth extremely modified. The upper lip is broad and fleshy, not separate from the skin of the forehead by a crease. At each side of the mouth a sharp fold of the skin is formed which descends to the middle line below, but is separated from that of the other side by a longitudinal crease. These folds pass under the lower jaw. In front of them the fleshy lower lip is split into two large depending lobes. Lower side of the head flat and broad. Eye in head nearly four and a half times. Depth in the length four to four and two-thirds times; head in length four and one-half times; Dorsal rays, twelve; anal, seven; the anal rays long. Caudal deeply forked. Pectorals falcate. Scales, 6-45-5. Color silvery above, with a tinge of olive; bright silvery below. Dorsal fin dusky; anal mostly white. Length about eighteen inches.

Tennessee and Arkansas northward. It has been recorded as having been taken by Dr. B. W. Evermann, in the Tippecanoe River, in Carroll County (23, '88, 45). It will doubtless be found to occur in most of the streams of the State.

Little is known concerning the habits of this singular species. It is said to spawn in May. Its teeth closely resembles those of the common red-horse, and its food is probably similar in nature.

Genus CATOSTOMUS LeSueur.

Form of body various. Fontanelle present in upper surface of head. Air-bladder in two parts. Dorsal fin with not more than eighteen rays. Mouth small to moderate, usually inferior in position. Pharyngeal bones weak, the teeth compressed, comb-like. Lateral line developed or not.

A genus containing a large number of species. As here defined, it includes Dr. Jordan's genera *Erimyzon* and *Minytrema*, since the characters on which those genera are based, the absence or partial development of the lateral line do not appear to me to be of generic value.

A. Scales more than sixty in the lateral line; much crowded together in front.

a. Scales along lateral line about one hundred.

catostomus, p. 188.

aa. Scales along the lateral line about sixty-five. *teres*, p. 189.

AA. Scales along the lateral line fewer than sixty; not closely crowded in front.

b. Lateral line absent or deficient. Head convex between eyes.

c. Lateral line absent at all times of life (*Erimyzon*).

sucetta, p. 189.

cc. Lateral line deficient in young; almost complete in the adult (*Minytrema*).

melanops, p. 190.

bb. Lateral line present and complete. Head concave between the eyes.

nigricans, p. 191.

CATOSTOMUS CATOSTOMUS (Forster).

Northern Sucker; Long-nosed Sucker.

Catostomus longirostris, Jordan and Gilbert, 1882, 3, 126.

Body elongated and rather slender; little compressed, but somewhat flat and broad above. Depth in the length five. Head broad above, pointed in front; the interorbital space two and one-half times in the length of the head. Snout a little longer than the remainder of the head. Eye small, eight times or more in the length of the head. Head in the length four and one-fourth to five times. Mouth wholly inferior, much overhung by the long snout; the lower lip consisting of two large flat lobes, which are furnished with coarse papillæ. Dorsal rays ten, the borders of the fin straight. Anal rays seven, reaching back to the base of the caudal. Scales small, especially in front of the dorsal fin, 20-95 to 114-15, about forty-eight in front of the dorsal. Lobes of the caudal equal and similarly colored. Upper surface of the body smoky-gray, the lower white. Along the side from the head to the tail, is a broad rosy band, below which is an obsolete brown band of about the same width. This becomes quite distinct on the shoulder. Further forward, on the sides of the head and on the snout, it becomes nearly black, and contrasts strongly with the white of the upper lip and lower half of the snout. The anal and the ventrals are reddish, the other fins are dusky. Males in the spring said to be profusely tuberculate on the head and anal fin. Size large.

Great Lakes and northward. Prof. Jordan, in his "Catalogue of the Fishes of Illinois" (14, No. 2), gives this species as belonging to Illinois, and states that it is abundant in Lake Michigan. It is sometimes seen in the markets of Chicago, and is a beautiful fish in its spring dress. Whether or not the rosy lateral band is confined to the male, I do not know. Dr. Bean (25, 25) says that it is. The flesh is rather soft and full of fine and forked bones.

CATOSTOMUS TERES (Mitchill).

Fine-scaled Sucker.

C. commersoni, Jordan and Gilbert, 1882, 8, 129; Jordan, 1884, 12, 614, pl. 223; *C. teres*, Jordan, 1888, 7, 46.

Body but slightly compressed. Depth in length four and one-fourth. Head short, its length in that of the body four and one-fourth to five; the interorbital space equal to nearly one-half the length of the head. Mouth small, u-shaped, the lips with papillæ. Snout one-half the length of the head or nearly so. Dorsal fin with twelve rays, the upper margin straight. Anal rays seven. Lateral line complete. Scales 10-65 to 70-8; crowded forward, about twenty-eight in front of dorsal. Color dusky above, silvery below; the sides and the head rosy in the spring. Fins all dusky. Length eighteen inches.

Found abundantly from the Gulf of Mexico to Canada and Montana. In Indiana it has been recorded from the following localities: Franklin County (23, '88, 57); Monroe County (1, '85, 410); Lower Wabash River (1, '77, 45); Marion County (1, '77, 377); Carroll County (23, '88, 45); St. Joseph's River, Kankakee River (1, '77, 45; 4, '88, 154, 155); Vigo County (16, 94); Eel River basin (4, '94, 36); Logansport. Other localities are given in 24, '93, 83.

This is a poor fish for food. It gives much amusement to the boys, however, since it is abundant and ready to bite. Prof. Forbes found the food of the young to be very similar to that of *Moxostoma duquesnei*.

CATOSTOMUS SUCETTA LeSueur.

Chub Sucker.

Erimyzon sucetta, Jordan and Gilbert, 1882, 8, 133; Jordan, 1884, 12, 614, pl. 220.

Body rather short and stout, the depth being contained in the length two and three-fourths to three times. Head moderate, the dorsal outline descending from the dorsal fin to the snout. Mouth small, terminal or somewhat inferior. Eye small, about five times in length of the head. Head in length, four to four and one half. Gill-rakers rather long. Dorsal rays with from ten to thirteen rays, usually eleven; anal rays seven. Scales large, somewhat crowded in front, forty to forty-five rows along the side and about fifteen rows between dorsal and the ventral. The pores of the lateral line are not developed at any time of life. Color varying with time of life. The adults are dusky above, becoming pale below, with no lateral band or blotches. There is also present a brassy

tinge. The fins are more or less dusky. Smaller specimens have a series of blotches or short transverse bars, while the young have a jet black band from the snout to the tail. The upper surface of the head with two longitudinal black bands. Dorsal surface dusky, with fine black dots. Anterior border of dorsal fin black. The length rarely becomes more than one foot.

Distributed from Massachusetts to Dakota and south. Indiana localities are as follows: New Harmony (4, '88, 162); Lawrence, Monroe and Brown counties (23, '84, 200); Green County (23, '84, 207); White River at Indianapolis (1, '77, 377); Tippecanoe River (1, '77, 45; 4, '88, 158); Lakes of Laporte County, St. Joseph's River, Maumee River, Kankakee River (1, '77, 45); Kankakee River (4, '88, 155); streams of Carroll County (23, '88, 45); Lake Michigan (14, No. 1, 48); Eel River basin (4, '94, 36).

This species of little value as an article of food. As to its manner of life, Prof. Forbes found that the two young specimens studied by him contained small entomostraca, some insect larvæ, and a considerable quantity of protozoa.

CATOSTOMUS MELANOPS Raf.

Spotted Mullet; Striped Sucker.

Minytrema melanops. Jordan and Gilbert, 1882, 8, 136.

Form varying considerably with age; the young elongated and little compressed; the adults deeper bodied and somewhat compressed. Depth in length three to four and one-half. Head in the length about four and one-half. Mouth small and inferior, the upper lip being very protractile. Eye small, five or more in the head. Dorsal rays twelve, anal rays seven. Scales large, about forty-five transverse rows and twelve to fourteen longitudinal rows, counting from the dorsal to the ventral fins. No lateral line of pores on the young; imperfect, but somewhat developed, in the adults. Dusky above, the sides and belly silvery or brassy. The scales on the sides of the adults each with a dusky spot at its base, as a consequence of which there are rows of spots along the sides. These may be missing in the young. Old males in the spring have the head covered with small tubercles. Length about eighteen inches.

Distribution from the region of the Great Lakes to South Carolina and Texas. Indiana localities are: Lower Wabash (1, '77, 45); Monroe County (1, '85, 410); White River at Indianapolis (1, '77, 377); Kankakee River at Plymouth (4, '88, 155); Posey County (4, '88, 162); doubtless also in Lake Michigan; Eel River basin (4, '94, 36).

This fish, like all the tribe of suckers, makes poor food. Jordan (2, '82, 5), says that it is tenacious of life and makes a good fish for the aquarium.

Prof. Forbes (*14*, II, '88, 444), found the food of the striped sucker to be made up mostly of mollusks. Some insect larvæ and a small amount of entomostracous crustaceans had also been eaten. The young eat young unios and protozoa. The young may be distinguished from all other suckers, except *C. succetta*, by not having a lateral line, from this by not having a black lateral band.

CATOSTOMUS NIGRICANS LeS.

Stone Roller; Hog Sucker; Hammer-head.

Jordan and Gilbert, 1882, *8*, 130; Jordan, 1884, *12*, 615.

Body elongated and little compressed, tapering backward from the head. Head large, flat or concave between the eyes, in front of which the profile descends to the snout and then turns abruptly downward. Sides of the head perpendicular. Eyes high up, small. Mouth rather small. Scales along lateral line, forty-eight to fifty-five. Pectoral fins large. Dorsal, eleven; anal, seven. Color silvery or olivaceous, and with more or less lustre of brassy. Dark above, paler on the belly. Back and sides of the younger specimens with cross blotches of dusky; head with mottlings of brown or black. The length is said to reach in some cases as much as two feet; usually much smaller.

Distributed from the Great Lakes southward. A common fish in all the clearer streams of the State. Falls of the Ohio (*9*, 9, 34); Clark and Ohio counties (*23*, '88, 56); Franklin County (*5*, No. 2, 5); Monroe County (*1*, '85, 410; *23*, '84, 200); White River at Indianapolis (*1*, '77, 377); Vincennes (*4*, '88, 162); Carroll County (*23*, '88, 45); St. Joseph River; Kankakee River at Plymouth, Tippecanoe River, Deer Creek at Camden, Eel River at Logansport, and Blue River at Columbia City (*4*, '88, 154-158); Vigo County (*16*, '94); Eel River Basin (*4*, '94, 36).

Dr. Jordan (*12*, 615), says of this fish: "The stone roller is extremely abundant in every running stream in the North and West, where its singular, almost comical form is familiar to every schoolboy. It delights in rapids and shoals, preferring cold and clear water. Its powerful pectorals render it a swifter swimmer than any other of its family. Its habit is to rest motionless on the bottom, where its mottled colors render it difficult to distinguish from the stones among which it lies. When disturbed it darts away very quickly, after the manner of the etheostomoids. They often go in small schools. I have never met this fish in really muddy water, and when placed in the aquarium it is the first fish to die as the water becomes foul. It is a 'boys' fish,' and not worth the eating."

Forbes (*14*, '88, 447), found the food of this sucker to consist almost wholly of the larvæ of aquatic insects. The amount of molluscan food was very small.

Genus ICTIOBUS.

Buffalo-fishes and Carp-suckers.

Body deep and compressed. Mouth more or less inferior, protractile downwards. Pharyngeal bones weak and furnished with numerous comb-like teeth. Air-bladder in two parts. Dorsal fin long; its rays about thirty in number. Scales large; about forty along the lateral line. Fontanelle present between the parietal bones.

A genus containing a number of species which are not well defined, and difficult of determination. The flesh is of rather poor quality and full of bones; nevertheless, on account of the large size attained by many of the species and their abundance in the larger streams, these fishes form an important item in the food supply of people living along our rivers.

ANALYSIS OF INDIANA SPECIES OF ICTIOBUS.

- A. Mouth moderate; more or less oblique; terminal, or nearly so; protractile forward and downward; color dusky, not silvery, and fins usually dark.
- a. Mouth rather large; terminal and protractile forward.
cyprinella, p. 193.
- aa. Mouth smaller and less terminal.
- b. Longest ray of dorsal not more than half the length of the base of the dorsal fin. *urus*, p. 193.
- bb. Longest dorsal ray considerably more than half the dorsal base. *bubalus*, p. 194.
- AA. Mouth small, inferior, protractile downward. Color paler and silvery; fins not dark.
- c. Form rather elongate; depth three in length.
carpio, p. 194.
- cc. Form ovate; the back arched; depth about two and one-half in length.
- d. Lips thick; the halves meeting at an acute angle.
velifer, p. 195.
- dd. Lips thin; the halves meeting at a large angle.
- e. Snout very blunt; eyes large; four in head.
difformis, p. 195.
- ee. Snout pointed; eyes small; five in head.
thompsoni, p. 196.

ICTIOBUS CYPRINELLA (C. and V.).

Buffalo-fish; Red-mouthed Buffalo.

Jordan, 1890, 7, 44; *Ictiobus bubalus*, Jordan and Gilbert, 1882, 8, 114.

Body high and compressed; heavy forwards; the back considerably arched in front of the dorsal; a line from the pupil to the middle of caudal falling below the middle of height at the front of the dorsal. Mouth rather large, nearly terminal and oblique. Opercles coarsely striated. Head in the length three and one-half. Depth in length two and one-half to three. Scales 8-40-6. Dorsal with twenty-eight to thirty rays, the most anterior about one-half the length of the base of the fin. Color dull brownish olive to nearly black above. Fins dark to black. Reaches a length of three feet and a weight of forty pounds.

Distributed throughout the Mississippi Valley. I find but few records of it in Indiana. Profs. Jenkins and Evermann took it in the Wabash River in Carroll County (23, '88, 44), Dr. Jordan (4, '88, 162) and myself have taken it at New Harmony; Vigo County (16, 94); also in Wabash River at Lafayette (24, '93, 82).

Prof. Forbes (14, '88, 451) found that the food of this species differs from that of *I. bubalus* in containing more vegetable matter. On an average about two-thirds the food was of animal origin, consisting of mollusca, aquatic insects, and the smaller crustaceans. This species is closely related to the next, so that the scientific experts are not always able to distinguish them. They may really be one and the same species.

ICTIOBUS URUS (Ag.).

Razor-backed Buffalo; Mongrel Buffalo.

Jordan and Gilbert, 1882, 8, 883; *Bubalichthys urus*, Jordan and Gilbert, 1882, 8, 116.

This species is regarded as differing from the preceding in having a smaller and more inferior mouth, which is protractile more or less downwards. The pharyngeal bones are regarded as stronger, and the teeth coarser. The lips are said to be thicker than those of *I. cyprinella*, and more plicate. But these distinctions do not always enable us to distinguish the two forms.

Eye in head six and one-half times. Dorsal fin twenty-five to thirty rays. Scales same as in *I. cyprinella*. Color smoky-gray to very dark above, somewhat paler below. Fins dusky. Reaches about the same size as the preceding species.

Distribution throughout most of the Mississippi Valley. In Indiana it has been taken, so far as reported, only in the Wabash River in Vigo

County (16, 94) and in Carroll County (23, '88, 44). It is doubtless to be found throughout the Wabash, and probably in the Ohio along our whole border. Prof. Forbes found this species to take almost identically the same kinds of food as *I. cyprinella*, mollusks, entomostraca, crustaceans, and aquatic insects. It is a fish of some importance as an article of food, but it is not regarded as a first-class fish.

ICTIOBUS BUBALUS (Raf.).

Sucker-mouthed Buffalo.

Jordan and Gilbert, 1882, 3, 114; Jordan, 1884, 12, 615, pl. 226.

Body deep and compressed, the back in front of the dorsal fin high and arched; depth in the length, two and one-half to three; head large and thick, its length in length of head and body, three and one-half to three and three-fourths times; snout rounded, projecting beyond the mouth, which is thus rendered somewhat inferior in position, and protractile downward; length of snout, one-fourth that of the head. Eye variable in size, four and one-half to six times in head. Opercles large and strongly striated. Rays of dorsal, twenty-six to twenty-nine, the longest much more than one-half the length of the base of the fin. Scales, 8-38-6. Color above, brownish olive, growing paler below. Fins dark. May reach a length of thirty inches and a weight of fifteen or more pounds. Streams of the Mississippi Valley. New Harmony, Evansville and Vincennes (4, '88, 162); Greene County (23, '84, 207); Lower Wabash River (1, '77, 45, 72); Carroll County (23, '88, 44); Vigo County (16, 94).

This species, with the other buffalo fishes, forms a considerable part of the fish food used by people living along the larger streams. The flesh is not of a fine quality, and there are many bones. Forbes (14, '88, 448) states that about one-fifth of the food of this species consists of vegetation, duckweed, etc. The remainder was of animal origin, equally divided among mollusks, crustaceans and insects. The crustaceans belonged, to a considerable extent, to the smallest species.

ICTIOBUS CARPIO (Raf.).

Carp Sucker.

Jordan and Gilbert, 1882, 3, 883; *Carpiodes carpio*, Jordan and Gilbert, *op. cit.* 118.

Body moderately deep and compressed; the back arched in front of the dorsal fin. Depth in the length close to three times. Head relatively small; its length, in length of head and body, four to four and two-thirds times. Space between the eyes convex. Opercles coarsely striated.

Snout rounded, projecting beyond the upper lip, longer than the diameter of the eye, which is contained in head four and a half times. Mouth small, semicircular. Dorsal rays twenty-six to thirty-two, the first about half as long as the base of the fin. Scales 8-37 to 40-6. Caudal fin considerably forked. Color above somewhat dusky, silvery below. May reach a length of one to two feet.

Ohio Valley and southwest. Falls of the Ohio (9, 9, 34); Lower Wabash River (1, '77, 45); East Fork White River, in Lawrence County (23, '84, 200); White River at Indianapolis (1, '77, 377); Wabash River (6, 1870, 484).

This fish is used for food, but is not highly esteemed.

ICTIOBUS VELIFER (Raf.).

Quill-back; Sailor; Spear-fish.

Carpiodes cyprinus, in part, Jordan and Gilbert, 1882, 8, 119; *Ictiobus velifer*, Jordan, 1885, 23, 2.

Body deep and much compressed, the back usually much arched from the head to the dorsal fin; an angle at the back of the head, in front of which the profile is nearly strait to the snout. This is blunt, projecting more or less beyond the mouth, and is contained in the length of the head about three and one-quarter times. Mouth small, the halves of the lower lip meeting at a sharp angle. Opercles large and striated. Head in the length three and three-quarters to four times. Dorsal rays twenty-six, the longest slender and reaching back two-thirds or more to the hinder end of the fin. Anal rays, eight. Caudal lobes blunt; the fork not deep. Scales, 8-38-6. Color bluish silvery above, white below. Paired fins, sometimes red. Length a foot or less.

Ohio to Iowa and south. Indiana localities: Ohio County (23, '88, 56); Franklin County (5, No. 2, 4); Carroll County (23, '88, 44); Wabash River (Cope, 6, 1870, 482); Vigo County (16, 94); Lake Michigan (14, No. 2, 65, *Carpiodes selene*); Logansport (4, '94, 36); Wabash County (24, '93, 82).

ICTIOBUS DIFFORMIS Cope.

Jordan and Gilbert, 1882, 8, 883; *Carpiodes difformis*, *op. cit.* 120.

Body high and much arched above; a slight angle at the back of the head. In profile view the snout is high and steep, the lower side of the head straight. Snout very short, its length in that of the head five times; the nostril near the tip. Diameter of the eye in head, three and one-half; greater than the length of the snout—(in *I. velifer* the snout equals the eye). Mouth small, semicircular, the corner lying behind a perpendicular from the anterior border of the eye.

Depth in the length, three and three-fourths; head in length, three and two-thirds. Dorsal rays, twenty-three; anal, eight. The anterior dorsal ray sometimes reaching backward beyond the base of the fin. Scales, 7-36-6. Opercle striated. Color brilliantly silvery, especially on the cheeks and opercles. Upper surface olivaceous silvery. Length, not more than one foot.

Ohio Valley; not a common fish. Vigo County (23, '88, 55); Lower Wabash River (1, '77, 45); Vincennes, Patoka, New Harmony (4, '88, 162); Evansville, (4, '88, 165); Eel River, at Logansport (4, '88, 158). Prof. Cope's types of this species came from the "Wabash River," probably at Lafayette

ICTIOBUS THOMPSONI (Ag.).

Jordan and Gilbert, 1882, 8, 883; *Carpiodes thompsoni*, Jordan and Gilbert, 1882, 8, 119.

Body deep and compressed, the back sharp. Depth in the length, two and three-fifths. The dorsal outline much arched between the head and the dorsal fin. Snout sharp, projecting beyond the mouth. Mouth small, n-shaped, and wholly inferior. Lips thin. Head, in length, four and one-fourth. Eye in head, five and one-half. Dorsal fin with twenty-six rays, the longest reaching to the hinder end of the base of the fin. Anal, seven. Scales, 9-41-7. Resembles *I. velifer*, except that the head is smaller, the snout sharper and more projecting. Said to be abundant in the Great Lakes; is, therefore, no doubt an inhabitant, or occasional visitant, of the Indiana shores of Lake Michigan. It is given by Nelson in his catalogue of the fishes of Illinois (14, No. 1, 49), as occurring in Lake Michigan.

Genus CYCLEPTUS Rafinesque.

Body elongated, moderately compressed. Mouth inferior. Pharyngeal bones with comb-like teeth. Air-bladder in two parts. Dorsal fin long, its rays about thirty in number. Scales small, about fifty-six in the lateral line. No fontanelle present between the parietal bones. A genus containing a single species.

CYCLEPTUS ELONGATUS (LeS.).

Black-horse.

Jordan and Gilbert, 1882, 8, 121; Jordan, 1884, 12, 615, pl. 224.

Body elongated and moderately compressed; depth in length, four to four and one-fourth; back more or less arched from the dorsal to the back of the head. Head small, narrow and pointed, the snout projecting beyond the mouth. Head in the length, five and one-half. Mouth of

moderate size and inferior, the lips with numerous papillæ. Eye small, its diameter in the length of the head six and one-half times. Snout nearly one-half the length of the head. Dorsal fin long; its rays twenty-eight to thirty; the most anterior lengthened. Anal, seven or eight. Pectorals and ventrals falcate. Scales, 10-56-7. General color dusky, each scale with a dark spot and a light border. Males nearly or quite black above. Fins livid blue. May reach a length of two and one-half feet.

Rather common in the streams of the Mississippi Valley. Has been reported in Indiana from Wabash River, in Vigo County (23, '88, 55), and Brookville, Franklin County (5, No. 2, 4); Ohio River (17, XVII, 456). This species has the reputation of being a much better food fish than the other suckers.

Family CYPRINIDÆ.

MINNOWS.

Body varying from terete and slender to deep and compressed; mouth various in form, toothless, its upper margin formed by the premaxillaries alone. Barbels sometimes present. Teeth on the lower pharyngeal bones, usually not more than seven on each side, these arranged in one, two, or rarely three series. Dorsal fin with not more than ten rays, except in some introduced species.

A family containing a large number of species, and represented in both the Old and the New Worlds. Most of the species are small and inconspicuous, and of no direct economic value. In most waters, however, they abound in great numbers and furnish food for the larger fishes. The Cyprinidæ are interesting fishes on many accounts. Many of the species, especially during the breeding season, assume the most brilliant and beautiful colors, while parts of their bodies become covered with hard prickles and warts.

In order to determine the species of Cyprinidæ it is often necessary to examine the air bladder, the intestines, and the pharyngeal teeth, as well as the external structures. The pharyngeal bones may be extracted by inserting a hook or the head of a pin just behind the last gill. After cleansing away the flesh the teeth may be counted. Any missing teeth may be determined from the stumps or from holes in the bone. Some of the teeth may be *hooked*; in some there is a *masticatory* surface, a flat, or concave surface, just below the hook.

From Dr. Jordan's "Manual of Vertebrates," edition of 1888, I have prepared the following modified

ANALYSIS OF THE GENERA OF CYPRINIDÆ FOUND IN INDIANA.

1. Dorsal of not more than ten rays.
 - A. Alimentary canal more than twice as long as the body. Peritoneum usually black.
 - a. Alimentary canal six to nine times as long as the body and coiled around the air bladder. *Campostoma*, p. 199.
 - aa. Alimentary canal shorter, but more than twice the length of the body; wholly below the air bladder.
 - b. Teeth, 5-5 or 4-5;* beginning of the dorsal behind the ventrals; scales, sixty or more along the lateral line.
 - c. No pseudobranchiæ present; lateral line complete. *Oxygeneum*, p. 200.
 - cc. Pseudobranchiæ present; lateral line incomplete. *Chrosomus*, p. 200.
 - bb. Teeth, 4-4; beginning of dorsal over the ventrals; not more than fifty scales along the lateral line.
 - d. Rows of scales in front of dorsal fewer than fifteen. *Hybognathus*, p. 201.
 - dd. Rows of scales in front of dorsals more than twenty. *Pimephales*, p. 202.
 - AA. Alimentary canal short, not more than twice the length of the body; peritoneum usually pale.
 - e. Teeth in the main row, 4-4; anal rays rarely as many as twelve.
 - f. Maxillary without barbels; premaxillaries protractile (as shown by a furrow between the upper lip and forehead).
 - g. Scales along lateral line not more than fifty.
 - h. Mandible interopercle, and suborbital with externally visible cavernous areas (like silvery cross-bars); dorsal over ventrals. *Ericymba*, p. 203.
 - hh. Mandible, etc., without cavernous areas.
 - i. Lower lip thin, not developed as a fleshy lobe on each side.
 - j. Teeth, 4-4, and about twenty-eight scales in front of the dorsal; a black spot on front of dorsal and another at the base of the tail. *Chiola*, p. 204.

* This means that there are five teeth on each pharyngeal bone, or four on one and five

- jj. Teeth, 4-4 in main row, with none, one, or two, in the inner row.
Notropis, p. 205.
- ii. Lower lip developed as a fleshy lobe on each side; teeth 4-4, without grinding surface; dorsal in front of the ventrals.
Phenacobius, p. 214.
- gg. Scales of lateral line, sixty or more; dorsal behind the ventrals; an obsolete barbel.
Rhinichthys, p. 214.
- ff. Maxillary with a barbel, sometimes minute.
- k. Premaxillaries not protractile; teeth, 2, 4-4, 2; dorsal behind the ventrals; scales, sixty or more.
Rhinichthys, p. 214.
- kk. Premaxillaries protractile.
- l. Teeth, 4-4 in main row; none or one in inner row; scales along the lateral line, fewer than sixty.
Hypopsis, p. 215.
- ll. Teeth, 2, 4-4, 2, or 2, 4-4, 1, without grinding surface; scales along lateral line, sixty or more; head convex above. *Couesius*, p. 219.
- ee. Teeth in the main row, 5-5 or 4-5.
- n. Teeth in two rows, 2, 4-5, 2, or 2, 5-5, 2.
- o. Maxillary with a small barbel, sometimes so minute as to be easily overlooked. (In our species scales of lateral line not more than sixty-five.)
Semotilus, p. 219.
- oo. Maxillary without barbel. (In our species scales of lateral line, seventy or more.)
Phoxinus, p. 220.
- nn. Teeth, one rowed, 5-5, and with grinding surface and serrate edges.
- p. Anal rays, eight; dorsal over ventrals.
Opsopoeodus, p. 221.
- pp. Anal rays, twelve to eighteen; dorsal behind ventrals.
Notemigonus, p. 221.
2. Dorsal fin long, of about twenty rays, the front a strong serrated spine; four long barbels about the mouth.
Cyprinus, p. 222.

Genus CAMPOSTOMA Ag.

Mouth inferior. Teeth, 4-4, with a grinding surface, but no hook. Alimentary canal, six to nine times the length of the body, and wound many times around the air-bladder. A single species.

CAMPOSTOMA ANOMALUM (Raf.).

Stone Roller.

Jordan and Gilbert, 1882, 8, 149.

This species can be mistaken for nothing else when the alimentary canal has been examined. The lateral line is complete. Scales, 7-53-8, crowded closely together forward. Dorsal rays, eight; anal, seven. The color is brownish and olive, often mottled with darker and with a brassy luster. The adult male in the breeding season has most of the dorsal and anal of a bright orange color with a cross-bar of black. At this season, too, the head and much of the body are covered with sharp tubercles. Length, occasionally, eight inches; usually four or five.

Distributed from New York westward and southward. Common in every stream in Indiana. Clark and Ohio counties (23, '88, 56); Franklin County (5, No. 2, 5); Monroe County (1, '85, 410); White River at Indianapolis (1, '77, 376); Maumee and Tippecanoe rivers (1, '77, 45); Lawrence County (23, '84, 200); St. Joseph River, Kankakee River at Plymouth, Eel River at Logansport, Whitley County (4, '88, 154-8); Vincennes and New Harmony (4, '88, 162); White River at Spencer (4, '88, 167); Falls of the Ohio (9, 9, 36); Vigo County (16, '94,); Eel River Basin (4, '94, 36); Richmond (18, 394); Decatur County, (Shannon).

This extremely abundant species ascends all our streams, penetrating even to the wayside ditches in spring, in order to deposit its spawn. On account of its small size, it is of no direct economical value. Prof. Forbes found the alimentary canal of the specimens examined to be full of mud and confervoid algæ. The mud contained diatoms, larvæ of dipterous insects, and protozoa.*

Genus CHROSOMUS Raf.

Mouth oblique; teeth 5-5 or 4-5, with grinding surface. Alimentary canal more than twice the length of the body. Dorsal behind the ventrals. Scales small. Lateral line incomplete. Pseudobranchiæ present. A single species.

*Genus OXYGENEUM Forbes.

Mouth large and terminal. Teeth 5-5, with grinding surface. No pseudobranchiæ. Lateral line complete. Scales small. Dorsal with its origin behind the ventrals. Intestine twice the length of the body or more.

OXYGENEUM PULVERULENTUM Forbes.

Forbes, S. F., 1885, 14, 135.

Head small and pointed, four and one-sixth in the length. Depth in length five. Scales of lateral line sixty-three, thirty-one in front of the dorsal. Dorsal eight, anal seven. Color pale, the back and sides with numerous dark dots. Illinois River at Peoria.

CHROSOMUS ERYTHROGASTER Raf.

Red-bellied Minnow.

Jordan and Gilbert, 1882, 8, 153.

Rather elongated, the head pointed. Depth in the length equal to head and from four to four and one-half times in the length of the body. Mouth terminal, somewhat oblique, small, the maxillary hardly reaching back to the eye. Teeth usually 5-5. Dorsal rays seven, anal eight. Pectorals short and broad, reaching the ventrals, which attain the vent. Lateral line reaching backward about one-half the length of the body. Scales small, 20-85-10. Colors brilliant. The belly is pale. From the snout, through the eye, a broad black band runs back to the tail. Above this is another narrower band of black. The interspace is a stripe of silvery, or, in breeding males, of scarlet. The back is olive, with numerous black spots, while the middle line is held by a narrow stripe of brown. Base of tail with a black spot. The base of the vertical fins of the males are scarlet, and the other fins bright yellow. Females plain. Length three inches.

Pennsylvania to Dakota and southward. Indiana localities are: Howard County (23, '88, 46); Franklin County (23, '88, 57); Monroe County (1, '85, 410); Marion County (1, '77, 377); Ohio River (10, '74, 223); Lawrence County (23, '84, 200); Miami County (4, '94, 36); Henry County (24, '93, 85).

Dr. Kirtland states that the spawn of this species is deposited during April and May on ripples. At this time their colors are most brilliant. By the time of midsummer the colors fade so much that the carmine tints are lost, and the black stripes become muddy brown. Jordan states that this species is hardy and one of the most desirable for aquaria. Forbes (14, No. 6, 80) says that 87 per cent. of the food consists of mud. The remainder is vegetable matter and a few crustaceans.

Genus HYBOGNATHUS Ag.

Mouth terminal. Teeth 4-4; with or without hook, and with grinding surface. Alimentary canal more than twice the length of the body. Dorsal fin over the ventrals. Lateral line complete. Scales rather large. Not more than fifteen in front of dorsal. Pseudobranchiæ present.

Suborbitals broad; color silvery.

nuchalis, p. 202.

Suborbitals narrow; color plumbeous

nubila, p. 202.

HYBOGNATHUS NUCHALIS Ag.

Jordan and Gilbert, 1882, 8, 156 (in part).

Body rather slender and somewhat compressed. Depth in length four and one-half. Head in length four and one-half to five. Mouth small, oblique, the maxillary reaching to a perpendicular from the front of the eye. Snout moderate and rather blunt. Anterior suborbital bone about one-half as wide as long. Eye three and one-half to five in head. Dorsal 8; anal 8. Scales 6-40-5; the lateral line complete. Color greenish, overlaid by silvery; a dusky band along the back, and often a leaden band along the side. Length four to nine inches. New Jersey to Dakota and Texas. Indiana localities are: Carroll County (23, '88, 46); Franklin County (23, '88, 57); Monroe County (1, '85, 410); Marion County (1, '77, 376); Lower Wabash River (1, '77, 45); Parke County (4, '88, 102); New Harmony (4, '88, 162); Evansville (4, '88, 165); Vigo County (16, 94); Logansport (4, '94, 36); Lafayette (18, 381).

Prof. Forbes found the alimentary canal of this species full of sand and an immense number of diatoms, together with some low forms of vegetable matter.*

Genus PIMEPHALES Raf.

Teeth 4-4, scarcely hooked, furnished with a grinding surface. Alimentary canal more than twice the length of the body. Scales in front of the dorsal small, more than twenty in number. Dorsal over ventrals.

Lateral line incomplete or wanting.

promelas, p. 202.

Lateral line complete.

notatus, p. 203.

PIMEPHALES PROMELAS Raf.

Fat-head; Black-headed Minnow.

Jordan and Gilbert, 1882, 8, 158; Blatchley, 1885, 1, 63.

Body quite short and deep, little compressed. Depth in length about four times. Head short; its length in that of head and body, four. Snout blunt. Mouth inferior, horizontal, small. Upper lip protractile. Dorsal, seven; anal, seven. Lateral line incomplete or wholly wanting. Scales, 7-47-6; about twenty-seven in front of the dorsal. Color,

* HYBOGNATHUS NUBILA (Forbes).

Cliola nubila, Jordan and Gilbert, 1882, 8, 167.

This species, which has been found from Northern Illinois to Western Arkansas, differs from *H. nuchalis* in having very narrow suborbitals and in being of a darker color. The scales are dark edged above. There is a more or less distinct dusky dorsal line. The sides are silvery, with a dusky band; sometimes nearly black. This follows the lateral line, and passes around the snout. This species may occur in Indiana.

olive; adults sometimes very dark; the head black; a black band across the dorsal fin. Length three inches or less.

Vermont to Dakota. Said to be abundant in sluggish brooks, but it does not seem to have been taken often in Indiana. Franklin County (5, No. 2, 5); Whitewater River (Cope in "Cyprinidæ of Pennsylvania"). Ponds along Ohio River at Madison, where I have found it in numbers. Nelson states that it is found at Evanston, Illinois (14, No. 1, 45).

Prefers muddy streams and ponds. The food consists of mud three-fourths and insects one-fourth (14, No. 6, 77).

PIMEPHALES NOTATUS (Raf.).

Blunt-nosed Minnow.

Hyborhynchus notatus, Jordan and Gilbert, 1882, 8, 157; *Pimephales notatus*, Blatchley, 1885, 1, 64.

Body rather elongated, somewhat compressed; head and body flat above. Depth in length, four and a half to five. Head in length, four and a half. Profile of head turned downward abruptly at the snout. Mouth inferior, horizontal, small. Upper jaw protractile. Dorsal, eight; anal, seven. Scales, 6-45-5, arranged in regular rows; those in front of the dorsal smaller, about twenty-three in number. Lateral line complete. Color olive, sometimes nearly black; a dark streak along the lateral line in front, reaching the snout, and ending behind in a caudal black spot. A black spot on front of dorsal of adults, but wanting in the young. Snout of males in spring with large tubercles. Length, about four inches.

Distribution, eastern United States west to Kansas. A common fish in every Indiana stream. Carroll, Marshall, Clark, and Ohio counties (23, '88, 46-56); Franklin County (5, No. 2, 5); Marion County (1, 77, 376); Lakes of Laporte County, St. Joseph River, Kankakee River, Tippecanoe River, Lower Wabash River (1, '77, 45); Lawrence County (23, '84, 200); Vincennes, Patoka and about New Harmony (4, '88, 162); Vigo County, (16, 94); Logansport, Winamac, Pulaski County; Eel River Basin (4, '94, 36). For other localities, see 24, '93, 86.

Forbes found the stomach of this fish full of dirt, with fragments of endogenous vegetation, confervoid algæ, and many diatoms. The mud made up about eighty per cent. of the food. About July 1 I found, at Logansport and Wiramac, many females of this species laden with eggs, while many males had the head covered with tubercles. The spawn must be deposited about this time.

GENUS ERICYMBA COPE.

Body rather slender; mouth somewhat inferior. Teeth 1, 4-4, 0. Mandible, interopercle, and suborbitals with conspicuous mucous cavities. Dorsal over ventals. Scales large. Lateral line complete.

ERICYMBA BUCCATA Cope.

Jordan and Gilbert, 1882, 8, 204.

Body elongate; little compressed. Depth in length about five times; the back not arched. Head rather long and with the muzzle broad; in the length not quite four times. Mouth small, somewhat inferior; the maxillary not reaching the eye. The suborbital bone broad and crossed by the conspicuous transparent mucous cavities. Dorsals over the ventrals; the rays eight; anal rays eight. Scales along the complete lateral line 5-35-5, about fifteen in front of the dorsal. Color rather pale, olivaceous, with a darker dorsal streak and silvery sides.

Michigan to Southern Mississippi. A common fish throughout Indiana, Clarke, Ohio and Franklin counties (23, '88, 56, 57); New Harmony (4, '88, 163); White River at Spencer (4, '88, 167); East Fork White River (23, '84, 202); Pulaski County (4, '88, 158); Carroll County (23, '88, 48); White River, Indiana (Cope in "Cyprinidæ of Pennsylvania," page 361); Vigo County (16, '94); Logansport; Eel River (4, '94, 37). See 24, '93, 86. This fish lives in clear streams and rivers. Its food, as determined by Prof. Forbes, consists of dipterous larvæ, much sand and some vegetable matter (14, No. 2. 80).

Genus CLIOLA Girard.

Body rather stout, head broad, mouth terminal. Teeth, 4-4, strongly hooked. Scales in front of dorsal small, about twenty-eight in number. Lateral line complete. First rudimentary ray of dorsal separated from first developed ray by membrane.

A genus not satisfactorily differentiated from *Notropis*.

CLIOLA VIGILAX (B and G.)

Bull-head Minnow.

Jordan and Gilbert, 1882, 8, 169; *C. tuditana*, *op. cit.*, 165; *C. taurocephalus*, *op. cit.*, 166; *C. vigilax*, Jordan, 1885, 23, 3; *Hybopsis tuditanus*, Cope, 18, 381.

Resembles *Pimephales notatus*, but the mouth is more terminal, and, besides, the alimentary canal is not twice as long as the body. Form stout. Head large and broad, flat above. Depth in length, four to four and one-half; head in length, four to four and one-half. Snout blunt. Mouth rather small. Eye three and one-half in head, high up. Caudal peduncle deep and broad. Scales along the complete lateral line, forty-two. Those in front of dorsal small, about twenty-eight in number. Color greenish, with the scales of the back dark-edged; a dusky band on the side ending at the tail in a black spot. Fins creamy, the dorsal with a black spot on its anterior rays. Length, three or four inches.

Distributed from Indiana to Southern Mississippi, Texas and Iowa. Tippecanoe River at Lafayette Cope, (18, 381); New Harmony (Hay); Vincennes and Posey County (4, '88, 162); Lawrence County (23, '84, 200); Carroll County (23, '88, 46); Owen County (24, '93, 86); Vigo County (16, '94). Cope's types of this fish were described from tributaries of Lake Michigan and of the Wabash River (14, No. 2, 56). Appears to prefer clear streams. Nothing distinctive is known regarding its habits.

Genus NOTROPIS Raf.

Alimentary canal short, and peritoneum pale. Teeth various, 4-4, or 1, 4-4, 0, or 1, 4-4-1, or 1, 4-4, 2, or 2, 4-4, 2; with or without grinding surface. First rudimentary ray of dorsal closely bound to the next ray. Bones of head not conspicuously excavated by mucous channels. Lateral line usually, but not always complete.

A genus containing a large number of species, many of them variable and difficult of determination. They are usually of small size, but abound in individuals, and constitute most of the schools of "minnows" which are seen in our streams.

- a. Teeth in main row, four; in inner row, none or one.
 - b. Scales on the sides not closely imbricated, their exposed edges about as wide as high. Dorsal fin situated over the ventrals. Anal rays, seven or eight.
 - c. Teeth, 4-4; no inner row.
 - d. Mouth small and slightly inferior.
 - e. Depth in length, five. *microstomus*, p. 206.
 - ee. Depth in length, about three and three-fourths to four and one-fourth. *scylla*, p. 206.
 - dd. Mouth terminal.
 - f. Mouth oblique; depth in length, five. *frentensis*, p. 206.
 - ff. Mouth very oblique; depth, four and one-half; lower jaw included. *anogenus*, p. 207.
 - fff. Mouth little oblique; depth, four; lower jaw projecting; chin black. *heterodon*, p. 207.
 - ffff. Mouth small; chin not black. *cayuga*, p. 208.
 - cc. Teeth, 1, 4-4, 0, or 1, 4-4, 1, or 1, 4-4, 2.
 - g. Mouth terminal, very oblique. Head in the length less than four. *boöps*, p. 209.
 - gg. Mouth nearly inferior. Head in length more than four. *hudsonius*, p. 209.
 - bb. Scales closely crowded, so that the exposed edges are much higher than wide, (This character not so evident in the young fishes.) Teeth serrated.

- h. Teeth usually 4-4. *lutrensis*, p. 210.
- hh. Teeth, 1, 4-4, 1. Dorsal just behind ventrals. *whipplei*, p. 210.
- aa. Teeth of main row, four; of the inner row, two.
- i. Anal rays, seven to nine. Dorsal over ventrals.-
- j. Head short, five in length; teeth with or without grinding surface. *hudsonius*, p. 209.
- jj. Head in length, about four and one-third; teeth with grinding surface; scales with exposed edges very narrow in adults. *megalops*, p. 211.
- jjj. Head in length, four; teeth with or without grinding surface; scales with exposed edges not so narrow.
- k. Eye, three to four in length of head. *heterodon*, p. 207; *jejunus*, p. 208.
- kk. Eye, two and two-thirds in length of head. *ariommus*, p. 211.
- ii. Anal rays, ten to eleven. Dorsal somewhat behind the ventrals.
- l. Twenty to thirty scales in front of dorsal; colors often brilliant. *ardens*, p. 212.
- ll. About fifteen scales in front of dorsal; colors plain; sides silvery.
- m. Depth in length, less than five. *rubrifrons*, p. 213.
- mm. Depth in length, more than five. *atherinoides*, p. 213.

NOTROPIS MICROSTOMUS* (Raf.).

Cliola deliciosa, Jordan and Gilbert, 1882, 8, 175; *C. straminea*, *op. cit.*, 167, Jordan, 1891, 4, 16.

A minnow of small size (two and one-half inches) and usually of pale color. The form is slender, the depth being contained about five times in the length. The mouth is small, nearly horizontal, and inferior, being overpassed by the blunt snout. Teeth 4-4, with hook and grinding surface. Eye in head about three. Lateral line complete. Scales, thirty-three to thirty-eight; twelve to fifteen rows in front of the

*NOTROPIS SCYLLA (*N. PHENACOBIVS* Forbes). Occurs from the Illinois River to the Rocky Mountains. It resembles *N. microstomus*, but is said to have a stouter body and shorter, blunter head. Scales, 31-33; 14-15 in front of the dorsal. (Jordan 4, 1891, 16). Its occurrence in Indiana is possible.

NOTROPIS FRETENSIS (Cope) (*Cliola fretensis*, Jordan and Gilbert, 1882, 8, 167), has been described by Prof. Cope from the Detroit River. It is stated to occur rarely in Illinois. In this species the body is slender, the depth being contained about five times in the length. The mouth is terminal and oblique. There are thirty-five scales along the lateral line, and seventeen in front of the dorsal. Head in length four, eye in head three and one-half. The color is olive, with a leaden lateral streak ending on the tail in a dark spot.

dorsal fin. Dorsal nearly over the ventrals. Dorsal rays, I, 8; anal, I, 7. Coloration pale, with a faint dorsal line, and sometimes there is a dusky lateral stripe.

From the Great Lakes to Virginia and Texas. Probably in most of the streams of Indiana. Carroll County (23, '88, 46); Marion County (1, '77, 377); Kankakee River (1, '77, 45); Lawrence County (23, '84, 201); St. Joseph's River, Kankakee River, at Plymouth (4, '88, 154 and 156); Logansport (4, '88, 158); New Harmony (4, '88, 162); White River at Spencer (4, '88, 167); Eel River basin (4, '94, 37). For a few additional localities, see 24, '93, 87.

About one-fourth of the food of this species consists of the seeds of grasses; the other three-fourths is made up of animal matter, neuropterous insects and entomostraca (Forbes, 14, No. 6, 84).

NOTROPIS ANOGENUS Forbes.

Forbes, S. A., 1885, 14, 138.

This species has been found in Cayuga Lake, New York, and in Northern Illinois. It has also recently been taken by Prof. P. H. Kirsch in Northeastern Indiana. It is an insignificant species, one and one-half inches long. The mouth is very oblique and small. The teeth are 4-4 with hook and grinding surface. Dorsal slightly behind the ventrals. Scales thirty-four to thirty-seven; thirteen before the dorsal. The color is dark above, yellowish beneath. Side with a very distinct black band ending behind in a black tail-spot. Pores of the complete lateral line each with a black speck. Fins all dusky. Head in length four to four and one-quarter; depth in length four to four and one-third. Whitley County (4, '94, 37).

NOTROPIS HETERODON (Cope).

Hemitremia heterodon, Jordan and Gilbert, 1882, '8, 163; Gilbert, 1884, 23, 207.

Form rather stout. Depth in the length four. Head in length four; mouth small, terminal, oblique; lower jaw often projecting. Eye in head three. Teeth usually 4-4, with hook and grinding surface. In some specimens referred to this species the teeth are 2, 4-4, 2. Dorsal, eight; anal, eight or seven. Lateral line usually developed only anteriorly. Olive or dusky above, with a dark lateral band passing around the snout. Length about two and one-half inches.

The typical forms of this species have the teeth 4-4, and the lateral line incomplete, but Dr. Gilbert (23, '84, 207) has referred specimens to this species which have the lateral line complete, and teeth, 2, 4-4, 2. At Winamac, Pulaski County, I have taken, July 1, numerous such specimens. The lateral line is not always, but usually, complete. The snout is rather blunt than sharp, as in Gilbert's specimens. Nor does the

dorsal fin appear to lie behind the ventrals. There are seventeen, instead of thirteen, scales in front of the dorsal. Anal rays, eight. These specimens with two teeth in the outer row may form a distinct species.

Western New York to Kansas. Indiana localities are: Vincennes (4, '88, 163); Greene County (23, '84, 207; teeth, 2, 4-4, 2); Pulaski County (23, '88, 55; 4, '88, 158); Tippecanoe River at Winamac; Tippecanoe River (1, '77, 45); Eel River system (4, '94, 37); Lake Maxinkuckee and Laporte County (24, '93, 87). This species eats some mud, a little vegetation, seeds and algæ. About three-fourths of the food consists of insects and crustaceans. The females taken at Winamac July 1 were filled with spawn.

NOTROPIS CAYUGA Meek.

S. E. Meek, Bull. U. S. Fish Commission, 1891, 117.

This species appears to range from New York to Iowa. It has lately been found in Northeastern Indiana by Professor P. H. Kirsch. It is nowhere common.

In general appearance it resembles *N. heterodon* and *N. anogenus*. Scales, thirty-six to thirty eight. Lateral line not complete. Dorsal rays, eight; anal rays, seven or eight. Head, in length, four or a little more; depth in length, four and one fourth. Mouth somewhat oblique, small, the lower jaw not projecting. Sides with a dark, lateral band; these meet on the upper jaw, but not on the lower. Eel River system (4, '94, 36).

NOTROPIS JEJUNUS (Forbes).

Minnilus jejunus, Jordan and Gilbert, 1882, 8, 194.

This species has its distribution from Pennsylvania to Kansas, and has recently been taken by P. H. Kirsch in Indiana, at Logansport. The form is rather slender; depth, four and one-half to four and two-thirds in the length. Head in length, four; the snout blunt; the mouth large and oblique; the teeth 2-4-4-2, and without grinding surface. The lateral line is complete and nearly straight. Scales, 5-37-3; sixteen in front of the dorsal. Dorsal opposite the ventrals; its rays, eight; anal, seven. Length about three inches. Logansport, on limestone bottom (4, '94, 37).

NOTROPIS BOÖPS Gilbert.

Gilbert, 1884, 23, 201.

Body rather stout, the depth in the length four times. A gradual slope from the dorsal fin to the front of the eye, the profile then descending more rapidly. Head flat above. Head in length three and three-fourths. Snout short, three and two-thirds times in length of the head. Mouth moderate, oblique, the maxillary reaching the front of the eye. Lower jaw included in the closed mouth. Eye large, three in head. Scales 5-37-4; twelve or thirteen in front of the dorsal. Rays of dorsal fin, eight; anal, eight. Caudal forked. Color, plain olive; the scales above with narrow brown edges. A silvery band along the sides. A dusky spot on the opercle.

Indiana to Arkansas. In our State specimens have been taken in the Wabash River in Carroll County (23, '88, 46); Brown and Rush counties (23, '84, 201); Marion and Decatur counties (24, '93, 87).

NOTROPIS HUDSONIUS (DeW. Clinton).

Spawn-eater.

Cliola hudsonia and *C. storeriana*, Jordan and Gilbert, 1882, 8, 171.

Body elongate and moderately compressed. Depth in length four and one-half to five times. Head short and the snout blunt; in the length four and one-half to five times. Top of the head rather wide and flat. Mouth small, inferior and nearly horizontal; the maxillary reaching the anterior border of the orbit. Eye in head three times. Teeth 2, 4-4, 1 or 1, 4-4, 1 or 0. Dorsal rays, eight; anal, eight. Scales 5-39-6, eighteen in front of the dorsal. The lateral line is nearly straight. Color pale, with a lateral silvery band. There may occur a dusky spot at the base of the caudal. Length eight inches at the most, usually much smaller.

Distributed from Lake Superior east to New York, thence south to Georgia east of the Mountains. In Indiana it has been taken only in the northern portions of the State. Lakes of Laporte County (1, '77, 45, under the name *Hybopsis storerianus*); Michigan City (4, '88, 137); Kankakee River at Riverside (24, '93, 87). The western form has the teeth usually 2, 4-4, 1. Prof. S. A. Forbes (14, No. 6, 82) says that this species is confined to the lakes, rivers and streams of some magnitude, and that it is abundant in Lake Michigan. He found that its food is mostly animal in its origin. A small part of it consisting of fishes and a few mollusks. Insects constituted about a

half of the diet. Crustaceans made up about thirteen per cent. of the food. A few of the specimens examined had eaten a considerable amount of vegetable matter.*

NOTROPIS WHIPPLEI (Girard).

Cliola whipplei, Jordan and Gilbert, 1882, 8, 178; *C. analostana*, Jordan and Gilbert, 8, 179.

Body elongated, considerably compressed, the head narrow and pointed. Depth in the length three and one-half to four. Head in the length four and one-fourth. Mouth oblique, small; the maxillary reaching to the anterior border of the orbit. Teeth 1, 4-4, 1, with usually a narrow grinding surface and serrated edges. Eye in head four to four and one-half. Dorsal rays, eight; anal rays, eight or nine. Scales 5-38 to 40-5. Dorsal somewhat behind the ventrals. Color leaden silvery, the males sometimes nearly steel-blue. The edges of the scales often dusky. Pectorals and ventrals of the males in the spring filled with a satin-white pigment; the head and back in front of the dorsal furnished with numerous prickles. A black blotch on the last dorsal ray. Length about four inches.

The range of this species is from Virginia west to Arkansas; although there is some reason for believing that the eastern form is a distinct species. In Indiana *N. whipplei* has been taken abundantly in all parts of the State. Carroll County (4, '88, 46); Clarke, Ohio and Franklin counties (4, '88, 56, 57); Monroe County (1, '85, 410); Marion County (1, '77, 377); Maumee River (1, '77, 45); Lower Wabash River (1, '77, 45); Lawrence County (23, '84, 202); Kankakee River (4, '88, 156); Maxinkuckee and Logansport (4, '88, 158); Vincennes, Patoka and Posey County (4, '88, 163); Evansville, White River at Spencer, Eel River in Owens County (4, '88, 166, 167); Vigo County (16, 94); Eel River in Whitley County (4, '94, 37). For a few other localities see 24, '93, 87.

The food of this common species consists of both animal and vegetable matters. Two-thirds of the food was found to be made up of insects and a few spiders. A few crustaceans were included. The vegetable food constituted nearly one-third of the diet, and consisted of algæ, seeds, anthers, pollen, etc. (14, No. 2, 80). The typical *whipplei* differs from our form, *analostanus*, in being deeper bodied, having shorter head, and anal with rays nine.

* NOTROPIS LUTRENSIS (B. and G.).

Cliola lutrensis, Jordan and Gilbert, 1882, 8, 175.

This species has been taken in Southern Illinois, and may therefore yet be found to occur in Indiana. Its range is further west. Body deep and compressed; depth in length three or less. Head in length three and two-thirds. Teeth 4, 4, the edges serrate. Lateral line strongly decurved. Scales 6-32-4; about fourteen in front of the dorsal. Color of male, steel-blue; belly and fins blood-red. Female plain.

NOTROPIS MEGALOPS (Raf.) .

Minnilus cornutus, Jordan and Gilbert, 1882, 8, 186.

Form stout and compressed. Head short and thick, in length of body four and one-half times. Mouth small, terminal, oblique. Teeth, 2-4-4-2, with hook and distinct grinding surface. Depth of body in its length three times; of the young, four to five times. Dorsal over or slightly behind the ventrals; of eight soft rays. Anal, nine. Lateral line bent downward. Scales, 6-40-5. with about twenty-three in front of the dorsal. Pectorals hardly reaching the ventrals; the latter attaining to the vent.

Color leaden, darker above. Scales of the sides often with blotches of black. In the breeding males the whole anterior part, including the pectoral and the ventral fins, may become beautifully rosy, with blotches of black; while the head becomes covered with sharp prickles. The females are more plainly attired.

This species reaches a length of from six to eight inches. It is abundant, and is often taken on hooks by boys. Its flesh is of little account, and soon decays.

Forbes found this species (14, No. 2, 80), to live chiefly on vegetation. Its stomach also included fragments of insects. Other studies (14, No. 6, 84) showed that the fish often takes a larger proportion of animal food, this sometimes amounting to two-thirds the whole. The larger part of this was made up of insects, but crustaceans had also been eaten.

This fish is widely distributed, being found from the Atlantic to the Rocky Mountains. In Indiana it has been taken in all parts of the State, and may be found in all streams. Carroll County (23, '88, 46); Clark County (23, '88, 56); Franklin County (5, No. 2, 5); Monroe County (1, '85, 410); Marion County (1, '77, 377); lakes of Laporte County; St. Joseph, Kankakee and Tippecanoe rivers (1, '77, 45); Logansport; East Fork White River (23, '84, 202); St. Joseph River (4, '88, 154); Kankakee River at Plymouth, Lake Maxinkuckee, Logansport (4, '88, 156, 158); Knox, Gibson and Posey counties (4, '88, 163); Evansville, White River at Spencer, Eel River in Owen County (4, '88, 165-167); Vigo County, (16, 94); Eel River in Northeastern Indiana (4, '94, 37). See, also, 24, '93, 88, where it is stated to have been found in Henry, Laporte and Decatur counties.

NOTROPIS ARIOMMUS (Cope.)

Big-eyed Shiner.

Minnilus ariommus, Jordan and Gilbert, 1882, 8, 194.

Form elongated and compressed. Depth in length, four and one-third times. Head rather large; its length in that of head and body, four

and one-quarter times. Profile slightly convex. Mouth terminal, decidedly oblique, the maxillary passing beyond the anterior border of the eye. Teeth, 2-4-4-2, without grinding surface. Eye large, its diameter entering into the length of head rather less than three times. Scales, 6-40-4. Lateral line complete. Dorsal fin with rays, eight; anal, nine. The upper parts are olive in color, the sides silvery, the belly pale. A handsome fish, conspicuous because of its large eyes. It may attain a length of three inches. Lives in clear and rapid streams.

Indiana to Alabama. White River, at Indianapolis (1, '77, 377); Rockford, in East Fork of White River (Hay); Parke County (24, '93, 89).

NOTROPIS ARDENS (Cope.)

Red-fin.

Minnilus ardens, Jordan and Gilbert, 1882, 2, 198; *M. umbratilis*, Jordan and Gilbert, *op. cit.* 200; *M. diplemius*, *op. cit.* 197.

Form and proportions highly variable. Body usually elongate and compressed, but sometimes deep and with the back elevated. Depth in length about four to five times, but in some highly developed males the depth becomes two and two-thirds. The head is usually rather long and pointed, being contained in the length about four and a half times. In the deep-bodied males the snout may be rather short. Mouth oblique, moderate or rather large, the maxillary attaining to a perpendicular to the front of the eye. Teeth, 2-4-4-2, with the grinding surface developed. Dorsal fin beginning behind the vertals; its rays, seven; anal rays, ten or eleven. Lateral line complete. Scales, 9-42 to 50-3; crowded in front of the dorsal, the number about thirty. The color of the upper surface varies from olive to purple and steel-blue. The females are pale. In the breeding season the males may have all the fins and even much of the body of a deep brick-red. Sometimes the fins are dark, almost black. The antedorsal region, the snout, the cheeks and the lower jaw of breeding males are covered with sharp prickles. Length about three and a half inches.

Distributed from Virginia to Kansas. Indiana localities: Carroll County (23, '88, 46); Marion County (1, '77, 377); Monroe County (1, '85, 410); Lawrence County (23, '84, 202); Franklin County (23, '88, 57); Clarke and Ohio counties (23, '88, 56); Winamac, Pulaski County; Eel River basin (4, '94, 37) See, also, 24, '93, 89.

This is one of our most beautiful fishes. It prefers clear streams. Specimens taken by myself, at Winamac, about July 1, were in the breeding stage. All the fins of the males were of a beautiful red, and the anterior parts of the body were covered with sharp tubercles. The females were filled with spawn. Dr. Forbes found that this species eats small diptera.

NOTROPIS RUBRIFRONS (Cope).

Rosy faced Minnow.

Minnilus rubrifrons, Jordan and Gilbert, 1882, 8, 202.

Body deeper and more compressed than in *N. atherinoides*. Depth in the length nearly five times. Head narrow, pointed; in the length four times, the profile with a very gentle curve to lip. Snout about equal to the diameter of the eye, which is contained three and one-half to four times in the length of the head. Mouth large, very oblique, the maxillary reaching to a line from the front of the eye. Jaws equal. Dorsal fin, eight; anal, ten. Olive above, the scales with dusky edges. Sides silvery, belly pale. A faint or distinct vertebral line. Anterior parts of the males in spring flushed with red, the snout covered with tubercles. Length about two and three-fourths inches.

N. dilectus (Girard) is sometimes recognized as a species distinct from *rubrifrons*. It differs in having a smaller eye, a shorter and blunter head (four and one-half in the length), and the body more compressed.

Habitat Ohio Valley. Indiana localities are: Carroll County (23, '88, 47); Clarke County (23, '88, 56); Franklin County (5, No. 2, 6); White River at Indianapolis (1, '77, 377); Tippecanoe and Lower Wabash rivers (1, '77, 45); East Fork White River, (23, '84, 202); St. Joseph's River (4, '88, 154); Kankakee River, at Plymouth (4, '88, 156), Fulton and Cass counties (4, '88, 158); Owen County (4, '88, 167); Vigo County (16, 94). The reader is referred to 24, '93, 89, where the localities are given for both *N. rubrifrons* and *N. dilectus*.

Like its ally, *N. atherinoides*, this species delights in the clear waters of rapid streams. The assumption of bright colors and the appearance of the tubercles on the head of the male indicate that the season of mating is in the spring.

NOTROPIS ATHERINOIDES (Raf.).

Emerald Minnow.

Minnilus rubellus, Jordan and Gilbert, 1882, 8, 202.

Form elongated and compressed; depth in length, five and one-half to six. Head in length, four and three-fourths; rather narrow and blunt. Eye large, about three and one-fourth in length of head. Mouth oblique, moderately large, the maxillary reaching the front of the eye; the jaws equal. Snout equal to eye. Teeth, 2, 4-4, 2, with no masticatory surface. Dorsal fin situated behind the ventrals. Dorsal rays, eight; anal, ten or eleven. Scales, 6-40-4. Lateral line somewhat bent downward. Color in life translucent green, the sides silvery, belly pale. Fins all pale. Reaches a length of six inches. Reaches a greater size than *rubrifrons* and *dilectus*. *Notropis arge* (Cope)

is closely related to *atherinoides*, and is probably only a variety of it. It is characterized by a projecting jaw, a slightly larger eye, a straight lateral line, a slenderer form, and a blackish line bordering the upper edge of the lateral silvery band. Great lakes to Tennessee. In Indiana *atherinoides* has been taken at various points. Carroll County (23, '88, 46); Knox, Gibson and Posey counties (4, '88, 163); Marion County (1, '77, 377); Franklin County (23, '88, 57); Parke and Cass counties (24, '93, 89); Clark County (23, '88, 56). The form *arge* is reported from Carroll County (23, '88, 47); Fulton and Cass counties (4, '88, 158). Eel River system (4, '94, 37). Professor Forbes found that the greater part of the food of this species consists of insects and small crustaceans. It lives in the clear waters of the larger streams and lakes.*

Genus RHINICHTHYS Agassiz.

Intestinal canal not more than twice the length of the body. Teeth 2-4-4-2, with hook, without grinding surface. Mouth small and inferior; the upper lip not protractile; the maxillary with a barbel, but this sometimes difficult of detection. Dorsal fin behind the ventrals. Scales along the lateral line sixty or more.

RHINICHTHYS ATRONASUS (Mitchill).

Black-Nosed Dace.

Jordan and Gilbert, 1882, 8, 208.

Body rather elongated and but little compressed. Depth in length about four and one-half. Head flat above; its length in length of head and body four times. Snout of moderate length. Mouth small, inferior, and the maxillary with a minute barbel. Eye shorter than the snout. Scales, 11-65-9. Color, dark above; many of the scales with blotches of black. A band passing along the side, usually black, but in the males during the breeding season this is bright red. After the breeding season is over this color fades to orange and yellow. Sometimes large portions or the whole of the male's body may be red. The females are plainer in their coloration. The length is about three inches.

Maine to Iowa and South. Indiana localities: Decatur County (Shannon); Carroll County (23, '88, 47); Kankakee River (1, '77, 45); Marion County (1, '77, 377); Franklin County (23, '88, 57); Monroe

*Genus PHENACOBIVS Cope.

This genus is characterized by a short intestine; teeth, 4-4 or 1, 4, 4, 1, without grinding surface; inferior mouth; lower lip developed as a fleshy lobe on each side; dorsal fin in front of ventrals; and small scales. One of its species, *P. mirabilis*, has been taken in the Illinois River, and, according to Nelson (14, No. 1, 46), as far east as McLean County, Ill. It may, therefore, occur as far east as Indiana. The body is slender; depth in length, four and one-fourth; mouth small; scales along the lateral line, fifty-one; color olivaceous, with a silvery lateral band.

County (1, '85, 410); Lawrence County (23, '84, 203); Ohio River (10, '74, 223); Logansport; Wabash County (Hay, Ulrey). Nelson took specimens of the species in clear tributaries of Lake Michigan in the vicinity of Chicago (14, No. 1, 45).

This species is said to live in the smaller and more rapid streams. At Logansport I found several specimens in a small, rocky stream on July 2. The brilliant colors of the males had already begun to fade. *R. obtusus* has been distinguished from *atronsus*. The body is said to be somewhat stouter, the head shorter, the barbel more distinct, and the coloration somewhat different. The lateral band of the males is rosy. To this doubtful species Dr. Jordan refers some specimens taken in Clear Creek, Monroe County.*

Genus HYBOPSIS Agassiz.

Alimentary canal not more than twice the length of the body. Teeth in the main row 4-4, with no grinding surface. Maxillary with a small barbel. Premaxillaries protractile. Scales along the lateral line fewer than sixty.

- a. Mouth inferior, horizontal; color silvery.
 - b. Eye more than three in the head; scales in lateral line about thirty seven. *hyostomus*, p. 216.
 - bb. Eye three and one-fourth; scales about fifty-two. *watauga*, p. 216.
 - bbb. Eye larger, three or less in head.
 - c. Scales along lateral line about forty-seven; teeth 4-4. *dissimilis*, p. 217.
 - cc. Scales of lateral line thirty-eight to forty-two; teeth 1-4-4-1, or 1-4-4-0.
 - d. Sides with a dusky band. *amblops*, p. 217.
 - dd. Sides without dusky band, bright silvery. *storerianus*, p. 218.
- aa. Mouth nearly terminal; color grayish, little silvery. *kentuckiensis*, p. 218.

* RHINICHTHYS CATARACTE (C. and V.).

The range of this species of *Rhinichthys* is from Massachusetts to Montana, in clear, cold streams. Dr. Jordan (2, 857), states that it has been found in tributaries of Lake Erie, and in the lake itself; and in his "Catalogue of the fishes of Illinois" (14, No. 2), he says it is found in clear tributaries of Lake Michigan, about Chicago. It may, therefore, be yet found to be a resident of Indiana streams. The body is quite slender, the depth being contained in the length five and one-half times. The eye is small, five times in head and two times in the length of the snout. Scales 14-65-8. The color is dusky, and there is no dusky lateral band.

HYBOPSIS HYOSTOMUS (Gilbert).

Nocomis hyostomus, Gilbert, 1884, 23, 203.

Form elongated and quite slender, the depth being contained in the length five and one-half times. Head long, its length in that of the body four times; the snout long and projecting considerably beyond the mouth. Eye rather large, three and one-half times in head. Mouth inferior, the maxillary provided with a long barbel. Dorsal rays, eight; anal, eight. Scales along the lateral line, thirty-seven; thirteen in front of the dorsal. Color silvery, the upper surface with numerous minute black specks. Length about two and one-half inches.

Distributed from Indiana to Alabama. In Indiana it has been taken in White River at Bedford (23, '84, 203); Gosport, Vincennes and New Harmony (4, '88, 48); Wabash River at Delphi (23, '88, 163); Eel River at Logansport (4, '94, 37).

HYBOPSIS WATAUGA (Jordan and Gilbert).

Jordan and Gilbert, 1888, 4, pl. XIV, Fig. 6; 23, 1888, 356.

This species is a close relative of that next described, *H. dissimilis*. Body elongated, little compressed, the back little elevated. Head flat on top. The snout blunt; the anterior profile decurved. Snout in the length of the head two and three-fourths. Mouth inferior, horizontal, the maxillary reaching to opposite the posterior nostril. Barbels evident. Eye in the head three and one-fourth. Depth in the length five and one-half to six. Dorsal rays, seven; anal rays, seven. Scales, 4-52-4; about twenty to twenty-four in front of the dorsal fin. Front of the dorsal in front of the insertion of the ventrals. Teeth 4-4. Color olive; sides with a dark bluish stripe, which is prolonged around the snout. On this lateral stripe are from eight to ten rounded blackish spots not so large as the eye. *Some additional spots on the back. Fins pale. Length four inches.

Virginia and North Carolina westward to Iowa and Arkansas. Has been taken in the Tippecanoe River at Marshland, Fulton County (4, '88, 158); White River at Gosport and Indianapolis (23, '88, 356); Eel River basin in Northeastern Indiana (4, '94, 37); Terre Haute (24, '93, 91).

This species differs from *H. dissimilis* in having a larger number of scales along the lateral line, more rows of scales in front of the dorsal, and in having a slenderer form.

HYBOPSIS DISSIMILIS (Kirtland).

Ceraticthys dissimilis, Jordan and Gilbert, 1882, 8, 215.

Form elongated and compressed. Depth in length four and one-half to five and one-half. Head long, in length of body three and three-fourths to four and one-half. Upper surface of head flat. Profile straight to between the nostrils, when it begins to descend rapidly to the upper lip. Snout very long, nearly half as long as the head. Upper jaw projecting beyond the lower, making the mouth inferior. The latter small, the maxillary reaching only to the nostrils. A distinct barbel at the extremity of the maxillary. Eye very large to moderate, two and three-fourths to three and one-half in head. Teeth 4-4. Dorsal, eight; anal, seven; the dorsal beginning distinctly in front of the ventrals. Scales, 6-44 to 47-6; twenty in front of dorsal. Dusky olive above, often with a narrow dorsal line. Sides silvery, with a leaden band from the eye to the caudal, this sometimes more or less broken up into dark blotches.

On account of its long snout and inferior mouth, this species resembles the young of some of the suckers. May reach a length of five inches.

Known to occur from Northern Ohio west to Iowa and south to Kentucky. White River at Indianapolis (1, '77, 376); Carroll County (23, '88, 48); Vincennes, New Harmony, Spencer (4, '84, 165, 167); Gosport (24, '93, 90).

Not much is known concerning the distinctive habits of this species. It appears to prefer the larger and clearer streams.

HYBOPSIS AMBLOPS (Rafinesque).

Silver Chub; *Big-eyed Chub*.

Ceraticthys amblops, Jordan and Gilbert, 1882, 8, 214.

Rather elongated and slender and somewhat compressed. Depth in length five. Head large; in length four; rather broad and flat. Snout blunt, the profile descending suddenly in front of the nostrils; its length three and one-half in head. Mouth inferior, horizontal, moderate in size, the maxillary extending to front of eye; a distinct barbel at tip of maxillary. Eye large; three in head. Teeth, 1-4-4-1; one of the inner sometimes missing. Scales, 5-40-4, sixteen in front of the dorsal. Dorsal rays, eight; anal, eight. Color above olive; the sides silvery, with a dark leaden band from the snout to caudal; this sometimes indistinct.

Ohio to Alabama. Indiana localities: Falls of the Ohio (9, 9, 32); New Harmony (Hay); Lawrence County (23, '84, 203); Monroe County (1, '85, 410); White River at Indianapolis (1, '77, 376); Carroll County (23, '88, 48); Eel River system (4, '94, 37); Wabash, Owen, Madison, Decatur and Lenoir counties (21, '93, 91).

HYBOPSIS STORERIANUS (Kirtland).

Ceratichthys lucens, Jordan and Gilbert, 1882, 8, 213.

Body rather elongated and compressed. The back elevated. Head flat above and the profile rapidly descending to form the rounded snout. Mouth inferior, horizontal, of moderate size. Preorbital bone large, extending nearly to tip of snout. Teeth as in *H. amblops*, without grinding surface. Eye large, three in head. Fins high, the caudal rays long. Head in length four and one-half; depth in length four. Dorsal rays, eight; anal, eight. Scales, 5-42-4. Color pale, the sides silvery. Bones of the head silvery; may attain a length of eight inches; seldom so large.

Ohio south to Tennessee and west to Nebraska. Falls of the Ohio (8, 214); Vincennes and Posey County (4, '88, 163); Spencer (4, '88, 167); Logansport (4, '94, 37); Owen County (24, '93, 91).

HYBOPSIS KENTUCKIENSIS (Rafinesque).

Horny-head.

Ceratichthys biguttatus, Jordan and Gilbert, 1882, 8, 212; Jordan, 1884, 24, 617, pl. 229.

Body rather heavy. Head large, broad above, its length in that of the body four and one-third times. Snout long. Mouth large, somewhat oblique, terminal, or nearly so, the lower jaw included. Depth of body in its length, four times. Dorsal rays, eight; the fin beginning slightly in front of the ventrals. Anal rays, eight. Caudal peduncle broad. Scales 7-42-6; eighteen in front of the dorsal fin. Color dusky above, with tints of reddish; each scale dark-edged. A dark shoulder stripe, and a dusky lateral band. In the spring the breeding males have the head covered with sharp tubercles; there is a bright red spot behind each eye and the fins are orange. The length may be as great as ten inches.

This is a species of wide range, being found from Pennsylvania to Dakota and south to Alabama. In Indiana it has been taken abundantly in the streams of all parts of the State. Carroll County (23, '88, 48); Franklin County (5, No. 2, 6); Monroe County (1, '85, 410); White River at Indianapolis (1, '77, 376); lakes of Laporte County, St. Joseph's River, Kankakee River, Tippecanoe River (1, '77, 45; 4, '88, 154-8); Lawrence County (23, '84, 203); Logansport (4, '88, 156); Spencer, Eel River in Owen County (4, '88, 167); Vigo County (16, 95); Winamac in Pulaski County; Eel River basin (4, '94, 37). Additional localities are given in 24, '93, 91.

This species is a resident of the smaller streams of the country, apparently not requiring such clear and pure waters as do most of the species of *Hybopsis*. On account of its considerable size it is sometimes

some game qualities. Professor S. A. Forbes found that this fish received less than one-half of its food from the animal kingdom. The vegetable matter eaten by it was made up of filamentous algæ and seeds of grasses. The animal food consisted mostly of insects, mostly of neuropterous larvæ. Crayfishes had been eaten by a few of the specimens examined.*

Genus SEMOTILUS Rafinesque.

Alimentary canal, not more than twice the length of the body. Teeth in two rows, four or five in the outer row, and two in the inner row. No grinding surface. Maxillary with a barbel, which is often minute. Mouth terminal. Dorsal beginning somewhat behind the ventrals.

SEMOTILUS ATROMACULATUS (Mitchill).

Horned Dace; Chub.

Semotilus corporalis, Jordan and Gilbert, 1882, 8, 221; Jordan, 1884, 12, 617, pl. 228; *Semotilus atromaculatus*, Bicknell and Dresslar.

Form rather heavy; head large and broad. Depth in length, four; head in length, three and three-fourths. Mouth large, terminal, somewhat oblique; the maxillary with a small barbel, which can be detected in the young only with difficulty. Teeth, 2-5-5-2; sometimes only four in one of the outer rows; without grinding surface. Eye small, five in head. Dorsal fin somewhat behind the ventrals; its rays, seven; anal rays, eight. Scales small, crowded forward, 10-52 to 65-7; thirty in front of the dorsal fin. Color leaden, the younger specimens with a dusky or black band along the side. Dorsal fin with a black spot at its base in front. Breeding males with coarse tubercles on the snout. May reach a length of ten inches.

Distributed from Massachusetts and Virginia to Louisiana and Dakota. Abundant in all streams.

Carroll, Marshall, Clarke, Ohio and Franklin counties (23, '88, 48-57); Monroe County (1, '85, 410); Marion County (1, '77, 376); Rivers of

*Genus COUESIUS Jordan.

Alimentary canal short. Teeth, 2, 4-4, 2, without grinding surface. Maxillary with a barbel at its extremity. Premaxillaries protractile. Scales small, fifty or more along the lateral line.

COUESIUS PLUMBEUS (Agassiz).

Couesius prothemius, Jordan and Gilbert, 1882, 8, 219.

Depth in length, four and one-half. The interorbital space flat; the profile straight or slightly concave to the nostrils, then descending to the upper lip. Mouth rather small, the maxillary not reaching the eye; slightly oblique; the lower jaw shorter than the upper. Snout, three in head. Scales small, the formula 12-68-8. Olive above, pale and silvery below. May attain a length of six inches. In the region of the Great Lakes. Has not been taken in Indiana territory, but Dr. Jordan states that it occurs in Lake Michigan, and that there are specimens of it in the National Museum from Evanston, Ill. In such case we can hardly doubt that it will eventually be found along the Indiana shore of Lake Michigan and in the lakes of Northern Indiana.

Northern Indiana (1, '77, 45); St. Joseph's River (4, '88, 154); Lake Maxinkuckee (4, '88, 158); New Harmony (4, '88, 163); Eel River at Cataract (4, '88, 167); Vigo County (16, 95); Eel River system (4, '94, 37); Wabash, Decatur, Henry and Laporte counties (24, '93, 92).

On account of the size of this species, its abundance in all our streams and the impulse which drives the small boy to the water with a hook and line, this fish above described becomes of some importance as an article of food. This importance is certainly due little to the quality of the flesh of the fish.

As to its food Dr. Forbes found that about seventy-five per cent. was composed of animal matter, this including some fishes, but principally insects. Some crayfishes had been eaten. About one-fourth of the food was made up of vegetation.

Genus PHOXINUS Agassiz.

Alimentary canal not more than twice the length of the body. Teeth 2-5-5-2 or 2-5-4-2. Lateral line complete or not. No barbels. Pre-maxillaries protractile. Dorsal fin inserted behind the ventrals.

A large genus, the species of which are found in both the New and the Old worlds.

PHOXINUS ELONGATUS (Kirtland).

Squalius elongatus, Jordan and Gilbert, 1882, 8, 232.

Body long, slender and considerably compressed. Depth in the length five times. Head long and pointed, contained in length of the fish three and three-fourths to four times. Snout rather longer than the eye, three and one-half in head. Mouth considerably oblique; large, the maxillary back to below the middle of the pupil. Lower jaw projecting beyond the upper. Teeth without grinding surface. Lateral line complete, decurved in front. Scales small, 12-70-6. Dorsal fin situated considerably behind the ventrals; its rays eight. Anal rays nine. The color is bluish, with mottlings of paler. Along the side runs a broad black band. In breeding males the front of this is red. Length about three inches.

Distributed from Pennsylvania to Minnesota, especially northward. Lake Michigan (14, No. 2, 61). A single specimen has been sent to me from Wabash County by Mr. John Fall. In this specimen the lateral black band is almost obsolete. Otherwise the specimen is typical. I know nothing about the habits of this fish, except that it is stated to prefer cold brooks.*

* PHOXINUS NEOGÆUS Cope.

Jordan and Gilbert, 1882, 8, 243.

This species has a short, little compressed body. The head is large and broad, the mouth moderate, and the lower jaw projecting. The lateral line is incomplete. Scales small, 18-80-11. The color is very dark, almost black. There is a black band from the snout to the tail along the sides. The species has been found in cold streams from Michigan to Wisconsin and to Arkansas. It will probably occur with the preceding in the northern part of the State. Prof. Cope described it from specimens found in Southern Michigan (Cephalopoda of Pennsylvania, p. 275).

Genus OPSOPEODUS Hay.

Alimentary canal short. Teeth 5-5, with grinding surface and serrated edges. Mouth small. Lateral line complete. Anal rays eight. Dorsal over the ventrals.

OPSOPEODUS EMILIE Hay.

Jordan and Gilbert, 1882, 8, 247.

A small, delicate species. Form rather slender, the head short, the snout blunt and rounded. Depth in length four to five times. Head in length about four and one-half times. The mouth very small, and the cleft almost perpendicular. Teeth 5-5. Eye about three in the length of the head. Scales 5-40-3; the lateral line complete or incomplete. Dorsal rays nine; anal rays usually eight. Color yellowish, the scales above with dusky edges. A dusky band along the side. Length about two inches.

This species was originally described by the writer from Eastern Mississippi. About the same time Prof. Forbes described it from Central Illinois under the name of *Trychærodon megalops*. It has more recently been found in the Maumee Valley, Ohio and in Arkansas. In Indiana I have taken it at New Harmony. Dr. Jordan also found it in Posey county (4, '88, 163, 166).

Genus NOTEMIGONUS Rafinesque.

Form deep and compressed. Anal fin long; its rays nine to eighteen. Mouth small, oblique. Alimentary canal short. Teeth 5-5, with grinding surface and crenate edges. Lateral line complete.

NOTEMIGONUS CHRYSOLEUCUS (Mitchill).

Bream; Golden Shiner.

N. chrysoleucus, Jordan and Gilbert, 1882, 8, 250; Jordan, 1884, 12, 616, pl. 227.

Body considerably compressed. Upper and lower outlines considerably curved. Depth in the length three to four times. Head short; its length in that of body about four and one-half. Mouth rather small, considerably oblique, the maxillary not extending back to the front of the eye. Snout shorter than the eye, which measures in the head three to four times. Dorsal beginning behind the ventrals; its rays, eight. Anal rays, twelve to fourteen. Lateral line complete. Scales, 10-50-4. Colors brilliant. Sides silvery, with tints of golden, and passing above into green. Fins often yellow; may reach the length of one foot, but usually smaller.

Abundant from New England to Dakota and Texas. In Indiana it probably occurs in every stream and pond. It has been reported from the following localities: Carroll County (23, '88, 48); Franklin County (5, No. 2, 6); Marion County (1, '77, 45, 377); lakes of Laporte County, Maumee River, Kankakee River, Tippecanoe River, Lower Wabash River, White River at Indianapolis (1, '77, 45); Lawrence County (23, '84, 204); Greene County (23, '84, 208); Posey County (4, '88, 163); Vigo County (16, 95); Wabash River at Wabash; Eel River basin (4, '94, 37); Laporte County (24, '93, 93).

This species appears to prefer slow streams and grassy ponds. It is sometimes found in numbers in the muddiest and apparently most uninviting holes. In its food habits it appears to be omnivorous. Forbes (14, No. 2, 81) found that its diet varies considerably in different situations. In some cases they had eaten altogether univalve mollusks. Some were found to have filled their intestines with mud. Other specimens had eaten only entomostaca, while one was discovered to have filled itself with wild rice.

Genus CYPRINUS Linn.

Size large; form stout, compressed. Teeth fitted for grinding, 1, 3-3, 1. Dorsal fin long, of twenty or more rays; both it and the anal preceded by a stout spine, which is serrated behind. Lateral line complete. Introduced from Asia.

CYPRINUS CARPIO Linn.

Carp.

Jordan and Gilbert, 1882, 8, 254; Jordan, 1884, 12, 618, pl. 230; 11, 1884.

A species originally from Asia, introduced into Europe and America as a food fish adapted for domestic culture, but which has escaped into our streams. The body is heavy and reaches a length of one or two feet. Dorsal rays, twenty, preceded by a stout spine, which is serrated behind. Anal rays, about five, also preceded by a serrated spine. The lateral line is complete. Scales, 6-40-5. In the "leather carp" the scales are entirely absent, while in the "mirror carp" there are a few rows of very large scales. Color, dusky above, brassy on sides and below.

For further information regarding the carp the reader is referred to the various publications of the United States Fish Commission. This fish is now reared in many artificial ponds, and from these has escaped and appears to be establishing itself in our streams. One specimen was taken by the writer in a small branch of the Tippecanoe River at Winamac, and another was seen on the border of Hyde Lake, near the

Indiana line, in the vicinity of Chicago. Professor Kirsch (4, '94, 36) reports having taken this fish at several points on Eel and Blue rivers, in Northeastern Indiana.

Order 7. ISOSPONDYLI.

This order is based on characters which require careful dissections for their determination. The most essential of these characters is the possession of a preopercoid arch. From the Eventognathi the order is distinguished by the fact that the lower pharyngeal bones are not enlarged, and do not bear teeth fitted for triturating food. It is more difficult to distinguish the members of the group from those of the next order—the Haplomi. An attempt to render aid in accomplishing this has been made on page 170, to which the student is referred.

ANALYSIS OF THE FAMILIES OF ISOSPONDYLI REPRESENTED IN INDIANA.

- A. Lateral margins of the upper jaw formed by the maxillaries.
- a. No adipose fin present.
 - b. Lateral line developed; conspicuous teeth on tongue.

Hiodontidæ, p. 223.
 - bb. No lateral line; teeth feeble or wanting.

Clupeidæ, p. 225.

Salmonidæ, p. 227.
 - aa. An adipose fin present.

Salmonidæ, p. 227.
- AA. Lateral margin of the upper jaw formed by the premaxillaries.

Percosidæ, p. 233.

Family HIODONTIDÆ.

Body compressed, covered with cycloid silvery scales. Head scaleless. Mouth large, oblique; the margins formed by the maxillaries, a row of teeth along the margin of the tongue, some of which are canine in form. Feeble teeth on the maxillaries. Teeth on the vomers, palatines and pterygoids. Eyes large. Gill rakers short, few. Lateral line present. No adipose fin.

Genus HIODON LeSueur.

Generic characters included in the above. Two species are found within our limits:

- a. Developed dorsal rays, nine; anal rays, thirty to thirty-two.

aliosoides, p. 224.
- aa. Developed dorsal rays, eleven or twelve; anal rays, twenty-eight.

tergisus, p. 224.

HIODON ALOSOIDES (Raf.).

Hyodon alosoides, Jordan and Gilbert, 1882, 8, 259.

Body deep and compressed, the lower outline more arched than the upper. Depth in the length, three and one-half; the young slenderer. The belly, both before and behind the ventrals, brought to a distinct edge. Head, in length, four and one-half. Snout, short and rounded, its length about a sixth of that of the head. Mouth large, the maxillary slender and extending considerably behind the eye. Eye moderate, three and one-half in head. Dorsal rays, nine; anal rays, thirty to thirty-two. Pectorals reaching the ventrals. Scales, 6-55 to 60-10. Color, bluish above, sides silvery. Dorsal, anal, and caudal with dusky tips. Length about one foot.

Ohio River and northward. Has been taken at New Harmony by Dr. Jordan (4, '88, 163); Vigo County, where it is reported as common by Professor O. P. Jenkins (16, 95); Gosport (Eigenmann, 24, '93, 93). So far as I am aware, no observations have been made on the habits of this animal. Its food is similar probably to that of the next species.

HIODON TERGISUS LeSueur.

Toothed Herring; *Moon-eye*.

Hyodon tergisus, Jordan and Gilbert, 1882, 8, 260; Jordan, 1884, 12, 613, pl. 219.

Form similar to that of the preceding. Depth in length, three and one-fourth. Head in length, four and one-third. Snout rounded, five in head. Eye large, three in head. Mouth not so large as in *H. alosoides*, the maxillary reaching to the hinder border of the pupil. Dorsal rays, twelve; anal, twenty-eight. Scales, 7-58-9. Pectorals falling considerably short of the ventrals. Belly in front of the ventrals rounded, keeled behind them. Color above bluish, bright silvery on all the scales. Fins pale. Length about twelve inches.

Great Lakes and southward in the Mississippi Valley. While this species is spoken of as being abundant, I have found few reports of its having been taken in Indiana. Messrs. Jenkins and Evermann found it in the Tippecanoe River, in Carroll County (23, '88, 48), and Professor Gilbert took it in Greene County (24, '93, 93); Professor Milner states (11, '72-3, 36) that in the Great Lakes the species is found from shore to a depth of twenty fathoms. Dr. Jordan (14, No. 2) states that it is a common fish in Lake Michigan.

Two specimens of this fish were examined by Professor Forbes. They were found to have eaten principally terrestrial insects. In one was found a trace of a univalve mollusk. Its large raptorial teeth would seem to indicate that it is accustomed to capture other fishes.

From the Cumberland River and southwards occurs another species of *Hiodon*, *H. selenops*. It is a slenderer fish than either of the above, the depth in length four. The eye is very large, two and one-half in head. Dorsal rays, twelve; anal rays, twenty-seven. It is possible that it may be found in the lower Ohio River.

Family CLUPEIDÆ.

Body compressed; covered with usually cycloid scales. Head scaleless. Mouth large or small, the upper margins formed by the maxillaries, which are composed of two or three pieces. Teeth feeble or entirely wanting. Gill-rakers numerous, long and slender. No lateral line. No adipose fin.

A large family containing numerous genera and species of fishes, many of which are of great economical importance. Our species come under two genera:

a. Mouth rather large, terminal; dorsal fin beginning in front of the ventrals.

Clupea, p. 225.

aa. Mouth small, inferior; dorsal beginning over or behind the ventrals.

Dorosoma, p. 226.

Genus CLUPEA Linn.

Body of moderate depth; compressed. Mouth moderate to large, terminal, the maxillary composed of three pieces each. Teeth feeble or entirely wanting. Dorsal fin beginning in front of the ventrals. Belly often compressed to a sharp edge.

One native and possibly two introduced species.

a. Vomer without teeth.

b. Gill-rakers few and short.

chrysochloris, p. 225.

bb. Gill-rakers numerous and long.

sapidissima,* p. 225.

CLUPEA CHRYSOCHLORIS Raf.

Skip-jack.

Jordan and Gilbert, 1882, 8, 266; Jordan, 1884, 12, 594, pl. 211.

Form elongated and much compressed, tapering from the front of the dorsal toward both snout and tail. Depth in length, three and three-fourths. Head in length, three and three-fourths. Mouth large, the

* Efforts have been made by the United States Fish Commission to introduce into our rivers the shad, one of the most valuable of the food fishes belonging to the family *Clupeidæ*.

The shad (*C. sapidissima*) has a rather deep body, two and two-thirds to three in the length, large mouth, long, slender and numerous gill-rakers, and about sixty scales along the lateral line. Dorsal rays, fifteen; anal, twenty-one. Belly strongly serrated. The young of this excellent food-fish have been deposited in the Ohio River, and a few specimens have since been captured. The success of the experiment is, however, very doubtful.

maxillary extending back to a perpendicular from the hinder border of the pupil. Lower jaw projecting beyond the upper. Eye in the head, four and one-third. Teeth usually present at the tips of both jaws. Gill-rakers comparatively short, stout, and few in number; about twenty-three below the angle of the gill-arch. Opercles striated. Dorsal rays, sixteen; anal, eighteen. Middle of belly strongly serrated from the throat to the vent. Tail forked. Scales, about fifty-five. Color, bright blue above, sides silvery, with golden reflections. Length, twelve to eighteen inches.

Lake Erie to the Gulf of Mexico in the larger rivers. Lake Michigan (14, No. 2, 55); Carroll County (23, '88, 48); New Harmony (4, '88, 166); Ohio River at Madison (Hay) and Evansville (Jordan)

This fish appears to have reached the Great Lakes through the canals. Mr. H. M. Smith (4, '92) states that it has become abundant in Lake Erie. It is one of our most beautiful fishes, but it is worthless as an article of food. Dr. Jordan (7, 73) says that in the Gulf of Mexico this fish becomes excessively fat. In the waters of our rivers, on the other hand, it is lean and poor, and its flesh is insipid. As to its food, Forbes says that it appears to be strictly predaceous. Those which he examined had, with one exception, eaten fishes. One had fed wholly on terrestrial insects.

Genus DOROSOMA Raf.

Body deep and much compressed. Head short and the snout blunt. Mouth small, inferior, the maxillary with a single supplementary bone. Gill-rakers numerous, of moderate length. Dorsal usually situated behind the ventrals. Anal rays many.

DOROSOMA CEPEDIANUM (LeS.).

Hickory Shad; Mud Shad; Gizzard Shad.

Jordan and Gilbert, 1882, 8, 271; Jordan, 1884, 12, 610, pl. 217.

Body deep and much compressed, elliptical in outline. Head short; snout shorter than the eye, which enters the head four and one-half times. Caudal peduncle narrow; tail forked. Depth in length, two to three times. Head in length, about four. Snout projecting beyond the small, inferior, horizontal mouth. The maxillary extending back to the pupil. Eye in head, four and one-half. Gill-rakers slender, but rather short. Belly serrated from the throat to the vent. Dorsal rays, twelve, the last ray prolonged into a filament. Anal rays, thirty-one. Scales in a longitudinal row, about fifty-six. Color, steel-blue above, silvery below, with a tint of blue. A black spot on the shoulder of the young.

Abundant along the Atlantic Coast from Cape Cod to Mexico, entering all rivers. In the Mississippi Valley it is a permanent resident in all the larger streams and some of the Great Lakes. It has been reported

from the following Indiana localities: Logansport (4, '94, 37); Carroll County (23, '88, 48); Clarke and Ohio Counties (23, '88, 56); Sullivan County (1, '77, 45, 69); Gibson and Posey Counties (4 '88, 163); Evansville (4, '88, 166); Vigo County (16, 95). Nelson (14, No. 1, 44) states that it is common in Lake Michigan about the mouth of Chicago River.

This fish is stated to be abundant in Lakes Michigan and Erie, and its presence there is regarded as resulting from the migration of the fish through the canals. It would seem to be possible for such a fish to reach the lakes through natural waterways. As regards its food habits, Forbes says that it is a mud-loving species. It has the habit of swallowing large quantities of mud containing a considerable amount of vegetable matter. In the vicinity of distilleries it feeds on the slops. Its stomach is muscular and resembles the gizzard of a chicken. A very small quantity of animal food is taken, small crustaceans, mollusks and insects. Professor Forbes makes the interesting statement that this fish, which is toothless in the adult stage, has, while young, a series of teeth on its maxillaries. Although a fine looking fish the hickory shad is utterly worthless as food for human beings. Its flesh is full of fine bones. It is not a worthless fish, however, since it furnishes an inexhaustible stock of food to the predaceous food-fishes.

Family SALMONIDÆ.

Body elongated and more or less compressed. Scales thin, cycloid. Head scaleless. Teeth present or absent. Upper margin of mouth formed by the maxillary, which is provided with a supplementary bone. An adipose fin present. Lateral line present and complete.

An extensive family of extremely valuable food-fishes, including the white-fishes, the salmons, trout, etc.

Teeth feebly developed or none. Scales of lateral line, seventy-five to one hundred. *Coregonus*, p. 227.

Teeth well developed. Scales of lateral line, one hundred and seventy-five or more. *Salvelinus*, p. 231.

Genus COREGONUS Linn.

WHITE-FISHES.

Body oblong, considerably compressed, tapering toward snout and tail. Head small. Mouth small, the maxillary with a supplementary bone. Teeth, usually none; if present, minute. Scales rather large.

A genus containing a considerable number of species, which inhabit the larger lakes of the cooler portions of the northern hemisphere.

- A. Lower jaw rather shorter than the upper and included within it in the closed mouth. Gill-rakers sixteen to twenty-five below the angle of the gill-arch.
- a. Gill-rakers short, about sixteen below the angle.
quadrilateralis, p. 228.
- aa. Gill-rakers long, slender, twenty-five below the angle.
clupeiformis, p. 229.
- AA. Jaws even, or the lower projecting beyond upper. Gill-rakers about thirty, below the angle of gill-arch.
- b. Body slender, the depth in length more than four times.
- c. Anal rays, ten. *hoyi*, p. 230.
- cc. Anal rays, twelve. *artedi*, p. 230.
- bb. Body deeper, depth in length less than four times.
- d. Depth more than three and one-half times. Fins blue-black. *nigripinnis*, p. 231.
- dd. Depth less than three and one-half times. Fins dusky. *tullibee*,* p. 228.

COREGONUS QUADRILATERALIS Richardson.

Menomonee White-fish; Round White fish.

Jordan and Gilbert, 1882, 8, 298; Jordan, 1884, 12, 541.

Body, slightly compressed, tapering each way from the dorsal fin, depth in length four and one-half. Back rather broad. Head small, in length five times; snout pointed, and projecting beyond the mouth, one-fourth the length of the head, narrow from side to side. Premaxillary bone higher than wide. Mouth small; premaxillary broad and short, not extending back to the eye. The lower jaw included within the upper in the closed mouth. Preorbital bone wider than the pupil. Gill-rakers short. Dorsal rays, eleven; anal, ten. Scales, 8-85-9. Color dark bluish above, silvery below. Lakes of New Hampshire and northward. Dr. Jordan, in his "Catalogue of the Fishes of Illinois" (14, No. 2, 54), states that this species is often taken in Lake Michigan; it may therefore be regarded as an Indiana fish.

* COREGONUS TULLIBEE Rich.

Tullibee.

Jordan and Gilbert, 1882, 8, 301; Jordan, 1884, 12, 541.

The tullibee is probably not to be reckoned an Indiana fish; it is even doubtful if it is a resident of the waters of Lake Michigan. The body is deep and compressed, the depth in the length three times. The outline in front of the dorsal considerably arched. Head, in length, four. Jaws equal when closed; when open, the lower projecting. Dorsal rays, eleven; anal, eleven. Scales, 9-75-10. Color, gray or olive above, quite dark on the middle of the back; sides silvery, with indications of longitudinal stripes; belly pale; fins dusky.

COREGONUS CLUPEIFORMIS (Mitchill).

Common White-fish.

Jordan and Gilbert, 1882, 8, 299; Jordan, 1884, 12, 507, pl. 196.

Body deep, compressed, elevated at the shoulder. Depth in length, two and one-half to four, the young being the more slender. Head short, five to six times in the length. Snout rather blunt. The preorbital not half as wide as the diameter of the pupil. Maxillary extending back past the anterior border of the eye. Eye four to five times in the head. Gill-rakers numerous, about two-thirds as long as the eye. Dorsal rays eleven; anal eleven. Scales 8-75 to 85-9. Length becoming in rare cases as great as thirty inches; weight as great as twenty-three pounds, but usually much less.

Inhabits all the Great Lakes; most abundant in Lake Michigan.

This is probably the most important of all our fresh-water food-fishes. This is due to its great abundance and to the excellent quality of its flesh, which is tender, sweet, finely flavored, and free from bones. Although far less abundant than formerly, great numbers are yet taken and sent to the markets. The work of artificially propagating and planting the young of this species in the Lakes has been undertaken by both the U. S. Fish Commission and the Fish Commissions of the States along the Lakes. The habits of the species have also been studied with some care. The food of the white-fish is made up of invertebrate animals, crustaceans, small mollusks, and insects. It seldom captures other fishes. The adults appear to be bottom feeders. The fish seldom takes the hook, but is taken in nets of various kinds. Prof. Forbes has studied the food of the young. He finds that it consists of the smallest entomostraca. He has also made the interesting observation that the mouth of the young fish is furnished with raptorial teeth. The fish breeds late in the year. The spawn is deposited from the middle of November until the end of the first week of December, and for this purpose the fish seeks the shallow waters along the shores of the lakes and at the mouths of rivers. They do not enter the latter to the extent they once did. The character of the spawning grounds vary greatly, being rocky, sandy, or covered with clay. During the spawning season, the males greatly worry the females. The pair may be seen swimming together, the male the smaller and the thinner. At times the two leap together out of the water, and at the same time the spawn and milt are expelled and falls into the water. There may be as many as sixty-six thousand eggs in a single female, but the average number is about ten thousand. The water-dog, *Necturus*, appears to be a great enemy of the white-fish, devouring the eggs in great quantities (Milner, 1872-3, 11, 44).

COREGONUS HOYI (Gill).

Moon-eye; Cisco.

Jordan and Gilbert, 1882, 8, 299; Jordan, 1884, 12, 541, pl. 197.

Form elongate and considerably compressed. Depth, in the length, four and one-half. Head rather long, four times in length. Snout long, three and one-third in the length of the head. Eye large, three and one-half to four in head. Mouth large; maxillary long, reaching to pupil. Preorbital long, its width equal to that of pupil. Premaxillaries wider than high. Lower jaw projecting little or none beyond the upper. Gill-rakers long and slender, as long as the eye. Dorsal rays, ten; anal rays, ten. Scales 8-80-8. Color bluish-gray above, silvery on the sides, white below. New York, westward to Lake Michigan, in deep water (14, No. 2).

Not much is known concerning the habits of the species here described. It appears to frequent only deep waters, being considered by Prof. Milner to range from thirty to seventy fathoms, where it has been taken in considerable quantities. Milner also states that it furnishes the principal food of the Mackinaw Trout. It reaches a length of ten inches.

COREGONUS ARTEDI LeSueur.

Lake Herring; Cisco.

Jordan and Gilbert, 1882, 8, 301; Jordan, 1884, 12, 541, pl. 197.

Form rather long, compressed, and tapering toward the snout and tail. Head small, four and one-half in the length; snout pointed; upper surface of the head rather flat. Mouth large, the maxillary reaching back to the pupil. Premaxillaries short and narrow, placed almost horizontally. No teeth present. Jaws about equal in the closed mouth, the lower projecting in the open mouth. Preorbital and supraorbital narrow. Suborbital and postorbitals broad. Eye small, four to five in length of head. Dorsal rays, ten; anal, twelve. Scales, 8-75 to 90-8. Color dusky above, with reflections of blue; scales of sides and belly silvery, with minute specks of dusky; fins pale, with edgings of dark. Length about nineteen inches; average specimens less than one foot. Distributed from the lakes of Northern Indiana northward; abundant. In Indiana it has been reported from the Tippecanoe River and its tributary lakes (1, '77, 45); lakes of Eel River system (4, '94, 37).

Professor Milner, who describes the fish under the name of *Argyrosomus clupeiformis* (11, '72-73, 65), gives us some facts regarding the habits of this important fish. It lives in the shoaler waters, from shore to a depth of twenty fathoms, sometimes going in immense schools. They often crowd into the pound-nets in masses, and do not appear to

diminish in numbers with catching. They are not so highly regarded for food as are the other species of the Salmonidæ. They are small and thin when opened, and become shrunken when pickled. They may, however, be made into a most delicious article of food by a slight pickling in salt brine and then exposing them to the smoke of a hot fire for a short time. The fresh fish command a low price in market. The fish has a terminal mouth and readily takes the hook. Their usual food seems to be certain insects and small crustaceans. They also appear to be great devourers of fish spawn, even of their own. They spawn about the middle of November, and the eggs probably hatch about the middle of May.

Professor Forbes (14, 2, 437) found that this fish subsists on small crustaceans (*Daphnia*, *Bosmina*, *Cyclops*, etc.) and terrestrial insects. Smith (4, '92, 207) states that the Cisco also eats fishes. One was taken in Lake Ontario with a large ale-wife in its mouth.

COREGONUS NIGRIPINNIS (Gill).

Blue fin; Black-fin.

Jordan and Gilbert, 1882, 3, 301; Jordan, 1884, 12, 541.

Body deep and much compressed. Depth in length three and three-quarters. Head compressed, pointed, in length four times. Snout in the head four times, equal to diameter of the eye. Mouth large, terminal, the lower jaw projecting beyond the upper, the maxillary reaching back to the hinder border of the pupil. A few minute teeth on the jaws. Gill-rakers long and slender. Dorsal rays ten, anal eleven or twelve. Scales 9-88-7. Dark bluish above, sides silvery. Fins blue-black. Length as great as twenty inches. This fish is a resident of the deep waters of Lake Michigan. It appears to be moderately abundant. Milner (11, '72-73, 35) says that it is most abundant in seventy fathoms of water and deeper, and are seldom taken in the fishing season even in as great a depth as fifty fathoms. At Grand Haven, Mich., it is taken during December in thirty to forty fathoms. That it has been actually taken in Indiana waters I am not certain.

Genus SALVELINUS Richardson.

Teeth on the jaws and palatines and tongue. Vomer boat-shaped; no teeth on its shaft. Scales very small, one hundred and seventy-five or more along the lateral line. Color dark, with red or gray spots. A genus containing a considerable number of beautiful fishes, among which is the brook trout (*S. fontinalis*), not a resident of Indiana, and the fol-

SALVELINUS NAMAYCUSH (Wallb.).

Mackinaw Trout; Salmon Trout.

Jordan and Gilbert, 1882, 8, 317; Jordan, 1884, 12, 485, pl. 191.

Body of moderate elongation, the depth in the length four times. Head in length four and one-half times, the upper surface flattened, the snout pointed. Mouth large, the maxillary extending back beyond the eye. Teeth well developed; the vomer and the hyoid armed. Dorsal rays, eleven; anal, eleven. Scales, one hundred and eighty-five to two hundred and five. Color, dark above, sometimes almost black, with numerous circular spots of gray or reddish. Size large, three feet or more.

Great Lake region. As a resident of the whole of Lake Michigan this species may be included among Indiana fishes (14, No. 2, 54).

Prof. Milner (11, '72-'73, 35) gives us some information regarding this fish. He says that it is one of the three most numerous fishes of the Great Lakes, and attains the greatest weight of any fish of the lakes, except the Sturgeon. The weight may reach as much as thirty-six pounds, but averages about fifteen. The flesh while fresh is about equal to that of the white-fish, but not so good when salted. The flesh is often red, although the fish does not eat crustaceans. The food consists principally of *Coregonus hoyi* and probably other of the smaller fishes. They were not found to eat the white-fish, as the fishermen supposed they did. The Mackinaw trout is a ravenous feeder. It is not an unusual thing for one to swallow a fish too large for its stomach and to swim about with the tail protruding until the head is digested. They are ready to swallow any kind of offal thrown from a ship, and they take the hook readily. The spawn is deposited about the last of October. For this purpose the fishes seek a rocky bottom at a depth of from seven feet to fifteen fathoms. They are known to spawn along the western coast of Lake Michigan from Racine northward; and on the eastern coast from St. Joseph northward. Each female may contain about 14,000 eggs. These hatch about the last week of January, if not too much retarded by cold weather.

Dr. H. M. Smith (4, '92, 202) discusses the present status of the fish in Lake Ontario. The catch of the trout has decreased rapidly within the last few years. The average size of the fish taken in trout nets is probably eight pounds.

This is one of the fishes to which the attention of the United States Fish Commission has been directed. In 1885 a considerable number of the young were introduced into the waters of Lake Michigan along the Indiana shore.

Family PERCOPSIDÆ.

Body elongated; covered with strongly ctenoid scales. Head naked; the bones cavernous. Dorsal and anal short. An adipose fin present. Teeth on the premaxillaries and lower jaw; none on vomers and palatines. Branchiostegals six. Premaxillaries forming the upper margins of the mouth. Pseudobranchiæ large.

Genus PERCOPSIS Agassiz.

Dorsal originating immediately behind the ventrals. No supplementary bone. Gill-rakers short. A medium bony crest along the middle of the head.

PERCOPSIS GUTTATUS Agassiz.

Trout perch.

Jordan and Gilbert, 1882, 8, 322.

Body elongated and compressed. Depth in the length four and one-half to five times. Head pointed and compressed; the profile increasing in convexity as it nears the snout. Mouth horizontal, small, the maxillary not reaching the eye. The bone of the head with cavities for mucous glands. Dorsal rays ten or eleven; anal rays eight. Scales strongly ctenoid; 8-55-8. Color pale olivaceous, with numerous splotches of brown. Sides with a silvery lateral band, especially distinct behind. Belly white. Length about six inches.

Occurs from the Potomac River to Kausas, and from the Ohio River to the Great Lakes. It appears to be quite abundant in Lake Michigan, and Dr. Jordan (10, '74, 220) records it from Jeffersonville, on the Ohio River. It is to be expected in any of the larger streams of Indiana. In the Great Lakes, it is found from shore to a depth of twenty fathoms. It is taken with hook and line from the piers at Chicago, and is sometimes washed up on the beach. While most closely related to the Salmonidæ, this fish has some characters in common with the perches.

Order 8. HAPLOMI

This order differs essentially from the Isospondyli in having no preopercoid arch. For combinations of characters by means of which the two orders may be distinguished, the student is again referred to page 170.

Families of HAPLOMI.

* Upper margin of mouth formed wholly by premaxillaries.

† Mouth large; lower jaw projecting; gill-membranes connected with the isthmus; head scaleless. *Amblyopsidæ*, p. 234.

†† Mouth small; jaws equal; gill membranes free from the isthmus; head scaled. *Cyprinodontidæ*, p. 235.

- ** Upper margin of the mouth formed posteriorly by the maxillaries.
 † No lateral line; mouth large. *Umbridae*, p. 238.
 †† Lateral line present; mouth large. *Luciidae*, p. 239.

Family AMBLYOPSIDÆ.¹

Small fishes, with large flattened heads. Mouth large; the non-protractile premaxillaries forming the whole of the upper margin. Head without scales, furnished with papillary ridges. Scales of the body cycloid and irregularly arranged. Vent at the throat.

Genera of AMBLYOPSIDÆ.

- a. Ventrals present, small; eyes blind; body colorless. *Amblyopsis*, p. 234.
 aa. Ventrals wanting.
 b. Blind, colorless fishes. *Typhlichthys*, p. 234.
 bb. Colored fishes with developed eyes. *Chologaster*, p. 234.

Genus AMBLYOPSIS DeKay.

Eyes concealed beneath the skin. Head without scales and crossed by tactile ridges. Gill-membranes connected with the isthmus. Ventral rays very small, situated near the anal fin. A single species known.

AMBLYOPSIS SPELÆUS DeKay.

Mammoth Cave Blind-fish.

Jordan and Gilbert, 1882, 8, 324.

Body rather long, heavy forward. Head long and flat. Depth in the length about four and one-half times. Head in length three times. Mouth large and directed upward. Head crossed by tactile ridges. Dorsal rays nine; anal eight. Colorless. Length five inches or less.

Kentucky and Indiana in caves and underground streams. Common in Wyandotte and neighboring caves.*

*The genus *Typhlichthys* differs from *Amblyopsis* in having the ventral fins wholly wanting. Only a single species is known, *T. subterraneus*. It has been found in caves and wells in Kentucky, Tennessee and Alabama, and is not unlikely to occur in the caves and underground streams of the region in Indiana occupied by the subcarboniferous limestone. It may be distinguished from *A. spelæus* by the absence of ventrals. Since these are quite small in the latter species, a close examination is necessary.

The genus *Chologaster* may also be represented in the fauna of Indiana, although of this there is yet no evidence. The genus differs from the two preceding in having well developed eyes and in having a pigmented skin like ordinary fishes. There are no ventrals.

C. agassizii occurs in subterranean streams in Kentucky. The color is a uniform light brown. The eye is large. The length is about an inch and a quarter.

C. papilliferus has been described by Forbes from Union County, Illinois. It reaches a length of only an inch. It is of a yellowish brown color, darker above. The sides have three dark streaks. The eye is small, six times in length of head.

Family CYPRINODONTIDÆ.

Small fishes having the head and anterior region depressed, while the hinder part of the body is compressed. Mouth terminal, small, the upper margin formed by the premaxillaries only. Jaws well furnished with teeth. Head scaly. Gill membranes free from the isthmus. Dorsal fin situated well back.

A large and widely extended family of fishes; containing a large number of genera, of which we have representatives of two.

Anal fin of male normal; of 7-15 rays; female not viviparous.
Fundulus, p. 235.

Anal fin of male much elongated and considerably in front of the dorsal; viviparous fishes.
Gambusia, p. 237.

Genus FUNDULUS LaC.

Body elongated or not; much or little compressed. Head flattened. Mouth small, the jaws with simple pointed teeth arranged in more than one row. Premaxillaries very protractile. Dorsal fin beginning in front of, or behind the anal.

As here defined the genus includes the species which are usually put in the genus *Zygonectes*. Until definite characters separating the two can be named, it seems to me better not to attempt to divide the species.

- * Dorsal fin of twelve or thirteen rays; sixteen or more cross-bars.
diaphanus, p. 235.
- ** Dorsal of nine rays; a lateral black band. *notatus*, p. 236.
- *** Dorsal of seven rays; sides with ten narrow dark stripes; males with about nine cross-bars. *dispar*, p. 237.

FUNDULUS DIAPHANUS (LeS.).

Spring Minnow.

Jordan and Gilbert, 1882, 8, 334; *Fundulus menona*, *op. cit.*, 335.

Body elongated, compressed behind. Depth in the length nearly five times. Head in the length four times, flat above. Dorsal rays thirteen; anal rays eleven. Ventrals scarcely reaching the vent in the females; a little longer in the males. Scales along the side 40-48, about twelve in a transverse row. Color olive, with silvery sides and fifteen to twenty-five dark cross-bars. Some specimens (var. ? *menona*), probably males, dark with about sixteen silvery cross-bands on the sides. Length about four inches.

Jordan and Copeland have described (1, '77, 68) the species, *menona*, which has since been regarded as simply a variety of *diaphanus*. It is characterized by the possession of about sixteen shining silvery bars running across the sides. Dr. Smith (4, '92, 65) suggests that these are the

males of *diaphanus*, while the individuals having the dark bars on a silvery ground are the females.

This species is found along the Atlantic Coast in brackish waters, and ranges in fresh-water streams and lakes westward to Colorado. In Indiana, it has been taken in Lake Maxinkuckee and neighboring streams (23, '88, 55; 4, '88, 159); Lakes of Laporte County and St. Joseph's River (1, '77, 44). "In Lake Michigan it abounds about the sandy mouths of tributaries, keeping in schools in the shallow water near the edge of Calumet River," (Jordan, 14, No. 2).

Forbes (14, No. 2, 78) found this species to have eaten mollusks belonging to the genera *Pisidium* and *Planorbis*, larvæ of dipterous insects, *Allorchestes*, and *Cladocera*. He also informs us (14, No. 6, 71) that about one-fifth of the food is composed of vegetable matter. The fish appears to prefer the colder and clearer waters of streams and springs.

FUNDULUS NOTATUS (Raf.).

Top Minnow.

Zygonectes notatus, Jordan and Gilbert, 1882, 8, 339.

Head and anterior region depressed, the remainder of the body compressed. Depth in the length, four to four and one-half. Head long, three and one-half in length, broad and flat. Interorbital space one-half the length of the head. Lower jaw projecting. Eye in head four times. Dorsal beginning behind the first ray of the anal; its rays, nine. Anal rays eleven. Both the dorsal and the anal higher in the males than in the females. Scales along the lateral line, about thirty-six; in a transverse row, twelve. Color, brownish olive. Along the side, from the snout to the tail, runs a broad black or blue-black band. Above this there are, on many scales, small black spots. The vertical fins all speckled with brown. On the middle of the upper surface of the head is a large pale spot. Length, two to three inches.

Michigan to Western Florida. Indiana localities from which it has been announced are: Carroll County (23, '88, 48); Clark County, (23, '88, 56); Marion County (1, '77, 376); St. Joseph's River, Maumee River, Lower Wabash River (1, '77, 44); region about Lake Maxinkuckee (4, '88, 159); Vincennes, Patoka and Posey County (4, '88, 163); Evansville (4, '88, 166); Vigo County (16, 95); Eel River Basin (4, '94, 38); Decatur, Monroe and Gibson Counties (24, '93, 94).

This fish prefers still waters, where it may be seen swimming near the surface. Unlike some members of the same family, this species lays its eggs, instead of hatching them within the body. As to its food, Forbes (14, No. 2, '78) found in the stomachs of specimens examined the bones of a small fish, various small insects, and small crustaceans. Elsewhere

(14, No. 6, 72) he reports that about 90 per cent. of the food is of animal origin, consisting principally of insects. This might be predicted from the habit which the animal has of swimming near the surface and from the structure of the mouth.

FUNDULUS DISPAR (Agassiz).

Zygonectes dispar, Jordan and Gilbert, 1892, 8, 341.

Form shorter and deeper than in the preceding species. Depth in length three and one-half. Head broad and much flattened, its length in that of the fish three and three-fourth times. Snout broad and rounded; the interorbital width about two-thirds the length of the head. Eye large, in head about three times. Lower jaw projecting. Dorsal rays, seven; anal rays, nine. Scales along lateral line about thirty-five; about ten in a cross-row. Color olivaceous; said to be bluish in life. Along the sides in the female run about ten narrow dark lines. The adults have a black spot below the eye. The males are distinguished by having about nine dark cross-bars on the sides. The length is about two and one-half inches.

Distributed from Northern Indiana to Mississippi. Has been taken in Indiana at several points. St. Joseph's and Tippecanoe rivers (1, '77, 44, 67); Greene County, "in myriads" (23, '84, 208); Lake Maxinkuckee (4, '88, 159); Vincennes, New Harmony, Mt. Vernon (4, '88, 163, 166).

This species has many of the habits of the preceding. It loves quiet pools where insects and small mollusks abound, and where it may be seen swimming slowly, "as if it were very hard work." Forbes found in the stomachs mollusks of the genera *Physa* and *Planorbis*, insects, and a few small crustaceans. About eighty per cent. of the bill of fare is of animal origin (14, No. 2, '78 and 14, No. 6, '73).

Genus GAMBUSIA Poey.

Small fishes differing from the species of *Fundulus* in having the anterior rays of the anal fin of the male much elongated and converted into an intromittent organ, by means of which the eggs are fertilized internally. The young reach an advanced stage of development within the mother's body. The females have often been mistaken for species of *Zygonectes*, from which it is difficult to distinguish them, except when they are pregnant.

GAMBUSIA PATRUELIS (B. and G.).

Jordan and Gilbert, 1882, 3, 893; *Zygonectes melanops*, J. and G., *op. cit.* 340 (females).

Body of the male rather elongated, the depth in the length about four times; of the females rather deeper, the depth in the length about three and one-half times. Head flat, snout broad, the lower jaw projecting. Eye in the head three to three and one-half times. Scales along the lateral lines from twenty-eight to thirty-eight. Dorsal rays seven to nine; anal rays nine. Anal fin of the males with the anterior rays elongated into an intromittent organ as long as the head. Color yellowish brown; the females with the scales dark-edged; the males sometimes with rows of dark dots along the sides; a dark spot below the eye. Length of the females about two and one-half inches; of the males about an inch.

Distribution from all the Southern States north to Southern Indiana. Has been taken in Posey County (4, '88, 163).

This fish is abundant throughout the Southern States from the Atlantic Coast, where it lives in the brackish waters, to the Rio Grande. It is interesting from the fact that it does not deposit its eggs, but retains them within the body, where they undergo their development. An interesting account of the development of the species has been given by Dr. Ryder (quoted 2, 909). The number of young brought forth by each female is from twenty-five to thirty. When ushered into the world the young are in as advanced a stage of development as is a shad at the age of from three to six weeks, and are eminently capable of taking care of themselves.

Family UMBRIDÆ.

A family containing a single genus and two species. One of these inhabits Austria, the other North America. It is related to the *Cyprinodontidæ*, but differs in having the upper margin of the jaw formed mostly by the maxillaries, in having nonprotractile premaxillaries, and in having teeth on the palatines. Dorsal fin in front of the anal. Ventrals small near the anal. Lateral line wanting in our species, obscure in the other.

Genus UMBRA Müller.

Body covered with cycloid scales. Mouth moderate. Ventral rays six. Gill-rakers short.

UMBRA LIMI (Kirtland).

Mud Minnow.

Jordan and Gilbert, 1882, *s*, 350; Blatchley, W. S., 1885, *1*, 12 (synonymy).

Form compressed, the caudal peduncle deep. Depth in the length, four and one-fourth. Head short, about four times in length. Mouth moderate, little oblique, the maxillary reaching the pupil. Whole head scaly. No lateral line. Scales, thirty-five along the side, about fifteen in a transverse row. Dorsal rays, fourteen; anal rays, eight. Color very dark, the sides usually with pale, irregular cross-bars. A vertical black bar at the base of the caudal. Length about four inches.

Canada to Minnesota and south to Indiana and North Carolina. In Indiana has been taken at many points. Carroll County (23, '88, 48); White River, at Indianapolis (1, '77, 376); lakes of Laporte County, St. Joseph's River, Maumee River, Tippecanoe River (1, '77, 44); region of Monroe County (23, '84, 204); Whitley County, Marshall County (4, '88, 159); Terre Haute (4, '88, 167); Vigo County (16, 95); Winamac and Winchester; Eel River Basin (4, '94, 38).

This species appears to delight in swampy situations. It often buries itself in the mud at the bottoms of clear ponds and quiet streams, and on stirring up such places one may sometimes find numerous fishes, where before none were to be seen. Professor Forbes (14, '78, 78) determined the food of this fish to consist of water-mites, the larvæ of various insects, entomostraca and small mollusks. Elsewhere (14, No. 6, 73) he informs us that it also eats a considerable per cent. of low vegetable matter.

Family LUCIIDÆ.

PIKES AND PICKERELS.

Body elongated, slightly compressed, and often of large size. Heads long, with produced and depressed snouts. Mouth large and armed with strongly developed teeth. Margin of upper jaw formed mostly by the maxillaries. A supplemental bone present behind the maxillary. Teeth on the premaxillaries, vomer and palatines. Scales cycloid, small. Dorsal fin placed far back, opposite the anal. No adipose fin.

Contains only the single genus *Lucius* (Jordan, 4, '88, 111). This is represented in Indiana by three species.

Genus LUCIUS Rafinesque.

The character of the genus included in those of the family.

- a. Cheeks and opercles entirely scaly. *vermiculatus*, p. 240.
- aa. Cheeks scaly; opercles bare on lower half. *lucius*, p. 241.
- aaa. Cheeks and opercles both bare on lower portion. *masquinongy*, p. 242.

LUCIUS VERMICULATUS (LeSueur).

Little Pickerel.

Esox salmoneus, Jordan and Gilbert, 1882, 8, 352; *E. vermiculatus*, Meek and Newland, 1, 1884, 369 (synonymy); *E. umbrosus*, Jordan, 1884, 12, 464, pl. 184.

Form that of its relatives. Depth, in the length five to six times. Head comparatively short, the length in that of the fish three and one-half times. Snout shorter than the rest of the head; the eye being exactly in the middle of the length of the head. Cheeks and opercles entirely covered with scales. Branchiostegals eleven or twelve. Scales along the lateral line about one hundred and five. Dorsal rays fourteen; anal eleven. Color olive or gray. On the sides are usually numerous bands of brown, irregular in breadth and direction; often forming a network and sometimes transverse bands. A black streak running downward from the eye. Length attained about one foot.

Found throughout the Mississippi Valley, entering the Great Lakes. Very abundant in Indiana, in all portions of the State. Ohio River (9, 9, 42); Wabash River (17, XVIII, 335); New Harmony (4, '88, 163); Monroe County (1, '85, 410); Carroll County (23, '88, 49); Marion County, Lakes of Laporte County, St. Joseph's River, Maumee River, Tippecanoe River (1, '77, 44); Greene County (23, '84, 208); Kankakee River at Plymouth (4, '88, 156); Marshall and Whitley counties (4, '88, 159); Owen County (4, '88, 167); Winamac; Eel River system (4, '94, 38). For a few additional localities see, 24, '93, 95.

Prof. Forbes found the food of this species to consist almost wholly of the larger aquatic insect larvæ and the smaller fishes in almost equal ratio, together with an occasional larva of batrachians. Like the other members of the family, in proportion to its size and strength this fish is active and ravenous. The larger specimens serve for food, but as a food-fish, it does not amount to much.*

* Under the name *Esox ravenelli*? Prof. S. A. Forbes, in Dr. Jordan's "Catalogue of the Fishes of Illinois," has described a pickerel, two and seven-eighths inches long, which agrees well with *Lucius reticulatus*, a species which, until recently, has been regarded as an inhabitant only of the region east of the Alleghany Mountains. Since it has, however, been taken lately in Arkansas, it is quite probable that Prof. Forbes' specimen belonged to this species. In such case, its occurrence in Indiana is not improbable.

In *L. reticulatus* the cheeks and opercles are wholly covered with scales. There are usually fifteen branchiostegals. Dorsal rays fourteen; anal rays thirteen. Scales along the lateral line one hundred and twenty-five. The front of the eye is at the middle of the head. The dark lines on the sides are reticulated, but mostly form more or less longitudinal bands. The length becomes as much as two feet.

LUCIUS LUCIUS (Linn.):

Pike.

Esox lucius, Jordan and Gilbert, 1882, 8, 353; Jordan, 1884, 12, 461 pl. 183; Meek and Newland, 1885, 1, 372 (synonymy).

This species differs from the preceding in having the lower portion, about half, of the opercles bare of scales. There are also fourteen to sixteen branchiostegals, instead of eleven to thirteen. Like the preceding, the eye is placed in the middle of the length of the head. There is a larger number of scales along the lateral line, one hundred and twenty-five, instead of about one hundred and five. Dorsal rays seventeen; anal rays fourteen. The color is olive or bluish, with numerous pale spots about the size of the eye. These are sometimes arranged in somewhat irregular rows, and in the young they may coalesce. The length may become as great as four feet, but this size is unusual. This species has a wide distribution, being found in the waters of Europe, North Asia and North America. In our country it is not known south of the Ohio River. St. Joseph's River (1, '77, 44); Wabash River, at New Harmony (1, '85, 373); Lake Michigan (1, '85, 373); Eel River Basin (4, '94, 38); Wabash County (24, '93, 95).

The habits of the pike are approximately those of its congeners. It is active, fierce and extremely voracious. For much interesting information concerning its size, age attained, habits, superstitions regarding it, and the methods employed in its capture, the reader may see Pennell's "Book of the Pike." This author states that the pike will eat almost anything. "Fish, flesh and fowl are alike acceptable to him; animal, mineral and vegetable—his charity embraces them all." They even do not hesitate to swallow weaker members of their own species. As to the edible qualities of the fish, there appears, according to this author, a good deal of difference of opinion. A few authorities have regarded it as among the poorest and coarsest of fishes. Others regard them highly. Much probably depends on the individual peculiarities of the fish, the kind of food it has eaten, the nature of the waters inhabited, etc. The unfavorable opinion held by some of the writers does not appear to be shared by the people of this country. So far as I have been able to learn, the pike is regarded in the markets of Chicago as an excellent fish.

Forbes (14, No. 2, 18) found the food of this fish to consist wholly of other fishes, many of the victims being species having spiny rays.

The eggs are deposited during the winter and early spring.

LUCIUS MASQUINONGY (Mitchill).

Muskallonge.

Esox masquinongy, Meek and Newland (1, '85, 373); *E. nobilior*, Jordan and Gilbert, 1882, 8, 353; Jordan, 1884, 12, 464, pl. 184.

This species attains a much greater size than any of the preceding. Dr. Jordan gives the maximum size as eight feet in length. A specimen six feet long will weigh about eighty pounds.

In the muskallonge the lower half of both cheeks and opercles are devoid of scales. There are from seventeen to nineteen branchiostegals. Dorsal rays seventeen; anal rays fifteen. The scales of the lateral line amount to about one hundred and fifty. The color is a dark silvery gray, and on this are scattered round blackish spots.

This species inhabits the waters of our country from the Ohio River northward, being more abundant in the lakes of the more northern States and British America. In Indiana it is rare. Ohio River at New Albany (1, '85, 374); Lake Michigan (14, I, 43, and 13, '77, 104).

The great size attained by this fish makes it one of the important food-fishes of the country, although it appears to be nowhere abundant. Being of active nature and of great size, it tests the skill of the sportsman who has been fortunate enough to have it attach itself to his hook. Its flesh is usually regarded as equal to that of any of the most esteemed fishes. "The meat is almost as white as snow, fine-grained, nicely laminated, and the flavor is perfect." Hallock says that it is a long, slim, strong and swift fish, in everything formed for the life it leads—that of a fierce and dauntless marauder.

Roosevelt ("Game Fishes") expresses a poor opinion of all the members of the genus *Lucius*. "They are dull sport in the catching and poor food in the eating. Believe no one who boasts of the fine flavor of the muskallonge; cook him as you will, he is nothing but a dirty, flabby, tasteless pickerel." The same author mentions the common carp (*Cyprinus carpio*) as being a delicate fish, but not equal to the "Western carp," some of our suckers, probably.

Professor Forbes has investigated the food-habits of this species. It consists almost wholly of other fishes, such as sun-fish, black bass, croppies, gizzard shad and buffalo-fishes. One was discovered to have eaten the larvæ of dragon-flies.

The spawn is deposited in April and May. One large female yielded sixty thousand eggs (25, 94).

Order 9. APODES.

THE EELS.

Body extremely elongated and serpent-like. Premaxillary bones not distinct, sometimes wanting. Arch bearing the pectoral fins not connected with the skull. No preopercoid arch. Ventral fins entirely wanting. Gill-openings narrow, widely separated.

An order containing a number of families, only one of which is represented in our fresh waters.

Family ANGUILLIDÆ.

THE TRUE EELS.

Body somewhat compressed, much elongated. Head long. Mouth large. Pectoral fins present, but no ventrals. Dorsal and anal fins usually confluent around the end of the tail. Body naked or furnished with minute imbedded scales.

This family contains but a single genus.

Genus ANGUILLA Thunberg.

Body elongated and compressed; covered with minute, narrow scales, which are placed obliquely, and some of them at right angles with the others. Head long and pointed. Dorsal and anal fins confluent around the end of the tail. Lateral line present.

ANGUILLA ANGUILLA (Linn.).

The Eel.

Anguilla rostrata, Jordan and Gilbert, 1882, 8, 361; *Anguilla anguilla*, Jordan, 1884, 12, 630, pl. 239.

Body long and snake-like. Pectoral fins present, but no ventrals. Dorsal fin long, occupying two-thirds of the length of the back, and passing around the tip of the tail into the anal fin. The latter running forward more than one-half the length of the fish. Head long and pointed; lower jaw projecting. Head in the length about eight times. Color above dark, sometimes tinged with yellow; paler below.

Found all along the Atlantic Coast from Maine to Brazil. Ascends all the rivers to their sources, and enters the Great Lakes. Not many records are made of the eel's having been taken in Indiana. I have seen it on the fish tables at market in Madison, on the Ohio River. It is taken occasionally at Brookville (5, No. 2; 6); and Dr. Evermann has taken specimens in the streams of Carroll County (23, '88, 49).

Vigo County (16, 95); Decatur County (Shannon). Dr. Jordan (14, No. 2, 57) gives it as occurring in Lake Michigan; Eel River in North-eastern Indiana (4, '94, 38).

The eel is a resident of both salt and fresh waters. It penetrates to the headwaters of our longest rivers, and when it gets ready to deposit its eggs it goes down again to the sea. The belief now is that it spawns once and then dies. Much remains to be learned concerning the breeding habits and the manner of development of the eel. Some investigations have shown that the ovaries of a female eel may contain as many as 9,000,000 eggs. The male eel never leaves the salt or brackish water. The young eel reaches a length of about three or four inches at the end of its first year. It is probable that at this time they make their way up the rivers. While living in the sea, eels appear to make migrations from one part of the coast to others. On the land they are able to move about on wet grass, and thus they can pass from one stream to another. Eels are extremely voracious, and are the terror of smaller fishes and crustaceans. They go about overturning stones and poking their snouts into every nook and corner, seizing and swallowing their prey. They appear to have a preference for the game fishes. Eels bring a good price in market as an article of food. Their skins also are an article of commerce, being regarded by some people as a remedy for rheumatism

Sub-class 4. PHYSOCLYSTI.

Primitive skeleton thoroughly ossified. Membrane bones well developed. Body usually covered with scales, which are often ctenoid. Tail homocercal. The vertical fins usually with some spines. The pectorals commonly, but not always, with a spine and five soft rays. Air-bladder of the adult, when present, without a duct. Ventrals usually thoracic or jugular. The absence of a duct connecting the usually present air bladder with the œsophagus distinguishes this group from the *Physostomi*. The characters derived from the nature of the scales, the position and structure of the ventral fins, and presence of spinous rays in the dorsal and anal fins, usually, but not always, hold good. We have representatives in our waters of three orders of the sub-class. All of these, with one exception, have two or more spinous rays in the front of the dorsal. The following analysis of the orders is intended to apply only to our species.

1. Ventrals abdominal or nearly so. Dorsal with two or more spines.
2. Dorsal with two or more stiff and free spines.

Hemibranchii, p. 245.

3. Dorsal with three or more slender spines in front.

Percesoces, p. 247.

4. Ventrals thoracic or jugular. Dorsal, with few exceptions, having spinous rays three or more in number.* *Acanthopteri*, p. 248.

Order 10. HEMIBRANCHII.

The essential characters of this order are found in their internal anatomy and need not be given here. In most of the species, which are marine, the bones of the head are prolonged into a long tube, with the mouth at the end; but in our species the head is rather short.

Family GASTEROSTEIDÆ.

Body fusiform, with head of moderate length and the caudal peduncle slender. No teeth on vomers or palatines. Skin without scales, but sometimes furnished with oblong bony plates. Dorsal fin preceded by two or more spines not connected by membrane with one another or with the rest of the fin. Anal with one similarly free spine. Ventrals well forward, but still abdominal in position; consisting of one spine and a rudimentary ray.

A family of small, but vigorous and aggressive fishes. They are stated to do great damage to the young of other species. Most of them build nests for the protection of the eggs, and these nests are defended by the males.

* Dorsal with seven to eleven spines which diverge from the middle line of the back. *Pygosteus*, p. 245.

** Dorsal with five spines, which become erected in the median plane of the body. *Eucalia*, p. 246.

Genus PYGOSTEUS Brevoort.

Dorsal fin with seven to eleven spines, which, when erect, deviate to right and left of the middle line. Bones bearing the ventral fins united along the middle line, feebly developed, the edges raised. Skin naked.

PYGOSTEUS PUNGITIUS (Linn.).

Nine-spined Stickleback.

Gasterosteus pungitius, Jordan and Gilbert, 1882, 8, 393; *Pygosteus pungitius*, Eigenmann, 1, '89, 235.

Size small, body long and slender. Caudal peduncle very slender and with a keel on each side. Depth in the length five to six times. Head in length four times, equal to the snout. Mouth quite oblique, of moderate size. Dorsal rays IX, 1, 9, the anterior spines not erecting in a straight line. Ventral spines more than one-third the length of the head. Anal rays I, 8. Olive above, with darker bars and dots; silvery below. Length about three inches.

*In this group must be included the genus *Lota*, which has two dorsals, no spines in any of the fins, and the ventrals jugular in position. There is a barbel at the tip of the chin.

Europe and North America; in the latter, from New York to Lake Michigan and north to Greenland. Found in both salt and fresh waters. Lake Michigan (10, 1874); Calumet River and Lake Michigan (14, '80, 69.)

This species is said by Dr. Jordan to be rather abundant in Lake Michigan in deep water. Dr. Forbes has examined the food taken by it. This consists of aquatic larvæ of insects and entomostraca, with a considerable percentage of vegetable matter.

Genus EUCALIA Jordan.

Dorsal spines five, erecting in a straight line. Body not furnished with bony plates.

EUCALIA INCONSTANS (Kirt.).

Brook Stickleback.

Gasterosteus inconstans, Jordan and Gilbert, 1882, 8, 394; *Eucalia inconstans*, Eigenmann, 1889, 1, 238.

Body deep and compressed; depth in the length four and one-half. Head in length three and one-half. Eye in head three and three-quarters. Mouth small, oblique. Caudal peduncle short, slender, and without keel. Dorsal rays IV, I, 10, the spines not leaning to right and left when erected. Anal rays I, 10., Olivaceous, with some mottlings of brown. Males in breeding season black, with more or less of red. Length about two and one-half inches.

New York, Indiana, and Kansas, north to Greenland. In Indiana has been taken by Prof. W. P. Shannon in Decatur County (23, '88, 57); in Wabash County by Prof. Ulrey (24, '93, 96).

Dr. Jordan (2, 998) states that in the aquarium these fishes are quarrelsome, and in default of other game they will destroy one another. The males during the breeding season build a nest for the eggs and vigorously defend it. They are said to frequent brooks; but Mr. McCormick speaks of finding them in two places in Lorain County, Ohio, in "hot, grassy holes," haunts quite different from those described by Kirtland and Jordan.

Forbes has investigated the food of the species. He says (14, No. 2, 78, 14, No. 6, 69) that it consists of entomostraca, insects and some algæ. One had eaten some eggs, probably those of some mollusk. This fish is also charged by other authors with destroying the eggs of other fishes. Some species of sticklebacks take vengeance on the fishes which may attempt to eat them. Pennell in his "Book of the Pike" states that the pickerel is often killed by attempting to swallow the sticklebacks. This on being attacked erects the spines, so that the little fish sticks in the throat of the larger fish and leads to its death.

Order 11. PERCESOCES.

Ventral fins abdominal. Scales cycloid. Spinous dorsal present (in our species, at least).

Represented in Indiana by a single species belonging to the

Family ATHERINIDÆ.

Small, slender fishes, having cycloid scales. No lateral line. Gill-rakers slender. Two dorsal fins, which are well separated; the anterior composed of three to eight slender spines. Anal with a single slender spine.

The spines of some of these fishes are so slender and flexible that they may be easily mistaken for soft rays. Such spines are not, however, cross-jointed.

Genus LABIDESTHES Cope.

Body long, slender and compressed. Head with the jaws produced into a beak. The margin of the upper jaw concave. Anal fin long. Anterior dorsal of four or five slender spines. Gill-rakers long and slender.

LABIDESTHES SICCULUS Cope.

Brook Silverside.

Jordan and Gilbert, 1882, 8, 406.

A small, slender, compressed fish, resembling in appearance a small pickerel. Depth in the length six to seven; head in length four and two-thirds. Snout long, two and one-half in head, narrow and pointed. Commissure of the jaws considerably curved, with the convexity of the curve upward. Eye large, three and one-half in head. Dorsal rays V, 11 or 12, a considerable space intervening between the two portions. Anal I, 24. No lateral line developed. Scales small, about eighty-five along the sides. The color of the back is a clear greenish, sometimes becoming quite dark. Top of the head, base of the pectorals and caudal, yellow. A black spot on the occiput. Sides silvery, with a conspicuous band of the same edged with black. Size about four inches.

Distributed from Michigan to western Florida. A beautiful and graceful fish, living in clear streams and ponds and swimming near the surface.

Carroll and Marshall counties (23, '88, 49, 55); Monroe County (1, '85, 410); White River, at Indianapolis (1, '77, 376); Lakes of Laporte County, Maumee River, Tippecanoe River (1, '77, 41); Logansport (4, '88, 159); Lawrence County (23, '84, 204); Gibson and Posey counties (4, '88, 163); Vigo County (16, 95); Winamac, in Pulaski County; Eel R. Basin (4, '94, 38); Decatur and Laporte counties (24, '93, 96).

Professor Forbes found this species to eat about equal quantities of insects and crustaceans.

Order 12. ACANTHOPTERI.

Ventrals thoracic or jugular; usually with one spine and five soft rays. Dorsal fin with a few or many of the anterior rays developed as stiff, in-articulate spines, the genus *Lota*, among our fishes, forming an exception. Anal with usually one or more spines. Scales generally, but not always, ctenoid.

An extensive order of fishes, including our sunfishes, bass, perch, etc.

KEY TO THE FAMILIES OF ACANTHOPTERI.

- A. Dorsal fin with three or more spines; anal with one or more spines. Ventrals usually thoracic. Scales usually ctenoid.
1. Dorsal with three or four spines. Ventrals without spine and with seven soft rays. *Aphredoderidae*, p. 248.
 2. Dorsal spines slender, six or more in number. Ventrals with one spine and three or four soft rays. Dorsal with six or more slender spines. Scales few or none. *Cottidae*, p. 290.
 3. Ventral fins with one spine and five soft rays. Dorsal spines four or more.
 - a. Dorsal spines four; anal three. Scales large, cycloid. Size of fish small, one and one-half inch. *Elassomatidae*, p. 250.
 - aa. Dorsal spines more than four.
 - b. Vomer with rare exceptions furnished with teeth. Lateral line not extending on the rays of the tail.
 - c. Pseudobranchiæ indistinct, covered with skin. Anal spines three to eight. *Centrarchidae*, p. 250.
 - cc. Pseudobranchiæ well developed.
 - d. Anal spines one or two. *Percidae*, p. 265.
 - dd. Anal spines three. *Serranidae*, p. 287.
 - bb. Vomer without teeth. Pores of lateral line extending on caudal rays. *Sciænidae*, p. 288.
- AA. Dorsal and anal fins without spines; the dorsal in our only genus divided into two distinct parts. Ventrals jugular. Scales small, cycloid. *Gadidae*, p. 293.

Family APHREDODERIDÆ.

Form perch-like. Head large. Scales strongly ctenoid. No lateral line. Teeth on vomers and palatines. Upper margin of mouth formed by the premaxillaries. Maxillary slipping under the border of the pre-orbital. Preopercle serrated. Opercle with a spine. Ventrals without spine and with seven soft rays.

Genus APHREDODERUS LeSueur.

Premaxillaries not protractile. Mouth of moderate size. Lower jaw projecting. Gill-rakers short. Gill-membranes joined to isthmus. Branchiostegals six. Vent of the adults jugular.

APHREDODERUS SAYANUS (Gilliams).

Pirate Perch.

Jordan and Gilbert, 1882, 8, 460; Blatchley, W. S., 1885, 1, 136.

Body compressed, the depth in the length about three times. Head large, thick, three times in length to caudal. Cheeks, opercles, and occiput covered with scales. Mouth moderate, somewhat oblique, maxillary reaching to perpendicular from the front of the eye. Scales strongly ctenoid, forty to fifty-eight in a longitudinal row; about thirty in a transverse row. Dorsal rays III, 10 or 11. Anal rays II, 5 or 6. Vent of the adults just behind the isthmus, that of the younger fishes somewhat further back. Color dark to pale olive, with numerous minute dots of bluish. Sometimes there is a streak of brown above the anal fin. Length about four inches.

Illinois River specimens have the color paler, the scales smaller, about fifty-eight along the side. Dr. Jordan regards them as forming a distinct sub-species, the *gibbosus* of LeSueur. Wabash River specimens show forty-eight to fifty-one scales (4, '88, 116).

Distributed from Louisiana to S. Dakota, Minnesota, and Lake Erie. In Indiana it has been put on record from the following localities: Wabash River (9, 9, 49); Monroe County (1, '85, 411); Maumee River at Kendallville (1, '77, 44); Brown County (23, '84, 204); Kankakee River at Plymouth (4, '88, 156); Whitley County (4, '88, 159); Wabash, Maumee and Calumet rivers (13, '77, 101.); Calumet River (14, No. 2, 49); Eel R. basin (4, '94, 38); Posey and Decatur counties (24, '93, 96); Winamac.

This species is an inhabitant of sluggish and grassy streams, and is, therefore, to be found in swampy regions. Its food consists of small crustaceans, the larvæ of aquatic insects, and occasionally some of the smaller fishes (14, No. 2, 77). One of the most peculiar things appertaining to this fish is the gradual change which the position of the vent undergoes during the growth of the fish. Jordan states that when the fish is an inch in length the vent is opposite the middle of the ventrals. When two inches long, it has moved forward to between the bases

of the ventrals. When the length has become about four inches, the vent is near the isthmus.*

Family CENTRARCHIDÆ.

FRESHWATER SUNFISHES.

Body usually deep and much compressed; covered with usually ctenoid scales. Lateral line developed, the row of pores not extending on rays of caudal fin. Mouth terminal, the maxillary often provided with a supplementary bone. Vomer furnished with teeth. None of the teeth of the jaws enlarged. Pseudobranchiæ indistinct, covered with skin. Dorsal fin with six to thirteen spines. Anal spines three to eight.

A family of about ten genera and twenty-five species of fishes which are confined to the freshwaters of North America.

ANALYSIS OF THE GENERA OF CENTRARCHIDÆ.

A. Anal fin nearly as large as the dorsal; its soft rays at least fifteen in number.

1. Spines of anal seven or eight; its soft rays fifteen.

Centrarchus, p. 251.

2. Spines of anal six; its soft rays seventeen or eighteen.

Pomoxys, p. 251.

AA. Anal fin considerably smaller than the dorsal; its soft rays not more than twelve.

3. Teeth on tongue and pterygoids.

a. Anal spines usually six.

Ambloplites, p. 253.

aa. Anal spines three.

Chaenobryttus, p. 254.

*Family ELASSOMATIDÆ.

Size very small. Body deep and compressed, covered with relatively large cycloid scales. Strong teeth on jaws and a few feeble ones on the vomer. Gill-membranes broadly united across the isthmus, but free from this. Ventral rays I, 5.

Genus ELASSOMA Jordan.

Upper jaw protractile. Mouth small and very oblique. Scales on the cheeks and the opercles. Gill-rakers short. Lateral line not developed. Dorsal with four spines, the anal with three. Two species known at present.

ELASSOMA ZONATUM Jordan.

Body deep and compressed. Depth in length three and one-half, the outline considerably arched above. Head in the length three. Mouth small, very oblique, the lower jaw projecting. Dorsal rays V, 9; anal III, 5. Lateral line wanting. Scales in a longitudinal row about forty. Color olive, with about ten dark bars crossing the body; these wider than the interspaces. A dark spot on each side below the dorsal. Length about one and one-half inches. Resembles a young sunfish.

Swampy regions from Louisiana to S. Illinois. May be expected to occur in Southern Indiana.

4. Tongue and pterygoid bones without teeth.
- b. Depth usually more than one-third the length ; scales along the lateral line fifty or fewer.
- Lepomis*, p. 255
- bb. Depth one-third of the length or less ; scales of the lateral line about seventy.
- Micropterus*, p. 262

Genus POMOXYS Rafinesque.

Body deep and compressed. Anal fin about as large as the dorsal ; its spines six or seven ; its soft rays seventeen or eighteen. Maxillary with a supplementary bone. Teeth on the vomer and palatines. Gill-rakers long and slender. Snout turned up. Scales ctenoid.

Dorsal spines seven or eight ; anal mottled with dark green.

sparoides, p. 251.

Dorsal spines six ; anal nearly plain whitish.

annularis, p. 252.

• POMOXYS SPAROIDES (LaC.).

Calico Bass ; Grass Bass.

Jordan and Gilbert, 1882, 8, 465 ; Jordan, 1884, 12, 406, pl. 159 ; Smith, H. N., 4, 209, pl. 42.

Body high and much compressed. Outline of back descending in both directions from the front of the dorsal. Over the eye the outline becomes concave. Lower jaw projecting considerably beyond the upper. Depth in the length two to two and one-half. Head in length three to three and one-half. Mouth moderate, the maxillary equal to the distance from the snout to the back of the eye. Cheeks with about six rows of scales. Opercles well scaled. Lateral line complete, running high. Scales mostly cycloid, 7-44-12. Dorsal rays VII or VIII, 15. Anal rays VI, 17 to 18. Color olive above, the sides silvery. With many irregular blotches of dark green. These scattering on the lower part of the sides, more numerous above, and running together so as to

Genus CENTRARCHUS C. and V.

Body deep and compressed. Dorsal fin little larger than the anal ; the spines of the latter seven or eight ; the soft rays fifteen. Maxillary with a supplemental bone. Teeth on vomers and palatines. Gill-rakers long and slender. Scales feebly ctenoid.

CENTRARCHUS MACROPTERUS C. and V.

This species has not yet been taken in Indiana. It is a common fish in the lowlands of the Southern States, and has been taken in considerable numbers in the southern part of Illinois. It may, therefore, be confidently looked for in the region of the lower Wabash River.

The depth is contained in the length about two times, the head a little more than three times. Dorsal rays XI or XII, 12. Anal rays VII or VIII, 15. The color is olive, with rows of dark spots along the sides.

occupy most of the upper surface. Dorsal and caudal fins ornamented with a network of broad, dark lines. Length reaching as much as one foot, and the weight nearly three pounds.

Distributed from Louisiana to Minnesota and eastward; most common northward. In Indiana it is found abundantly, especially in the northern portion of the State. Wabash River (17, III, 88); Carroll County, (23, '88, 49); Tippecanoe River (1, '77, 44); Marshall County (4, '88, 159); Clark County (23, '88, 56); Monroe County (1, '85, 410); Marion County (1, '77, 376); Greene County (23, '88, 209); Vincennes, Gibson and Posey counties (4, '88, 163); Vigo County (16, 95); Winamac; Eel River Basin (4, '94, 38).

This is one of the most important of the native food-fishes of the country. It is found in the larger and deeper rivers and lakes. Dr. Jared Kirtland states that it usually resorts to deep and sluggish waters, but finds its way into streams where the conditions are quite different, and soon adapts itself to its new surroundings. He regarded it as "the fish for the millions," being perfectly adapted for stocking ponds. It increases rapidly and thrives with little care. It disturbs no other fishes, bites readily, and is an excellent pan fish. Smith (*loc. cit.*) says that it is one of the most important and least appreciated of our fishes. He states that it occurs chiefly where there are grassy shores. It is a common fish in the markets of Chicago. As to the food, Dr. Forbes did not find it to be distinguishable from the next described species.

Dr. Bean states (25, 103) that gravid females of this species have been taken in May.

POMOXYS ANNULARIS Rafinesque.

Crappie; Bachelor; Campbellite.

Jordan and Gilbert, 1882, 8, 464; Jordan, 1884, 12, 407, pl. 160.

Body deep and compressed. Depth in the length about two and one-half times. Head in length about two and two-thirds. The profile is very concave over the eyes, so that the snout appears much upturned. Lower jaw projecting much beyond the upper. Mouth oblique, very large, the maxillary reaching back to a perpendicular from the middle of the pupil. Preorbital serrated below. Scales, 6-8-14. Rays of the dorsal VI, 15; of anal VI, 18. General color silvery, more olive above and with dusky mottlings. Fins usually nearly plain whitish, but often with some dark mottlings. Greatest length about one foot.

Distributed throughout the Mississippi Valley, more common southward. Falls of the Ohio River (Rafinesque); Vigo County (23, '88, 55); Clark County (23, '88, 56); Franklin County (5, No. 2, 6); Monroe County (1, '85, 410); White River at Indianapolis (1, '77, 376); region

of Brown County in Salt Creek (23, '84, 204); Posey County (4, '88, 163); Evansville (4, '88, 166); Eel R. Basin (4, '94, 38); Cedar Lake (25, 104).

This fish probably has about the same habits and qualities as the preceding and closely related species. Professor Forbes (14, No. 3, 57) tells us that this species is commonest in the southern portion of Illinois. When the size is below an inch, they seem to live entirely on entomostraca. As the size increases, insect larvæ are added until the insect element becomes as much as thirty per cent. of the whole. The adults likewise eat large quantities of entomostraca and the larvæ of neuropterous insects. The autumnal diet was found to include about one-third of small fishes, minnows, etc.

This is one of the best of food fishes and it takes the hook readily.

Genus AMBLOPLITES Rafinesque.

Body moderately deep and compressed. Mouth large, the lower jaw projecting. Teeth on vomer, palatines, pterygoids and tongue. Gill-rakers moderately long and rather strong. Anal with six spines. Scales feebly ctenoid.

AMBLOPLITES RUPESTRIS (Raf.).

Red-eye; Goggle-eye.

Jordan and Gilbert, 1882, 8, 466; Jordan, 1884, 12, 404, pl. 149.

Body moderately deep and compressed, but not becoming so deep as some of the other *Centrarchidæ*. The depth in the length two to two and one-half times. Head large, contained in the length about two and two-thirds times. Lower jaw projecting. Mouth large and oblique. The maxillary extending back to perpendicular from the hinder border of the orbit; provided with a supplementary bone. Eye large, three and one-half in length of head. No opercular flap. Cheeks and opercles scaled, about eight rows on each. Scales of the body, 6-43-12. Lateral line running high up on body. Dorsal rays, XI, 10; anal rays, VI, 9. Color green, tinged with brassy. Each scale with a dark central spot; these producing longitudinal stripes. A black spot on hinder border of the opercle and a black streak running downward and backward from the eye. Young with irregular dusky cross-bars. Reaches a length of twelve to fourteen inches and a weight of two pounds.

Distributed from Vermont to Manitoba and south to Louisiana. Abundant in all streams of Indiana. Carroll County (23, '88, 49); Marshall County (23, '88, 55); Clark County (23, '88, 56); Franklin County (5, No. 2, 6); Monroe County (1, '85, 410); Marion County (1, '77, 44, 376); St. Joseph's River, Tippecanoe River, Lower Wabash (1, '77, 44); Lawrence County (23, '84, 204); St. Joseph's River (4, '88, 154);

Kankakee River at Plymouth (4, '88, 156); Vigo County (16, 95); Lake Michigan, Eel River Basin (4, '94, 38); Madison County, Laporte County (24, '93, 98).

This is an excellent food fish, but is said by some to be lacking in game qualities. The spawn is deposited in May and June on gravelly shoals (25, 106). Forbes (14, No. 3, 44) states that the young, up to less than an inch, live principally on entomostracous crustaceans. Beyond this size, up to a length of three inches, the diet consists principally of insects, mostly *Corixa*. The adults were found to have taken some minute fishes, over forty per cent. of neuropterous larvæ, and about thirty per cent. in cray-fishes.

Genus CHÆNOBRYTTUS Gill.

Form much like that of *Ambloplites*. Head large. Mouth large and oblique. Teeth on vomer, palatines, pterygoids, and tongue. Anal fin with three spines. Scales ctenoid.

CHÆNOBRYTTUS GULOSUS (C. and V.).

Warmouth.

Jordan and Gilbert, 1882, 8, 468; Bollman, 1888, 11, 562; Jordan, 1884, 12, 405, pl. 152; *C. antistius*, Jordan and Gilbert, *op. cit.* 467.

Form moderately deep and compressed. Depth in length about two times. Profile moderately concave over the eyes. Head large, in the length two and two-thirds. Mouth large and oblique, the maxillary reaching a perpendicular from the hinder border of the pupil; with a supplementary bone. Eye in head about four and one-half times. Gill-rakers well developed. Dorsal rays X, 10. Anal III, 9. Scales 7-42-12. General color dark green. Sides with blotches of coppery red; belly orange. Coppery streaks on the cheeks and opercles between the streaks of dark. Lower jaw and throat blue. Dorsal fin spotted with dusky on a membrane of yellow, and a dusky spot on the last rays. Young with dark cross-bars. Length about ten inches.

Is found in the streams and lakes of the whole eastern portion of the United States.

Indiana localities are: Wabash River (9, 9, 49); lakes of Laporte County, Tippecanoe River (1, '77, 44); Greene County (23, '84, 209); Kankakee River at Plymouth (4, '88, 156); Vincennes and Posey County (4, '88, 163); Eel River Basin (4, 94, 38); Lake Michigan, Winamac.

Like all the species of the family which reach a sufficient size, the Warmouth is a good fish for the table; and being widely spread and abundant, it holds an important rank among the food-fishes.

Dr. Forbes has studied the food-relations of this species (14, No. 3, 44). The young up to a length of one inch, subsist on entomostraca. When a length of an inch and a half has been attained, insect food appears in the diet. Later on, insect food predominates. The adults were found to eat fishes principally, although they depend to a considerable extent on insects.

Genus LEPOMIS Rafinesque.

Form deep and compressed. Mouth moderate or small. Supplementary maxillary bone developed or not. Teeth on vomer and sometimes on the palatines, but not on pterygoids and tongue. Gill-rakers mostly short; dorsal fin with ten spines; the anal with three spines.

The species of this genus are numerous and much alike, and there is great difficulty in identifying them. Attention must be given to the character of the teeth on the lower pharyngeal bones. These bones may be removed by inserting a hook behind the last gill. The teeth are then to be cleaned of the adhering matter and examined with a lens. They are usually slender and sharp; in a few species they are broad and rounded.

ANALYSIS OF THE INDIANA SPECIES OF LEPOMIS.

- A. Lower pharyngeal bones rather narrow; the teeth on them conical and sharp.
1. Pharyngeal teeth very slender and sharp. Colors usually bright.
 - a. A well-developed supplementary bone behind the maxillary; palatine teeth present; gill-rakers rather long and stiff.
 - b. Scales of the lateral line about forty-eight; mouth large. *cyanellus*, p. 256.
 - bb. Scales of lateral line about thirty-five; mouth moderate. *symmetricus*, p. 261.
 - aa. Supplementary bone very small or missing; palatine teeth few or none; mouth small.
 - c. Gill-rakers stiff, not usually very short.
 - d. Opercular flap short, about as large as the eye.
 - e. Cheeks with blue stripes. *ischyrus*, p. 261.
 - ee. Cheeks without blue stripes. *machrochirus*, p. 257.
 - dd. Opercular flap of the adult becoming very long and conspicuous.
 - f. Scales of the lateral line about thirty-five. *humilis*, p. 257.
 - ff. Scales of the lateral line about forty-five.

- cc. Gill-rakers short and weak; no palatine teeth; opercular flap of adult very long; head with blue streaks.
- g. Color containing much blue and orange.
megalotis, p. 258.
- gg. Color dusky, with rows of bronze spots.
garmani, p. 259.
2. Pharyngeal teeth bluntly conic; color mostly plain greenish.
euryorus, p. 262.
- AA. Lower pharyngeal bones broad; their teeth broad and rounded, so as to form a sort of pavement. Opercular flap short, its lower edge bright scarlet.
1. Sides with much orange and blue; cheeks with blue streaks.
notatus, p. 260.
- Side plain in color, little orange; cheeks without blue stripes.
gibbosus, p. 260.

LEPOMIS CYANELLUS (Raf.).

Green Sun-fish.

Jordan and Gilbert, 1882, 8, 473.

Form stout and compressed, the back not so elevated as in related species. Depth in the length two and one-half or less. Head in the length three or less. Mouth large, oblique, the maxillary with a supplementary bone. The lower jaw projecting. Lateral line running high. Scales 7-48 to 50-17. Dorsal rays, X, 11; anal III, 9. Color in life green, each scale with a blue spot. Fins mostly blue, the lower ones edged with orange. Cheeks with blue stripes. Dorsal and anal each with a dark spot on its hinder rays. May reach a length of seven inches, but usually smaller.

Great Lakes south to Mexico. Indiana localities are as follows: Falls of the Ohio River (9, 9, 19); Carroll County (23, '88, 49); Marshall County (23, '88, 55); Franklin County (5, No. 2, 7); Monroe County (1, '85, 410); Marion County (1, '77, 44, 376); lakes of Laporte County, Kankakee River (1, '77, 44); Lawrence County (23, '84, 204); Vincennes and New Harmony (4, '88, 163); Owen County (4, '88, 167); Vigo County (16, 95); Eel River Basin (4, '94, 38); Madison and Decatur Counties (24, '93, 98).

This is a beautiful fish and one of the commonest. It lives principally in stagnant ponds and in sluggish, muddy streams. When large enough this fish is probably as good for food as the related species, but on account of its usually small size it does not amount to much as a food-fish. The young live principally on entomostraca. From this size up to

two inches the diet includes a considerable proportion of insects. The adults drop entomostraca and live mostly on fishes and crayfishes. The larger insects form a considerable part of the adult diet (Forbes).

LEPOMIS MACHROCHIRUS (Raf.).

Chain-sided Sun-fish.

Jordan and Gilbert, 1882, 8, 475; Bollman, 1888, 11, 567.

Body moderately deep and compressed. Depth in the length about two and one-third. The upper outline concave above the eyes and the snout projecting. Mouth moderate, the maxillary extending to a perpendicular from the front of the pupil. Eye longer than snout, three and three-fourths in head. Opercular flap with a red margin. Scales 6-40 to 43-13. Pectoral fins long, reaching back to the first soft rays of the anal. The color is olive, with chain-like cross bands of darker. Fins plain. Drs. Jordan and Gilbert describe the fish as being steel blue, with orange so arranged as to make the cross bands, and with the fins ornamented with bronze and orange. The length becomes about five inches.

Western Pennsylvania to Kentucky and Illinois. It was originally taken at the falls of the Ohio and in the Wabash by Rafinesque (9, 9, 18; 17, VII, 455); Dr. Jordan reports (1, '77, 44) having taken twenty-five specimens in the White River at Indianapolis. It is regarded as a rare fish, and I have not seen it.

LEPOMIS HUMILIS (Girard).

Jordan and Gilbert, 1882, 8, 479; Bollman, 1888, 11, 571.

Body moderately deep and compressed. Depth in the length about two and one-half times. Head short, in the length less than three times. Mouth of moderate size, the maxillary reaching back to front of the pupil. Eye in head about four. Cheeks with five rows of scales. Opercular flap rather large and conspicuous, surrounded with a broad red margin. Gill-rakers stiff and of moderate length. Scales 5-35-11. Pectoral fins short, not as long as the head. Color olive, with some greenish specks posteriorly. Orange spots occur on the sides. The belly and lower fins red. Length about two and one-half inches.

Distributed from southern Indiana to Texas. In Indiana it has been taken in Posey County by Dr. Jordan (4, '88, 163).

This is a brilliant little fish, but of no economical value, on account of its small size. It is abundant westward and southwestward.

LEPOMIS PALLIDUS (Mitchill):

Blue Sun-fish; Copper-nosed Bream.

Jordan and Gilbert, 1882, 8, 479; Jordan, 1884, 12, 406, pl. 155.

Body deep and compressed, especially in the adults. Depth in the length two times, the young slenderer. Head in length three, the profile steep. Mouth small, the maxillary not reaching beyond the anterior border of the pupil. Palatine teeth usually present. Eye in head three and one-half to four times. Opercular flap larger than the eye. Gill-rakers about ten; these equal to one-half the diameter of the eye. Dorsal fin X, 11; anal III, 10. Pectorals reaching beyond first anal ray. Scales 7-44-12. Cheeks with five rows of scales; opercles with same number of rows. Color pale olive. No blue on the cheeks. Belly of old specimens red. Dorsal and anal each with a black spot at the base of the last rays. Young purplish, with dark cross-bands. May reach a length of one foot. Resembles *L. notatus*, but differs in the character of the pharyngeal teeth.

Distributed over the greater part of the eastern United States. Abundant throughout Indiana. Tippecanoe River (23, '88, 49); Marshall County (23, '88, 55); Marion County (1, '77, 376); Lakes of Laporte County, St. Joseph's River, Maumee River, Tippecanoe River, Wabash River (1, '77, 44); Greene County (23, '84, 209); Kankakee River, at Plymouth (4, '88, 156); Vintennes and Posey County (4, '88, 163, 166); Calumet River and Lake George, Indiana (14, No. 3, 50); Vigo County (16, 95); Eel R. basin (4, '94, 38).

This is one of the valuable food fishes. Its food, according to Forbes (14, No. 3, 49) varies with the locality inhabited. In the case of the fishes taken from clear inland lakes, about two-thirds of the food consisted of the larvæ of neuropterous insects, the remaining third of the crustacean *Allorchestes dentata*. Specimens taken from Calumet River and Lake George were peculiar in the large numbers of *Allorchestes* and *Asellus* eaten. Specimens taken from the Illinois River had eaten considerable quantities of mollusks and land insects, as well as vegetable matter to the amount of one-third the whole.

LEPOMIS MEGALOTIS (Raf.).

Long-eared Sun-fish.

Jordan and Gilbert, 1882, 8, 477; Bollman, 1888, 11, 572, pl. 70, fig. 3.

Body short and very deep. Depth in the length one and two-thirds to two and one-half, the young being slenderer than the adults. The upper outline is high in front and descends rapidly to the snout. Head (to

base of the ear-flap) in the length three. Flap of the adults sometimes half as long as the head; that of the younger specimens shorter. Mouth small, the maxillary reaching little, if any, beyond the anterior border of the orbit. No palatine teeth. Gill-rakers very short. Dorsal rays X, 10; anal rays III, 9. Scales 6-38-12. Brilliantly colored. Sides brassy and orange, many scales indigo-blue. Belly orange or red. Cheeks and opercles orange, with horizontal streaks of blue; these anastomosing more or less. Snout and lower jaw blue. Membranes of the dorsal fin deep orange. Anal fin mostly orange, tipped with blue. Ear-flap black, with a pale or scarlet border. Length six or eight inches.

Distributed from Michigan to Mexico. Abundant in all parts of Indiana. Carroll County (23, '88, 49); Marshall County (23, '88, 55); Clarke and Ohio counties (23, '88, 56); Franklin County (5, No. 2, 7); Monroe County (1, '85, 411); Marion County (1, '77, 44, 376); Kankakee River (1, '77, 44); Lawrence County (23, '84, 204); St. Joseph's River (4, '88, 154); Kankakee River, at Plymouth (4, '88, 156); Logansport (4, '88, 159); Gibson and Posey counties (4, '88, 163); Vigo County (16, 95); Winamac, in Pulaski County; Eel River basin (4, '94, 38); Wabash and Decatur counties (24, '93, 99).

This is one of the most brilliantly colored fishes that is to be found in our streams. It is frequently taken on the hook and is, barring its usually small size, as good as any of our other sun-fishes. It haunts quiet holes in clear streams. Of its breeding habits I know nothing. Prof. Forbes (14, No. 3, 53) found in the alimentary canal of the specimens examined by him about sixty per cent. of *Chironomus* larvæ, sixteen per cent. of mollusks, and the remainder of the food to consist of crustaceans and insects.

LÉPOMIS GARMANI Forbes.

Garman's Sun-fish.

Forbes, 1885, 14, Vol. II, 135; Bollman, 1888, 11, 574.

A small sun-fish reaching a length of about four inches. Depth in the length two and one-fourth. The dorsal outline well arched, and with a depression at the nape. Head in the length, somewhat less than three times. Mouth of moderate size, the maxillary scarcely reaching the front of the pupil. No teeth on the palatines. Eye in head a little less than four times. Cheeks with five rows of scales, the opercles with six. Gill-rakers very short and few. Dorsal fin X, 10 or 11. Anal fin III, 8 to 10. Pectorals reaching the anal. Lateral line high-arched. The scales 6-34 to 41-14. Color dark, with a purplish tint; sides striped with rows of bronze spots, one on each scale.

Wabash Valley. This species was originally described by Prof. Forbes from specimens taken in White County, Illinois. Since that time, it has been taken in considerable abundance in Posey County, Indiana, by Dr.

Jordan (4, '88, 163). Of the habits of this interesting fish I know nothing.

LEPOMIS NOTATUS (Agassiz).

Jordan and Gilbert, 1882, 8, 482; *Lepomis heros*, Bollman, 1888, 11, 575.

Form deep and compressed, the profile moderately steep; concave over the eyes, so that the snout projects somewhat. Depth in the length two to two and one-half. Head in the length three. Mouth oblique, of moderate size, the maxillary reaching back to front of orbit or a little more. Teeth paved. Opercular flap not so large as the eye, margined with pale. Cheeks with four rows of scales. Pectoral fins longer than the head. Scales 4-34 to 40-13. Dorsal rays X, 12. Anal rays III, 11. Color olive, pale or dusky; lower surface silvery. Fins plain. Length eight inches.

This species is southern in its range, from southern Illinois to Alabama, but has been taken in Indiana. Dr. Jordan reports (4, '88, 163) having captured it at Mackey's Ferry in Posey County. I have in my possession two specimens which I took some years ago in the East Fork of White River at Rockford, Jackson County. Prof. Kirsch has lately secured specimens in Round Lake, Whitley County (4, '94, 39).

There is doubt whether the form here described is specifically distinct from *L. holbrooki* of the Southern States east of the Alleghany Mountains. It is probably, but not certainly, identical with Baird and Girard's *L. heros*. In case this identity exists there is the further uncertainty which of the two names, *notatus* or *heros* has the priority.

Forbes (14, No. 3, 54) says that the food of this fish consists of mollusks and insects.

LEPOMIS GIBBOSUS (Linn.).

Pumpkin-seed; Sunny.

Jordan and Gilbert, 1882, 8, 482; Jordan, 1884, 12, 405, pl. 153; Bollman, 1888, 11, 576, pl. 72, Fig. 1.

Body deep and compressed. The slope from the dorsal fin toward the snout steep and somewhat convex to between the eyes, where it becomes a little concave. Base of the dorsal quite convex. Head in the length three to three and one-half. Depth in length two to two and one-eighth. Mouth small and oblique; the maxillary equal to distance from snout to front of the eye; not reaching a perpendicular from the front of eye. Eye moderate, four to five in the head. Scales 6-38 to 48-13. Cheeks with four rows of scales. Opercles with about six rows. Pectoral fins long, passing behind the front of the anal fin and longer than the head. Colors brilliant. Orange and blue predominate, the former above, the latter below. The cheeks are covered with blue streaks. The sides are bluish, spotted with orange, as is also the dorsal fin. The lower fins are

mostly orange. The opercular spot is black, margined with red, and somewhat larger than the eye. In alcohol the brighter colors fade, but there usually remain evidences of their former presence. Length attained by old specimens about eight inches.

Minnesota and region about the Great Lakes east to New England and south to South Carolina east of the mountains. In the Mississippi Valley the species is rarely seen far south in Illinois and Indiana. Prof. Forbes has reported it from Peoria, and Dr. O. P. Jenkins appears to have captured it in Vigo County, Indiana (16, 95). In northern Illinois and Indiana it is extremely abundant.

Lakes of Laporte County, St. Joseph's River, Maumee River, Kankakee River and Tippecanoe River (1, '77, 44); St. Joseph's River (4, '88, 155); Marshall County (4, '88, 159); Lake George in Lake County (14, No. 3, 53); Eel River basin (4, '94, 39); Vigo and Wabash counties (24, '93, 100).

Forbes (14, No. 3, 53) has given attention to the food of this species. The young eat *Chironomus* larvæ to the extent of fifty-one per cent. of the whole diet, entomostraca twenty-six per cent., together with insects' eggs and small crustaceans. Somewhat older specimens had eaten insects and *Gammaridae*. A few mollusks also had been devoured. The adults were found to have taken forty-six per cent. of mollusks, principally univalves, twenty per cent. of insects, twenty-two per cent. of crustaceans, and twelve per cent. of vegetation. No fishes were found in the stomachs. The large quantity of molluscan food will serve to explain the character of the teeth in this and the preceding species. In both species the teeth are rounded or flattened on the grinding surface, thus being fitted to crush shells, etc. The eggs are laid in nests in the mud, sand and gravel, and are watched by the male (Bean 25, 116).*

*The following species of *Lepomis* have not yet been taken within the State, but occur within such close proximity to our borders that they will almost certainly be ultimately found to belong to our fauna.

LEPOMIS SYMMETRICUS Forbes.

Jordan and Gilbert, 1882, s, 473.

This is a small species, about two and one-half inches in length. It was first described by Forbes from specimens taken in Illinois, but it has since been found to range to Louisiana. It has a supplementary bone and palatine teeth. The scales are relatively large, the formula being 6-34-14. The mouth small. The pectoral fins attain the anal. The color is dark green, and there are ten vertical bars on each side. No stripes on the cheeks. The male has a dark spot on the last dorsal rays.

LEPOMIS ISCHYRUS Jordan and Nelson.

Jordan and Gilbert, 1882, s, 474; Bollman, 1888, 11, 570.

Of this species only one or two specimens have so far been found. One of these was obtained in the Illinois River. Another is said to have been taken by Nelson in the Calumet River near South Chicago. The length is seven inches. The scales are 7-46-15. Depth in length two. Head in length three. Both the pectorals and the ventrals reach to the anal. There is an evident supplementary bone. The gill-rakers are long. Opercular flap larger than the eye and bordered all round the dark spot with paler. The general color is dusky, mottled with orange and blue; the cheeks with wide, blue stripes. Belly

LEPOMIS EURYORUS McKay.

McKay, 1881, 23, 89; Kirsch, 1894, 4, 38.

This species was originally described from a single specimen taken at Fort Gratiot, on Lake Huron, Michigan. Bollman (11, '88, 576) did not regard it as a distinct species, considering it to have been probably based on an old example of *L. gibbosus*. On this point he was doubtless mistaken. Mr. Lewis McCormick (15, 27) has more recently taken nine specimens of it in Lorain County, Ohio, and Dr. T. A. Bean has stated that there is another specimen of it in the National Museum from Minnesota. Recently Prof. P. H. Kirsch has secured three more specimens in the Eel River basin in Whitley County (4, '94, 381).

The general appearance of the fish resembles that of *L. cyanellus*. Depth in the length two to three times; head in the length two and one-half times. The mouth large, quite oblique, the lower jaw projecting considerably beyond the upper. The membranous ear-flap rather large in the adults and with a broad margin, narrower in smaller specimens. Dorsal rays X, 11; anal rays III, 10. The dorsal spines rather low. Scales, 7-48-15; six or seven rows of scales on the cheeks. Eye rather small; six in the head. The pharyngeal teeth are bluntly conic. Scales 5-43-11. The color is a nearly plain greenish. The ear-flap has a broad pale margin. The tail and the lower fins are sometimes margined with orange.

Genus MICROPTERUS LaCépède.

Body elliptical and moderately compressed; not so deep as most of the species of the family. Mouth large, oblique; the maxillary with a large supplemental bone. Teeth on the vomer and palatines. Lower jaw projecting beyond the upper. Branchiostegals, 6. Dorsal spines 10; anal spines 3. A notch between the spinous and the soft portions of the dorsal fin.

1. With about eleven rows of scales between the lateral line and the dorsal fin. *dolomieu*, p. 262.
2. With seven or eight rows of scales between the lateral line and the dorsal fin. *salmoides*, p. 264.

MICROPTERUS DOLOMIEU (LaC.).

Small-mouthed Black Bass.

Jordan and Gilbert, 1882, 8, 485; Jordan, 1884, 12, 401, pl. 148; Henshall, J. A., *Book of the Black Bass*.

Body oblong and somewhat compressed. Depth in the length about three and one-half times; the young more slender. Head in the length three to three and one-half. Mouth moderately large, the maxillary

bone extending back to a perpendicular from the middle of the eye. Eye in the head four and one-half. Cheeks and opercles scaly. Dorsal rays X, 13; anal rays III, 11; the two portions of the dorsal fin separated by a notch which is comparatively shallow. Scales 10-75-18. Color extremely variable. Usually some shade of green, but sometimes slate color or very dark on the upper surface. Lower regions much paler. Young greenish, with sometimes dark spots and vertical dark bars; never with a dark lateral band. Tail of the young often with a yellow base. Length sometimes as great as two feet.

United States east of the Rocky Mountains and north into British America. Has been taken in Indiana wherever fishing has been done. Abundant in all our streams. Wabash River (17, III, 57); Carroll County (23, '88, 49); Marshall County (23, '88, 55); Clark and Ohio counties (23, '88, 56); Franklin County (5, No. 2, 7); Monroe County (1, '85, 411); Marion County (1, '77, 376); St. Joseph's River and Lower Wabash (1, '77, 44); Kankakee River at Plymouth (4, '88, 156); Logansport (4, '88, 159); Vincennes and Posey County (4, '88, 164); Owen County (4, '88, 167); Vigo County (16, '95); Eel River basin (4, '94, 39); Decatur, Henry, and St. Joseph counties (24, '93, 100).

Of the habits of both this species and the next, a full account may be found in Dr. J. A. Henshall's "Book of the Black Bass." Both are food and game fishes of the first order. Dr. Henshall states that the black bass is extremely prolific, the female yielding fully one-fourth her weight of spawn. The time of depositing the spawn depends somewhat on the temperature of the water. In our State it is deposited from about the middle of May to the middle of July. For this purpose the fishes seek shallow places in streams and lakes. They form nests on sandy or gravelly bottoms in water from eighteen inches to six feet deep. The nests are from one to three feet in diameter, and are formed by the removal of all sand and silt, so as to leave a bed of pebbles. These nests are often made close to one another. Occasionally they are made on muddy bottoms, having a foundation of small sticks and leaves. The eggs are deposited on the nests in rows and become glued to the pebbles or sticks. As they are being deposited they are fertilized by the male. They hatch in from one to two weeks. When hatched the young are from one-fourth to one-half inch in length. They hover over the nests three or four days, after which they hide in deeper water. During the period of incubation the nest is jealously guarded by the parents. The young eat minute animals and the eggs of other fishes. They grow rapidly and when a year old are four inches long. When two years old they will measure from eight to twelve inches and weigh about a pound. They may grow thereafter at the rate of a pound a year until they reach the usual weight of four or five pounds. Henshall states that during the winter in the Northern States the black bass buries itself in the mud, in

crevices of rock, and under masses of weeds or sunken logs in the deepest waters, and remains dormant until spring.

Forbes (14, No. 3, 4) found that specimens from one to two inches long had eaten a small quantity of entomostraca; the remainder of the food consisted of insects. As the size increased, the insect food increased, and soon fishes appeared in the stomachs. When from three to four inches long, they mostly drop insects, devour more fishes, and betake themselves to crustaceans again, now mostly the *Amphipods* and *Isopods*. *Corixas* amounted to fifty per cent. of the food of the young. The adults devour crayfishes and fishes; among the latter are specimens of *Noturus*.

MICROPTERUS SALMOIDES (LaC.).

Large-mouthed Black Bass.

Jordan and Gilbert, 1882, 8, 484; Jordan, 1884, 12, 401, pl. 147; Henshall, J. A., *Book of the Black Bass*.

Body compressed; moderately deep. Depth in the length about three times; the young more slender. Head in the length about three and one-fourth times. Mouth very large, the maxillary bone extending back to or beyond the hinder border of the eye. Lower jaw projecting. Cheeks and opercles scaled. Lateral line arched upward. Scales, 8-65 to 70-15. Dorsal fin X, 12 or 13; anal III, 10 or 11. Middle of the tongue with a patch of small teeth; olive above, sometimes quite dusky, at other times with some tints of reddish; pale below. Young with a dark lateral band, a spot on the opercle, and three horizontal stripes on the cheeks. Some of these markings may be retained into adult life. The young are never cross-banded. Length said to become as much as two and one-half feet.

Eastern North America from Mexico to British America. A resident of all Indiana streams. Carroll County (23, '88, 49); Marshall County (23, '88, 55); Clark and Ohio counties (23, '88, 56); Franklin County (5, No. 2, 7); Marion County (1, '77, 376); lakes of Laporte County, St. Joseph's River, Maumee River, Tippecanoe River, Kankakee River and White River (1, '77, 44); Lawrence County (23, '84, 204); Greene County (23, '84, 209); Kankakee River at Plymouth (4, '88, 156); Marshall and Whitley counties (4, '88, 159); Gibson, Knox and Posey counties (4, '88, 164); Evansville (4, '88, 166); Owen County (4, '88, 166); Vigo County (16, '95); Eel River basin (4, '94, 39); Winamac and New Harmony.

The habits of this species are greatly like those of the preceding. The excellent work of Dr. Henshall ought to be consulted by all desiring further information. The food habits, as ascertained by Forbes, are not greatly different at any age from those of the small-mouthed bass.

Family PERCIDÆ.

THE PERCH-LIKE FISHES.

Body short or long, compressed or terete. Mouth various; teeth on jaws and usually on vomer and palatines. Scales ctenoid. Lateral line present or absent. Maxillary without supplementary bone. Branchiostegals, six or seven; gills four, a slit behind the last. Dorsal fins two, the anterior of six to fifteen spines; anal with one or two spines.

This important family of fishes contains a doubtful number of genera, and these have been assigned to two sub-families. One of these, the *Etheostomatinae*, consists of a large number of mostly small, but vigorous and highly adorned fishes, characterized technically by the rudimentary condition of the pseudobranchiæ and air bladder. The other sub-family, the *Percinae*, have these organs well developed, and besides attain a large size and are of considerable economical importance.

The *Etheostomatinae* are abundant in all our clearer streams. They are small, have large pectoral fins, are usually highly colored, and hide among stones or repose on the bottom. They have until recently been divided into a great number of genera on trivial characters. More recently the authorities on matters ichthyological have united all these genera into a single one, *Etheostoma*. This, while apparently a progress to the other extreme, may yet be justified. I have thought best here to take a median course. The difficulties in the way of establishing genera among the numerous species are many.

KEY TO THE GENERA OF PERCIDÆ

- A. Adult size small. Pseudobranchiæ and air-bladder imperfect or wanting. Preopercle entire. Branchiostegals six. (*Etheostomatinae*.)
1. Premaxillaries protractile, sometimes only slightly so.
 - a. Body elongated; with at least the belly devoid of scales, often but few scales present; body in life translucent. *Ammocrypta*, p. 266.
 - aa. Body well covered with scales.
 - b. Vomer with teeth; maxillary not bound to preorbital. *Boleosoma*, p. 267.
 - bb. Vomer without teeth; maxillary closely bound by skin to the preorbital. *Diplesium*, p. 270.
 2. Premaxillary not protractile.
 - a. Mouth overhung by a pig-like snout. Scales of the lateral line about 90. *Percina*, p. 271.
 - aa. Mouth not decidedly inferior, often terminal; scales of lateral line 35 to 85. *Etheostoma*, p. 272.

AA. Pseudobranchiæ and air-bladder well developed; preopercle serrate; branchiostegals seven; adult size large (*Percinæ*).

a. No canine teeth; scales along lateral line about 75.

Perca, p. 284.

aa. Canine teeth present; scales about 90 to 95.

Stizostedion, p. 285.

Genus AMMOCRYPTA Jordan.

Small, delicate fishes with bodies nearly translucent during life. Form long, slender, and nearly cylindrical. Head long. Mouth terminal and wide. Middle of the belly naked; often with only a few scales along the lateral line. Vomer with teeth. Anal spines one or two. Lateral line developed.

AMMOCRYPTA PELLUCIDA (Baird).

Sand Darter.

Jordan and Gilbert, 1882, 8, 489.

Body elongated, slender and cylindrical. Head small, long and pointed. Caudal peduncle slender. Depth in the length about nine. Head in length about five. Mouth nearly horizontal, the maxillary reaching back to front of eye. Gill-membranes united, but free from the isthmus. Dorsal rays XI, 10. Anal rays I, 8. Considerable areas of the body devoid of scales, as the middle of the belly, the region in front of the spinous dorsal, and the chest. Five or six rows of feeble scales along the lateral lines, about seventy-five in a row. A few scales on cheeks and opercles, and a few on the back of the neck. Color in life translucent, with a series of dark dots along the middle of the back and another series on each side. Also a gilt band along each lateral line. Fins pale. In alcoholic specimens, the general color is white. Reaches a length of two and one-half inches. The variety *clarum* (Jordan and Meek, 23, '88, 49) differs in having no scales on the neck and few anteriorly, except the five or six rows close to the lateral line.

Mississippi Valley from Pennsylvania to Minnesota, living in clear sandy streams. Found probably throughout Indiana. Carroll County (23, '88, 49, variety *clarum*); Marion County (1, '77, 44, 375); E. Fork White River (23, '84, 204); Logansport (4, '88, 159); Posey County (4, '88, 164); Vigo County (16, 95); Eel River system (4, '94, 39). Dr. Evermann informs me that the variety *clarum* is also found in Vigo County.

This species has the habit of concealing itself in the sand at the bottom of streams in such a way that only its eyes and snout are visible. For an account of its habits see Jordan and Copeland, *American Naturalist*, 1877, 86. Forbes has studied the nature of its food. This consists of the larvæ of dipterous and neuropterous insects.

AMMOCRYPTA ASPRELLA Jordan.

Jordan and Gilbert, 1882, 8, 490.

Form elongate and slender. Depth in length, about eight times. Head in length, about four and one-third. Snout long, three in head, the upper profile descending to tip of snout, with a regular curve. Mouth horizontal, moderate, the maxillary not extending back to front of eye; premaxillary hardly protractile; the lower jaw included. Eye a little less than the snout. Gill membranes free from the isthmus. Scales small, completely covering the body, except the middle of the belly; about ninety-five along the lateral line. Cheeks and opercles with scales. Dorsal rays XIV, 13; anal, I, 12. Translucent, with about a dozen dusky spots along the lateral line, and five to fifteen cross-bars on the back. A dark spot on each opercle. Fins plain. Length as much as five and one-half inches.

Streams of region from Arkansas to Southern Indiana. Rising Sun (7, 123); Knox and Posey counties (4, '88, 164). Has also been taken in the Little Wabash River, Effingham County, Ills.

The size, scaliness and very slightly protractile premaxillaries of this fish relate it to some of the species of *Etheostoma*.

Forbes (14, No. 3, 23) found that the food consists principally of the larvæ of dipterous insects.

Genus BOLEOSOMA DeKay.

Form short to moderately elongated; usually little compressed. Body completely scaled. Mouth small or large, more or less inferior. Teeth on the vomer. Premaxillaries protractile. Maxillaries not bound closely to the preorbitals by the skin. Anal spines one or two.

The genus, as here defined, includes the genera *Boleosoma*, *Vaillantia*, *Ulocentra*, *Cottogaster* and *Imostoma* of Jordan and Gilbert's "Fishes of North America."

A. Anal spine single.

1. Lateral line complete, or nearly so. *nigrum*, p. 268.
2. Lateral line wanting on hinder half of the body. *chlorosoma*, p. 268.

AA. Anal spines two.

1. Gill-membranes broadly united across isthmus (*Ulocentra*). *histris*, p. 269.
2. Gill-membranes scarcely united.
 - a. Belly with a series of enlarged scales along the middle; or, if these have fallen, with a naked strip (*Cottogaster*). *copelandi*, p. 269.

- aa. Middle of belly with ordinary scales posteriorly; anteriorly with somewhat enlarged scales, or with a naked strip (*Imost-ma*).
- b. Dorsal rays X, 15. *shumardi*, p. 270.
- bb. Dorsal rays XI, 13. *uranidea*, p. 270.

BOLEOSOMA NIGRUM (Raf.).

Johnny

Jordan and Gilbert, 1882, 3, 492.

Body elongated, little compressed. Depth in length, five to five and one-half. Head short, in the length about four times. Snout pointed, the profile descending gradually from the occiput to the snout. Eyes high up; mouth small, horizontal, a little inferior, the maxillary reaching back to the perpendicular from the pupil. Premaxillaries protractile. Lateral line complete, or missing on a few of the hindermost scales. No enlarged scales on the middle of the belly. Opercles scaly; cheeks naked or scaly. Scales 4-50-7. Dorsal rays IX, 12 to 14; anal rays I, 8 or 9. Color pale olive, with about eight square blotches of brown; sides with numerous W-shaped markings. Male sometimes nearly black. Length two and one-half inches.

Massachusetts to Dakota and south. Found everywhere in clear streams in Indiana. Carroll County (23, '88, 50); Marshall County (23, '88, 55; 4, '88, 59, 156); Clark and Ohio counties (23, '88, 56); Franklin County (5, No. 2, 7); Monroe County (1, '85, 411); Marion County (1, '77, 375); Lawrence County (23, '84, 204); Parke County (4, '88, 105); Cass and Whitley counties (4, '88, 159); Knox, Gibson and Posey counties (4, '88, 164); Owen County (4, '88, 167); Vigo County (16, '96); Eel River basin (4, '94, 39). See for a few additional localities 24, '93, 101.

This species, like the others belonging to the family, delights in clear water. It may, at almost any time, be seen darting about or resting quietly on the bottom.

BOLEOSOMA CHLOROSOMA (Hay).

Vaillantia chlorosoma and *V. camura*, Jordan and Gilbert, 1882, 3, 494.

Body rather long and slender, especially the caudal peduncle. Depth in the length about five and one-half times. Back somewhat elevated. Head small, the profile convex, descending rapidly in front of the eye. Snout shorter than the eye. Mouth small, somewhat inferior. Lateral line incomplete, the pores missing on the hinder half of the body. Cheeks, opercles and breast scaly. Scales 5-56-10. Dorsal rays IX, 11, or X, 10. Anal, I, 8. Color greenish yellow, with many

blotches and zigzag markings of brown. A dark streak from eye to snout. Length about two inches.

Indiana southward and westward. Posey County (4, '88, 164, 166).

BOLEOSOMA HISTRIO (J. and G.).

Etheostoma histrio, Jordan and Gilbert, 1887, 23, 47.

Body rather elongate, the depth in the length about five times; slightly compressed. Head narrow; in length of body, four to four and one-fourth. Snout short, nearly five in the length of the head. The profile rapidly descending until at the tip of the snout it is perpendicular. Mouth very small; inferior; upper lip somewhat protractile. Maxillary reaching a perpendicular from the anterior border of the pupil. Gill-membranes broadly united across the isthmus. Dorsal rays X, 13; anal rays II, 7. Lateral line complete. Scales 6-53 to 57-8. Cheeks naked; opercles naked, or with a few large scales. Pectoral fins long and narrow, reaching the vent. Color dusky, with about ten obscure brown blotches along the sides and six across the back. Brown streaks on the snout below the eye and on the opercle. A spot at the base of the caudal, but this sometimes absent. All the fins more or less mottled and barred with brown. In life the color is dark green. Length, one and three-fourths inches.

Originally described from Fort Benton, Arkansas. More recently a number of specimens has been taken at Patoka, Gibson County, some of them considerably larger than the original types (4, '88, 164).

BOLEOSOMA COPELANDI (Jordan).

Cottogaster copelandi, Jordan and Gilbert, 1882, 8, 498.

Body long and slender; depth in length, about five and one-half. Head long and narrow; contained in the length four and one-fourth times. Mouth moderate, horizontal, somewhat inferior; the maxillary reaching the pupil. Eye rather large. Gill-membranes very slightly united. Lateral line complete. Scales along the sides, forty-four to fifty-nine; those on the middle line of the belly enlarged and spinous; sometimes fallen away, leaving a naked strip. Cheeks naked or scaled; breast naked; opercles with scales. Dorsal rays XI, 10 or 11; anal rays II, 8 or 9. Color olive, with many specks above of brown and with some oblong blotches along the lateral line; no bright colors; a dusky bar across the spinous dorsal. Length about two and one-half inches.

Lake Champlain to Arkansas. Originally described from specimens taken by Mr. Copeland in White River at Indianapolis (1, '77, 375); Carroll, Vigo and Owen counties (23, '88, 50); Posey, Knox and Vigo counties (4, '88, 164, 167).

BOLEOSOMA SHUMARDI (Girard).

Imostoma shumardi, Jordan and Gilbert, 1882, 8, 498.

Body elongate, heavy forward. Depth in the length about five; little compressed; head in the length three and three-fifths; broad behind; the thickness through the opercles equal to the half length of the head. Snout equal to the eye; four times in the length of the head. Profile descending with a moderate convexity to the snout. Mouth moderate, the maxillary reaching the front of the eye; premaxillary protractile; lower jaw included. Dorsal X, 15; anal II, 11. Pectorals long, but not reaching the anal; ventrals as long as the pectorals. Cheeks and opercles scaly. Scales of body 6-52 to 56-11. Color dark olive, with blotches of darker and some indistinct dusky bars along the sides. In life the belly is sometimes largely orange-yellow. Length about three inches.

Indiana to Texas. Carroll County (23, '88, 51); Sullivan County (1, '77, 43); White River at Indianapolis (1, '77, 43); Knox and Posey counties (4, '88, 164); Vigo County (4, '88, 167).

BOLEOSOMA URANIDEA (J. and G.).

Etheostoma uranidea, Jordan and Gilbert, 1887, 23, 48.

Body rather stout and nearly terete. Depth in the length five and one-half times. Caudal peduncle slender. Head long, in length three and three-fourths times. Snout pointed, a little longer than the diameter of the eye, three and one-half in length of head. Profile descending with a regular curve to the lip. Mouth large, terminal, slightly oblique, the maxillary reaching the pupil. Upper jaw protractile. Eye in head four. Gill membranes not united. Pectorals not reaching the vent. Anterior portion of midline of belly with slightly modified and enlarged scales. Cheeks naked; opercles scaled. Scales of body 6-52 to 60-8. Lateral line complete. Dorsal rays XI, 13. Anal rays II, 10 or 11. Color olive, with four or five brown dorsal cross-bands, which reach well down on the sides. The broadest of these crosses the back between the two dorsal fins. Along the lateral line is a number of small blotches between the ends of the dorsal bars. Living specimens have the lower surface yellow or orange. Length three inches or a little more. Southern Indiana to southwestern Arkansas. Has been taken at Vincennes and New Harmony (4, '88, 164).

Genus DIPLESIUM Rafinesque.

Body elongate, little compressed. Head large with short snout and swollen cheeks. Mouth small, inferior, horizontal. Premaxillary little protractile. Maxillary closely bound by the skin to the preorbital, so as to be non-protractile. No teeth on vomer or palatines. Gill membranes broadly united. Lateral line complete. Anal with two strong spines.

DIPLESIUM BLENNIOIDES (Raf.).

Green-sided Darter.

Jordan and Gilbert, 1882, 8, 496.

Body elongate, little compressed. Depth in the length about five times. Head short, in length four and one-half times, compressed, the profile descending rapidly in front of the eyes. Eyes high up, the inter-orbital space very narrow. Mouth small, inferior, the maxillary not reaching back to a perpendicular from the front of the eye; bound by skin closely to the preorbital. Premaxillary somewhat protractile, but with a narrow band of skin joining the lip with the forehead. Lateral line complete. Scale 6-65 to 70-8. Dorsal rays XIII, 13. Anal rays II, 8. Pectorals and ventrals long, reaching nearly to the vent. Cheeks and opercles scaly. Colors in life very brilliant. General color olive, darkest along the back. Along the sides are about eight Y-shaped blotches of green. Many scales with orange spots. Spinous dorsal fin orange-brown at the base, blue above; soft dorsal bluish-green and red. Females less brilliantly colored. Length occasionally as much as five inches.

Pennsylvania to Kansas and south. Abundant in all suitable streams in Indiana. Seen by Rafinesque at the Falls of the Ohio and in the Wabash River. Carroll County (23, '88, 50); Clark and Ohio counties (23, '88, 56); Franklin County (5, No. 2, 8); Monroe County (1, '85, 411); Marion County (1, '77, 43); Lower Wabash River (1, '77, 43); East Fork White River (23, '84, 204); Marshall, Cass and Whitley counties (4, '88, 159); Owen County (4, '88, 167); Vigo County (16, 96); Eel River basin (4, '94, 39); Decatur County (Shannon); Henry County (24, '93, 102).

This is one of our most brilliantly colored, most beautiful, and most abundant fishes. Little has been published concerning its habits. The habits of our *Etheostomatinae* would richly repay the observations of our naturalists.

Genus PERCINA Haldeman.

Body long and slender. Head broad between the eyes. Snout pig-like, projecting beyond the mouth. Premaxillaries not protractile. Gill membranes not united across the isthmus. Teeth on vomer and palatines. Scales small, about ninety along the lateral line. Midventral line with a series of enlarged, spinous scales, which may fall off and leave a naked strip.

PERCINA CAPRODES (Raf.).

Log-perch; Hog-molly; Hog-fish.

Jordan and Gilbert, 1882, 8, 499; Jordan, 1884, 12, 417.

Body elongated and a little compressed. Depth in the length six times. Head broad between the eyes. Snout pointed, piglike, projecting beyond the mouth, which is, therefore, inferior; it is also small, the maxillary reaching only two-thirds the distance to the front of the eye. Gill-membranes distinct from each other and from the isthmus. Paired fins rather short, falling far short of the vent. Scales small, 12-92-19; the middle line of the belly with a row of scales enlarged and furnished with a few coarse teeth. These scales may continue on to the breast. They are liable to be shed and be wanting. Cheeks and opercles scaled. Yellowish green, the back and sides crossed by about fifteen dusky bars alternating with which are other less conspicuous bars. A dark round spot at the base of the caudal rays. Dorsal and caudal fins mottled and barred. Other fins mostly plain. Length six to eight inches.

Great Lakes and south to the Gulf. Carroll County (23, '88, 51); Northern Indiana (1, '77, 53, 67); Clark County (23, '88, '56); Franklin County (5, No. 2, 8); Monroe County (1, '85, 411); Marion County (1, '77, 44, 375); Lower Wabash (1, '77, 44); St. Joseph's River (1, '77, 44, 53); East Fork White River (23, '84, 204); Cass County (4, '88, 159); Knox, Gibson and Posey counties (4, '88, 164); Spencer, Owen County (4, '88, 167); Vigo County (16, 96); Calumet and Vermillion rivers, Ills. (14, No. 1, 36); Eel River Basin (4, '94, 39); Decatur County (Shannon).

This curious species lives in clear and rapid streams, where there is a gravelly bottom. Forbes (14, No. 3, 23) has studied its food. This appears to be made up of crustaceans, entomostraca and amphipods. One specimen had eaten a few small mollusks.

Genus ETHEOSTOMA Rafinesque.

Premaxillary not protractile, the skin of the upper lip passing in the midline into that of the forehead. Mouth large or small, seldom inferior. Teeth on the vomer. Maxillary not closely bound to the pre-orbital by skin. Body usually more or less compressed. Scales covering whole of the body.

A. Lateral line running backward to base of caudal fin.

1. Mid-ventral line with a row of enlarged scales; or, if these have fallen away, with a naked strip.

a. Palatine teeth present.

b. Gill-membranes scarcely united across the isthmus.

- c. Cheeks and opercles almost wholly naked.
 - Scales along the lateral line about seventy-seven. *macrocephalum*, p. 274.
 - Scales along the lateral line about fifty-five. *ouachitea*, p. 274.
 - cc. Cheeks and opercles scaled.
 - Scales of lateral line fifty-five; dorsal rays XII, 13. *ouachitea*, p. 274.
 - Scales of lateral line sixty-five to seventy-five; dorsal XIII to XV, 12. *aspro*, p. 274.
 - Scales of lateral line sixty-eight; dorsal XII, 13. *phoxocephalum*, p. 275.
 - bb. Gill-membranes broadly united across the isthmus; dorsal rays XIII, 14. *scierum*, p. 276.
 - aa. Palatine teeth not present. Dorsal rays XI, 11. *evides*, p. 276.
2. Mid-ventral line covered with scales of the common sort.
- a. Anal fin with rays II, 9 to 11.
 - Scales 11-75-16; dorsal XI or XII, 13. *niangua*, p. 277.
 - Scales 9-58-10; dorsal XII 12. *maculatum*, p. 277.
 - Scales 8-51-9; dorsal XIII, 13. *variatum*, p. 278.
 - Scales 6-47-7; dorsal XII, 12. *jessica*, p. 282.
 - aa. Anal with rays II, 7 or 8.
 - Gill-membranes broadly united across the isthmus. *zonale*, p. 278.
 - Gill-membranes scarcely united. *camurum*, p. 279.
- AA. Lateral line incomplete or wholly wanting.
- 1. Lateral line developed on anterior part of body; scales of the lateral line forty or more.
 - a. Gill-membranes broadly united across isthmus.
 - Head wholly without scales. *fabellare*, p. 280.
 - Cheeks and opercles scaled. *squamiceps*, p. 280.
 - aa. Gill-membranes little united.
 - c. Cheeks naked, or nearly so.
 - Scales 11-74-16; dorsal XI or XII, 13 or 14; anal II, 11 or 12. *niangua*, p. 277.
 - Scales 5-45-8; dorsal X, 12; anal II, 7. *cæruleum*, p. 281.
 - Scales 5-50-8; dorsal XII, 12; anal II, 7. *tippecanoe*, p. 282.
 - cc. Cheeks scaled.
 - Dorsals XII, 12; anal II, 9. *jessica*, p. 282.
 - Dorsal IX or X; anal II, 7. *fusiforme*, p. 282.

2. Lateral line wholly wanting. Scales along the sides in fewer than forty transverse rows. *microperca*, p. 283.

ETHEOSTOMA OUACHITÆ J. and G.

Jordan and Gilbert, 1887, 23, 49.

Form elongated and slightly compressed. Depth in the length about six and one-half times. Head in the length four. Snout equal to diameter of the eye, three and one-half in length of head. Profile descending gently to the upper lip. Mouth rather large, horizontal, the lower jaw included, the maxillary reaching the anterior margin of the orbit. Caudal peduncle slender. Cheeks and opercle scaly; sometimes, however, smooth or with imbedded scales. Dorsal rays XI or XII, 13; anal rays II, 10. Scales of the body in forty-six to fifty-two transverse rows. Color in alcohol olive, with about eight brown blotches along the lateral line, and about as many across the back alternating with those along the lateral line. A dark stripe in front and behind the eye and another below it. The one behind the eye is continued on the operculum. Dorsals and pectorals with faint bars of light and dark. The species closely resembles *E. peltatum*, a species found east of the Alleghany Mountains. *E. ouachitæ* was originally described from the Washita River in Arkansas, but it has more recently been taken at Patoka, in Gibson County (4, '88, 160) and at New Harmony (4, '88, 113). Some of the specimens taken there were three inches long, larger than the original types.*

ETHEOSTOMA ASPRO Cope and Jordan.

Black-sided Darter.

Alwordius aspro, Jordan and Gilbert, 1882, 8, 501.

Body elongated and somewhat compressed. Depth in the length five to six times. Head rather short, not high, pointed in front, contained in the length four to four and one-half times. Interorbital space equal to the diameter of the eye, four times in length of head. Mouth moderate, the maxillary reaching back to the pupil. Gill-membranes scarcely united. Preopercle not serrated. Scales usually about 8-65-12; sometimes as many as seventy-five in a longitudinal row. The belly with a

* ETHEOSTOMA MACROCEPHALUM Cope.

Alwordius macrocephalus, Jordan and Gilbert, 1882, 8, 501.

This species has been taken in Western Pennsylvania and may be looked for in south-eastern Indiana. Hence, a short description of it is included.

Depth in length seven. Head in length three and three-fourths. Snout long, three and one-fourth in head. Mouth large, terminal. Palatine teeth present. Cheeks naked; opercles wholly or almost wholly naked; sometimes with a row of scales along the upper edge of the subopercle. A row of enlarged scales along the mid-ventral line; or, if these are wanting, a naked strip. Dorsal rays XIV, 13. Anal rays II, 11. Olive, with about ten brown spots along the sides and a spot at the base of the caudal. Length three inches.

median row of enlarged and modified scales, or with a naked strip. Cheeks and opercles scaly. Dorsal rays XIII to XV, 12 or 13. Anal rays II, 9 or 10. Pectorals and ventrals short, lacking much of reaching the vent. Color olive, with mottlings of brown. Sides with eight or nine large brown spots. Back with the same number of dusky blotches. A black spot below the eye. Spinous dorsal with a dusky base. A black spot at the base of the caudal. Length about four inches or less.

Western Pennsylvania to Dakota and Arkansas. A common fish in suitable streams. Has been taken at many localities in Indiana. Franklin County (5, No. 2, 8); Carroll County (23, '88, 51); Monroe County (1, '85, 411); Marion County (1, '77, 375); Lawrence County (23, '84, 205); St. Joseph's River (4, '88, 155); Kankakee River at Plymouth (4, '88, 156); Cass and Whitley Counties (4, '88, 159); Posey County (4, '88, 164); Vigo County (16, 96); Eel River Basin (4, '94, 39); Decatur County (Shannon).

One of these fishes taken by myself at Logansport had seventy-five scales along the lateral line. The usual number is about sixty-five. Such variations in scales are often met with in our fishes. Some specimens taken by Dr. Jordan at Plymouth were more than four inches in length and all extremely plump and very dark in color. In his "Fishes of Ohio," Jordan says that this fish is the most graceful of all the darters, and delights in clear streams with gravelly bottoms. It is less closely confined to the bottom and to the shelter of stones than the others, swimming more freely in the waters. As an aquarium fish, it is "hardier than any other fish as pretty and prettier than any other as hardy." Dr. Forbes (14, No. 3, 23) found that it eats the larvæ and pupæ of mayflies, dragonflies, etc., and some entomostraca.

ETHEOSTOMA PHOXOCEPHALUM Nelson.

Alwordius phoxocephalus, Jordan and Gilbert, 1882, 8, 501.

Body elongate and somewhat compressed. Depth in length five times. Head in length three and three-fourths to four; narrow and with the snout pointed. Snout equal to the eye, four and one-half in the length of the head. Profile descending gently to the tip of the snout.

Mouth moderate, slightly oblique, the maxillary reaching back to the anterior border of the eye. Palatine teeth present. Pectoral fins short, failing much of reaching the vent. Mid-ventral line naked or with a row of modified scales. Gill-membranes united for a short distance across the isthmus. Dorsal rays XII, 13. Anal rays II, 9. Scales 12-68-14. Cheeks and opercles densely clothed with scales. Color in alcohol pale olive; about fifteen lateral blotches of brown; also a few

dusky blotches. A small black spot at the base of the caudal. Length about four inches.

Distributed sparingly from northern Ohio to Arkansas. Wabash River, at Wabash and Terre Haute (23, '88, 51); Monroe County (1, '85, 411); Lower Wabash River (1, '77, 44); Lawrence County (23, '84, 205); Cass County (4, '88, 159); Knox, Gibson and Posey counties (4, '88, 164); Owen County (4, '88, 167); Logansport (4, '94, 39); Crawford County (24, '93, 103).

There is little definite knowledge concerning the habits of this fish. Forbes found its food to be essentially the same as that of *E aspro*. Prof. Kirsch found it living only on grassy bottoms (4, '94, 39).

ETHEOSTOMA SCIERUM (Swain).

Serrariasciera, Swain, 23, '84, 205.

Body rather elongate and compressed. Depth in the length five and one-half. Head in length four times. Snout equal to the eye, four in length of head. Profile considerably convex in front of the eye. Upper lip not protractile. Mouth rather small, the lower jaw slightly the shorter. Palatine teeth present. Preopercle serrated, at least in the smaller specimens. Gill-membranes broadly united, Pectoral fins short. Dorsal rays, XIII, 14. Anal II, 9. Scales 8-68-12. Breast, cheeks and opercles scaled. Middle of the belly with a row of slightly enlarged scales. Color dusky, with about eight large brown blotches along the side, and some indistinct dorsal blotches. A dark streak through the eye to the opercle. Three black spots at the base of the caudal fin in a cross-row. Fins with more or less black.

Length sometimes as great as five inches.

Distributed from Indiana to Texas. Carroll County, in the Tippecanoe (4, '88, 160); Monroe County (23, '88, 51, and 1, '85, 411); Owen County (23, '88, 51); Knox, Gibson and Posey counties (4, '88, 164); White River, at Spencer (4, '88, 167).

ETHEOSTOMA EVIDES (Jordan and Copeland).

Alvordius evides, Jordan and Gilbert, 1882, 8, 503.

Body rather stout, moderately compressed. Depth in the length five and one-half; head in length, four. Snout short, equal to the diameter of the eye; four in length of head. Profile descending rather rapidly in front of the eyes. Mouth terminal, slightly oblique, moderate in size, the maxillary reaching a little behind the anterior border of the eye. No palatine teeth. Dorsal rays XI, 11; anal rays II, 8. Scales 8-65-11. Middle line of the belly with a row of somewhat modified scales. Cheeks naked; opercles scaled. Ground color dark olive, with about eight large quadrate dusky blotches, which pass across the back

and descend on the side below the lateral line. In life these blotches, in the case of the male, are blue green, while the interspaces are yellow, spotted with coppery red. Throat, cheeks and upper fins orange. Dorsal fins dusky and with dark spots between the basis of the spines. Anal and ventral blue black, or sometimes pale. Length about three inches.

Central and southern Indiana to northern Illinois and Arkansas. In Indiana it has been taken in White River at Indianapolis (1, '77, 375); Wabash River at Delphi (23, '88, 51); St. Joseph's River and Lower Wabash (1, '77, 44); Fulton and Cass counties (4, '88, 160); Knox and Posey counties (4, '88, 165); Owen County (23, '88, 51); Logansport (4, '94, 39).

This brilliant fish is found in clear and rapid waters. There is in the Illinois State collection at Champaign a specimen of this species from Rock River in northern Illinois. *

ETHEOSTOMA MACULATUM Kirtland.

Nothonotus maculatum, Jordan and Gilbert, 1882, 8, 507; *N. sanguifluus*, *op. cit.* 506.

Body moderately elongate and considerably compressed; the caudal peduncle thin and deep. Depth in the length, four and one-half to five and one-fourth. Head pointed, the profile above descending to the tip of the snout; that of the lower jaw ascending to meet it. Snout equal to the eye, four in the head. Interorbital space very narrow; upper jaw not protractile. Mouth moderate, terminal, slightly oblique, maxillary reaching to the front of the pupil. Dorsal rays XII, 12 or 13; anal II, 9; the first anal spine the longest. Scales of the body 9-58-10. Cheeks naked; opercles scaled. General color in alcohol olive brown; sides covered with numerous irregular blotches of dusky. Many single

*ETHEOSTOMA NIANGÆ Gilbert and Meek.

Gilbert and Meek, 1887, 23, 52.

Body elongated, slightly compressed. Depth in the length six times. Head long and pointed; in length of body, four. Snout long; four and one-third in the head; longer than the diameter of the eye, which enters five and one-half in head. Profile descending gently to near the lip. Mouth large, terminal, slightly oblique, the lower jaw included. Maxillary reaching back to front of pupil. Palatine teeth present. Gill membranes very slightly connected. Caudal peduncle slender. Scales, 12-75-15. Cheeks and opercles naked, or with a few rudimentary scales. Mid-ventral line covered with scales of the common kind. Dorsal rays, XI or XII, 13 or 14; anal, II, 11 or 12. The spines weak. Pectorals not extending back two-thirds the distance to the vent.

Color olive, with about ten broad bars passing across the back and descending on the sides; in the male, encircling the body. The interspaces contain some carmine red spots. A dark band at the base of the caudal fin, and in front of the band two black spots. Dorsal fin dusky, with spots of red and with a red edge. The other fins also mottled with red. Length of the type specimens, three and three-fourths inches.

This species was originally described from Missouri. It has since been found in Owsley County, Kentucky, and may be looked for in southern Indiana.

scales with a dusky spot. Sometimes, at least on the caudal peduncle, these brown dots form longitudinal rows. Dorsal fins finely barred with brown. A transverse row of four dark spots at the base of the caudal. In life there is to be seen in the male a yellowish dorsal band; the throat is blue, while the sides and back are adorned with crimson spots. The soft dorsal is blood red. The female is less gaudily colored. Length about two and one-half inches.

Tennessee to Western Pennsylvania and Northern Indiana. One specimen of this species was taken in Deer Creek and four in the Tippecanoe River in Carroll County (4, '88, 160); others were secured by Dr. Jordan in White River at Indianapolis; in the Kankakee, Maumee and St. Joseph's rivers (24, '93, 104).

ETHEOSTOMA VARIATUM Kirtland.

Blind Simon.

Nanostoma tessellatum, Jordan and Gilbert, 1882, 8, 511; *Etheostoma variatum*, Jordan, 1885, 23, 163.

This beautiful species, originally described by Dr. Jared Kirtland, has until recently been confused with other species. It has, however, been rediscovered by Mr. A. W. Butler at Brookville, Franklin County, and redescribed by Dr. Jordan.

Body moderately elongate, not greatly compressed, the back somewhat arched. Head short and thick. Snout short and blunt. The profile strongly decurved. Diameter of eyes greater than length of the snout, three and three-fourths in the head. Mouth small, the lower jaw included, the maxillary reaching the front of the eye. Gill membranes broadly united. Cheeks naked. Opercles with a very few scales. Lateral line complete. Breast with scales. Scales of body 8-51-9. Pectorals reaching the front of the anal. Dorsal rays XIII, 13; anal II, 9. Color dusky greenish above, the center of the scales darker, lower half of the body in front of the anal fin bright yellow-orange; hinder half of the body with alternating cross-bars of greenish and bright orange; spinous dorsal blue-black, bordered above and below with paler; soft dorsal blue-black, with orange at the base; anal like the soft dorsal; ventrals blue-black. Females probably plain. Length three and one-half inches.

Ohio Valley, scarce. Brookville, Franklin County (23, '85, 163).

ETHEOSTOMA ZONALE (Cope).

Nanostoma zonale, Jordan and Gilbert, 1882, 8, 510.

Form moderately slender and slightly compressed. Depth in the length five. Profile convex, the snout becoming strongly decurved. Head narrow above; the interorbital space in the head five times.

The head in the length four to four and one-fourth times. Eye rather large, three and one-third in head. Mouth small, slightly oblique, and somewhat inferior. Dorsal rays X or XI, 10 to 12; anal II, 7. Lateral line complete. Cheeks, opercles and breast densely scaled, the latter occasionally naked (var. *arcansanum*). Scales of body, 5 or 6—48 to 50—7. Color in alcohol olive, with about six or eight squarish dorsal blotches of brown; similar blotches on the sides of the caudal peduncle. Considerable amount of brown marbling along the sides of the body. Fins dark. In life about eight dark bluish bands pass down from the mottling along the lateral line and nearly encircle the belly. The pectorals, anal, and the caudal are said to be golden, spotted with brown. At the base of the dorsal are some round red spots. The head is spotted with brown. Length about three inches.

Western Pennsylvania to Kansas and south. Has been taken in Indiana at the following points: "Miami River, Indiana" (Cope 6, 1871, 212); Franklin County (5, No. 2, 10); Kankakee River at Plymouth, Marshall County (4, '88, 156); Crawford County (24, '93, 104).

Forbes (14, No. 3, 24) found that the specimens of this species examined by him had eaten nothing but the larvæ of small dipterous insects.

ETHEOSTOMA CAMURUM (Cope).

Blue-breasted Darter.

Nothonotus camurus, Jordan and Gilbert, 1882, 8, 506.

Body considerably compressed. Depth in the length four and one-half to five times. Head in the length four. Snout shorter than the eye. Four and one-half in head. Eye three and one-half. Profile descending, to snout with a gentle but increasing curve. Mouth oblique, rather large, the maxillary reaching the eye; the lower jaw short, so that the mouth is slightly inferior. Gill membranes free from the isthmus and from each other. Dorsal rays X or XI, 12 or 13; anal, II, 7 or 8. Scales 6—53—8. The males are dusky—almost black above, while the belly is paler. On the sides are numerous small crimson spots. Breast and throat deep rich blue. Narrow dusky lines, one for each row of scales, run along the sides. Fins black edged. Second dorsal, caudal, and anal crimson and yellow. Females less gaudily colored and somewhat cross-barred. Length about two and one-half inches. Indiana to Tennessee. White River at Indianapolis (1, '77, 375); Tippecanoe River in Fulton County (23, '88, 51); Eel River System (4, '94, 39).

One of the most gorgeously colored of our fishes. Lives in clear streams and appears to be rather rare.

ETHEOSTOMA FLABELLARE Rafinesque.

Fantailed Darter.

Jordan and Gilbert, 1882, 8, 513.

Body elongate, compressed; head narrow and pointed. Caudal peduncle deep. Depth in the length five. Head in the length three and one-half to four. Mouth terminal, somewhat oblique. Jaws equal, or the lower the longest. Maxillary reaching to the anterior border of the pupil. Snout equal to diameter of the eye, four in head. Gill-membranes broadly united across the isthmus. Upper jaw not protractile. Scales 7-45 to 50-8. Cheeks and opercles naked. Lateral line developed about half-way. Dorsal rays VII or VIII, 11 or 12; anal rays II, 7 or 8. Dusky olive, with about ten dark cross-bars in the male, and often with longitudinal lines produced by each scale having a dark center (variety *lineolatum*). Spinous dorsal with a dusky band along the upper edge. Soft dorsal barred with dusky. Caudal cross-banded. An enlarged black scale at the shoulder. Length about two and one-half inches.

Distributed from western New York to North Carolina and westward. Carroll County (23, '88, 51); Ohio County (23, '88, 56); Franklin County (5, No. 2, 11); Monroe County (1, '85, 411); White River at Indianapolis (1, '77, 43, 375); region about Lawrence County (23, '84, 205); Marshall and Whitley Counties (4, '88, 160); Vanderburgh and Owen counties (4, '88, 166); Vigo County (16, 96); Wabash Valley (14, No. 1, 34); Eel River system (4, '94, 39); Decatur County (Shannon).

Dr. Jordan states that this is the most active and wary of the darters and the most hardy in the aquarium. Forbes (14, No. 3, 24) found that it feeds on chironomous larvæ, ephemerids and the smallest crustaceans (*Cyclops*).

ETHEOSTOMA SQUAMICEPS Jordan.

Jordan and Gilbert, 1882, 8, 514.

Body rather stout, little compressed anteriorly. Depth in length five. Head in length three and one-half to four. Caudal peduncle deep and compressed. Head with the upper profile descending gently to the nostrils, then rapidly to the lip; the snout, therefore, blunt. Snout equal to the eye, five in the head. Mouth large, terminal, oblique, the maxillary reaching the middle of the pupil. Gill-membranes slightly joined across the isthmus. Pectoral fins not reaching the vent. Lateral line wanting on the caudal peduncle. Scales 6-50 to 60-6 to 9. Opercles and breast scaled, and usually the cheeks also. Dorsal rays IX or X, 12 or 13; anal, II, 7. Color olive, with many mottlings and splotches of

brown. Some indications, distinct or vague, of brown cross bars. A dark spot in the shoulder, and a dark bar at the base of the caudal. Pectorals, dorsals, and anal finely cross-banded with black; nearly wholly black in some males. Length about two and one-half inches.

Southern Indiana to West Florida; not common. In Indiana it has been taken only at New Harmony, Posey County. It lives in shallow sandy streams.

ETHEOSTOMA CERULEUM Storer.

Blue Darter; Rainbow Darter.

Pecilichthys ceruleus, Jordan and Gilbert, 1882, 8, 517.

Body moderately stout and considerably compressed. Depth in the length, four and one-fourth. Head large and compressed; in the length three and three-fourths. Interorbital space narrow. Profile moderately convex. Mouth of medium size, the maxillary reaching to the front of the eye; terminal and oblique. Palatine teeth present. Cheeks naked or nearly so; opercles scaled. Dorsal rays X, 12; anal, II, 7. Scales 5-45 to 50-8, with pores on about thirty-three. Males highly colored; sides with about a dozen indigo blue bands running downward and backward, the hinder half dozen the most distinct. The interspaces bright orange. Breast and belly orange; also the gill-membranes. Dorsal fins banded with indigo and orange, the spinous portion mostly indigo, the soft portion mostly orange. Anal and caudal indigo. Females smaller and plainer. Sides with vertical dusky bands, but with little orange or blue. Belly pale, back often yellowish. Sometimes there are dark longitudinal bands along the sides, one for each row of scales (the so-called variety *spectabile*). Length about two and one-half inches.

Distributed in gravelly streams from Indiana to Kansas. Carroll County (23, '88, 51); Clark and Ohio counties (23, '88, 56); Franklin County (5, No. 2, 11); Monroe County (1, 85, 411); Marion County (1, '77, 43, 375); St. Joseph's River, Kankakee River, Maumee River, Tippecanoe River (1, '77, 43, 48); St. Joseph's River (4, '88, 155); Marshall County (4, '88, 156); Lawrence County (23, '84, 205); Marshall, Cass and Whitley counties (4, '88, 165); Knox County (4, '88, 165); Owen County at Spencer (4, '88, 167); Vigo County (16, '96); Eel River basin (4, '94, 39). See also 24, '93, 105.

A very gaudily colored fish. For that reason, perhaps, sometimes called "soldier fish." It is a common species in gravelly streams. Dr. Forbes found (14, No. 3, 23) that it subsists on the larvæ of small diptera, ephemerids and case worms.

ETHEOSTOMA JESSIE Jordan and Brayton.

Pecilichthys jessie, Jordan and Gilbert, 1882, 8, 518.

This species is closely related to the preceding, *E. cæruleum*. It differs in having the cheeks more scaly, although they may be partly naked. The head is more pointed than in *E. cæruleum*. Head in length four; depth, five. Dorsal rays XII, 12; anal, II, 9. Scales 6-47-7, with pores on about thirty-five scales. The general color is brownish. On the sides are some cross bars of dark blue and some greenish blotches on the back. The dorsal fin and anal are speckled with golden. Length about three inches.

Distributed from Indiana to Georgia and Texas. Has been taken in Indiana at Delphi, Carroll County (23, '88, 52); Vincennes and New Harmony (4, '88, 165).

ETHEOSTOMA TIPPECANOE Jordan and Evermann.

Jordan and Evermann, 1890, 23, 3, with figure.

This species is closely allied to both *E. cæruleum* and *jessie*. The head is still more pointed than in *jessie*, and the opercle is shorter than in either of the other species, its length being little more than that of the snout. Eye equal to the length of the snout. Depth in the length, four and three-fourths. Head four and one-half. Mouth large and oblique, the maxillary reaching to the front of the pupil. Scales 5-50-8, with pores on about twenty-three. Dorsal rays XII, 12; anal, II, 7. Color olive, with about a dozen cross-bars, which in life are probably blue. Base of the caudal with three dots in a cross series. A black scale at the shoulder.

Taken by Dr. B. W. Evermann at Marshfield, Fulton County (23, '90, 3).

ETHEOSTOMA FUSIFORME (Girard).

Pecilichthys fusiforme and *eos*, Jordan and Gilbert, 1882, 8, 520; *P. palustre*, Gilbert, 1884, 23, 209.

Body more or less elongated and moderately or strongly compressed. Depth in the length, about six times. Caudal peduncle long and slender. Head relatively long, three and one-half to four in the length. Snout short; profile rapidly descending to the lip. Jaws equal. Mouth moderate, oblique; the maxillary extending behind the anterior border of the orbit. Eye large, three to four in head. Cheeks and opercles scaly. Breast naked or with a few medium scales. Scales of body forty-three to fifty-eight. Dorsal rays VIII to X, 9 or 10; anal rays II, 7 or 8. Pores on from twelve to twenty-six scales. Color pale or dark olive, with markings of still darker; sometimes nearly plain, with

dark specks; sometimes with ten dark dorsal bars and about as many across the lateral line. This species has been described under many names, and some of them may stand for distinct varieties or sub-species. The typical *fusiforme* has depth in length six; a dark lateral band and some red markings; lateral line, fifty-five; pores on ten to twenty scales. *Palustre* has a depth of four and one-half to five and one-half; no bright red; sides with greenish cross shades. *Eos* has a depth four and one-half to five and one-half; sides with crimson spots and some dark blue bars across the back and lateral line; scales, fifty-eight, pores on twenty-five. Dr. Eigenmann (24, '93, 105) separates the two forms, *fusiforme* being found in the southern part of the State; *eos* in the northern.

Massachusetts to Minnesota and southward. Greene County (23, '84, 209, *palustre*); Posey County (4, '88, 165); Vigo County (4, '88, 166-7 and 16, 96); Carroll County (23, '88, 52, *eos*); Marshall County (23, '88, 55); Lakes of Laporte County, St. Joseph's River, Maumee River and White River at Indianapolis (1, '77, 43, 46); Eel River Basin (4, '94, 39).

This species is extremely variable in form, color, and in number of scales and fin rays. It appears to be a swamp-loving species, and in this respect differs greatly from most members of the sub-family. Its food is essentially the same as that of the others—larvæ of aquatic diptera and ephemerids (Forbes, 14, No. 3, 22, "*Boleichthys elegans*").

ETHEOSTOMA MICROPERCA J. and G.

Microperca punctulata, Jordan and Gilbert, 1882, 8, 523.

Size very small, not exceeding one and one-half inch. Form stout and compressed. Depth in the length about four and one-half. Head in length three and three-quarters. Snout pointed. Mouth moderate; oblique; the maxillary reaching the front of the eye. Cheeks naked; opercles with a few scales. Scales in a row along the side about thirty-four. No pores developed. Dorsal rays VI or VII, 10; anal, II, 6. Anal spines strong. Olive, with zigzag and irregular markings and specks of brown. A dark spot on the shoulder and dark bands about the eyes.

Distributed from central Indiana to Minnesota. Eel R. system (4 '94, 39); White River, at Indianapolis (1, '77, 375); Lakes of Laporte County, St. Joseph's River, Maumee River, Noble County (1, '77, 43); said by Nelson to be common in clear tributaries to Lake Michigan, about Waukegan, Illinois. Not common in the Wabash Valley (14, No. 1, 34). Length one inch to one and one-half.

This is one of the smallest of known fishes. Forbes found that it subsists on the larvæ of dipterous and ephemerid insects, but principally on minute crustaceans.

Genus PERCA Linnæus.

Body fusiform, somewhat compressed. Preopercle and shoulder-girdle serrated. Premaxillaries protractile. Teeth on jaws, vomer and palatines; none of the teeth enlarged so as to form canines. Branchiostegals seven. Pseudobranchiæ small, but perfect. Lateral line complete.

PERCA FLAVESCENS (Mitchell).

Yellow Perch.

Perca americana, Jordan and Gilbert, 1882, 8, 524; 1884, 12, 414, pl. 168.

Body rather stout and moderately compressed. Depth in the length three and one-quarter. Head in length three and one quarter. Back somewhat elevated. Mouth slightly oblique, of moderate size, the maxillary reaching to pupil. Cheeks with scales. Opercles nearly naked, furnished with a single spine. Scales 5-75-17. Dorsal rays XIV, 14; anal rays II, 7. Olivaceous, darker above, paler below. Sides yellow, with about six to eight dusky bands running down to near the belly. Dorsal fins dusky; pectorals and ventrals usually orange. Length about one foot.

Minnesota to Quebec and southward, east of the Alleghany Mountains, to S. Carolina. In the Mississippi Valley, not known to occur south of Indiana. Far more abundant toward the north, especially in the region of the Great Lakes.

It is common in Lake Michigan and in its tributaries and in the small lakes in northern Indiana. It has been reported by Dr. O. P. Jenkins as having been taken in Vigo County, but this seems to be the most southerly locality where its occurrence is known. Abundant in Lake Maxinkuckee, Marshall County (23, '88, 55); Lakes of Laporte County, St. Joseph's River, Tippecanoe River (1, '77, 44); Eel River system (4, '94, 39); Vigo County (16, 96). Dr. Forbes has found it to occur in Illinois as far south as Peoria.

This fish is one of the important food-fishes of our State. It is sold in large numbers in the markets in Chicago, and is the fish most often seen on the hooks of the fishermen who repose on the piers along the lake. It takes the hook readily and shows some pluck when captured. It is not, however, regarded as a first-class fish.

Its spawn is deposited from December to April (Bean 25, 127). The eggs are laid in flat bands, consisting of a single layer agglutinated together by an adhesive material. The eggs are heavy and sink to the bottom. They are in all probability suspended by the female upon submerged objects, where they are left to hatch out (Ryder 11, '85, 518).

Prof. Forbes has examined the food of this species. Up to about one and one-half inch in length the food consists of small crustaceans

(*Cyclops* and *Daphnia*); as the size increases more insects are taken. Specimens two and one-half inches long had eaten nothing but hemiptera (12%) and neuroptera (88%). The latter consisted nearly entirely of the larvæ of mayflies. The adults cease to eat entomostraca, but capture crayfishes, fresh-water shrimps, amphipods, isopods and a large proportion of insects. The Lake Michigan specimens were found to have eaten 87% of fishes, all minnows.

Roosevelt (Game Fishes, 228) states that the perch is despised equally by the gourmand and the sportsman. He says that the flesh is coarse, white and tasteless, and that the fish is pursued only by boys and ladies.

Genus STIZOSTEDION Rafinesque.

Body fusiform, not much compressed. Preopercle serrated. Premaxillaries protractile. Teeth on jaws, vomer, and palatines. Some teeth on jaws and palatines developed as long, sharp canines. Branchiostegals seven. Differs from *Perca* especially in having strong canine teeth. Includes four species, two American and two European.

- a. Pyloric cœca three; dorsal fin XIII-I, 21. *vitreum*, p. 285.
 aa. Pyloric cœca four to seven; dorsal XIII-I, 18. *canadense*, p. 286.

STIZOSTEDION VITREUM (Mitchill).

Blue Pike; Wall-eyed Pike; Yellow Pike; Jack Salmon.

Stizostedium vitreum, Jordan and Gilbert, 1882, 8, 525; 1884, 12, 417, pl. 169. Smith, 1892, 4, 208, pl. 47.

Body tapering from dorsal fin toward snout and tail; slightly compressed, becoming more so as the size increases. Head in length about four times. Depth in length four to six. Snout long and pointed. Mouth nearly horizontal, large, the maxillary extending back to a perpendicular from the hinder edge of the pupil. Cheeks naked or scaly; opercles more or less scaly and ending behind in a single spine. Anterior dorsal fin of thirteen long slender spines. Posterior dorsal of a spine and 21 soft rays. Anal spines two; soft rays twelve. Scales 11-90 to 100-15. The sides brassy yellow, mottled with olive; or the olive may predominate, especially on the back. Head mottled with olive and brassy. Belly white. Lower fins more or less yellow, the pectorals without, a dusky spot at the base. Both the dorsal and the caudal marked with yellow and dusky. Length occasionally as great as three feet.

Great Lakes and Mississippi Valley. Abundant northward. Ohio River (4, 9, 48); Vigo County (16, 96); Lake Michigan (14, No. 1, 36; 14, No. 2, 44).

This is one of the most valuable of the food fishes furnished by the Great Lakes. Its flesh is excellent, and it reaches a size that makes its capture worthy of effort. It was formerly much more abundant than at

present. Professor Milner (11, '72-3, 50) states that between 1830 and 1842, at Fort Gratiot, Michigan, a Mr. Clarke took, in some years, 1,000 barrels of this fish

The eggs measure about one-twelfth of an inch in diameter, and are strongly adhesive. They are laid in early spring. In hatching houses the young, if not fed, begin not many days after hatching to devour one another. The eggs in our climate hatch about June 1. Smith (4, '92, 56) states that the eggs are deposited during April, near shore.

Forbes (14, No. 3, 32) found the food of the adults of this species to consist wholly of fishes. Hickory shad, worthless for human food, become, through the agency of the yellow pike, transformed into materials that are savory and nourishing. The young eat entomostraca and small fishes.

STIZOSTEDION CANADENSE (C. H. Smith).

Sauger; Sand Pike; Gray Pike.

Stizostedium canadense, Jordan and Gilbert, 1882, 8, 526; 1884, 12, 424, pl. 169; Smith, 1892, 4, pl. 48.

Body elongated, and but slightly compressed. Depth in the length, four and one-half to five and two thirds. Head long and pointed, in the length, three and one-half times. Cheeks and opercles covered with small ctenoid scales. Upper surface of the head more or less scaly. Mouth large, the maxillary extending back beyond the pupil. Eye small, five to six in head. Dorsal fin XIII-I, 18; anal, II, 12. Pectorals and ventrals extending little more than half-way to the vent. Scales of body, about ninety-five along the lateral line. Color brassy, the sides with dark blotches; belly pale. Spinous dorsal with two or three rows of round, dark spots. Anal and ventrals pale. Base of pectorals with a dark spot. May reach a length of a foot and a half, usually smaller.

Great Lakes to Ohio Valley and Dakota. Apparently not common outside of the larger lakes, at least in Indiana. Franklin County (5, No. 2, 11); Vigo County (16, 96); New Harmony, where I took a specimen some years ago.

This is also an excellent fish for the table, but it does not equal in economical importance the yellow pike (*S. vitreum*). It does not grow so large, and is apparently far less abundant. It seems strange that all the reports of the occurrence of this fish in Indiana should come from localities along the southern portion of the State. Nelson, in his catalogue of the fishes of Illinois (14, No. 1, 36), was uncertain whether or not it occurred in Lake Michigan.

Forbes (14, No. 3, 31) found that this species eats only other fishes, and among these he found hickory shad, cat-fishes, sheepshead, and sun-fishes.

Family SERRANIDÆ.

Body more or less compressed, and covered with ctenoid scales. Lateral line fully developed, but not running back on the caudal rays. Dorsal with stiff spines. Anal spines three. Ventral with one spine and five rays. Pseudobranchiæ large. Premaxillary protractile. Teeth on vomer and palatines, and often on the tongue. Canine teeth sometimes present on the jaws. Preopercle with its posterior margin usually serrate.

Teeth on the base of the tongue; anal rays III, 12; lower jaw projecting. *Roccus*, p. 287.

No teeth on base of tongue, but patches at the tip; anal rays III, 9; jaws equal. *Morone*, p. 288.

Genus ROCCUS Mitchill.

Body elongate, little or much compressed. Mouth rather large, nearly horizontal. Teeth on the base of the tongue in one or two patches. Lower jaw projecting beyond the upper. Dorsal fins separated. Anal rays III, 12.

ROCCUS CHRYSOPS (Raf.).

White Bass.

Jordan and Gilbert, 1882, 8, 529; 1884, 12, 428, pl. 171.

Body deep and compressed, the outline descending to the snout; slightly concave over the eyes. Depth in the length about two and one-half. Head pointed, in the length three and one-third times. Mouth moderate, the maxillary reaching back to a perpendicular from the pupil. Preopercle sharply serrated. Lateral line complete, nearly straight. Scales 10-55-13; those of the body closely overlapping. Small scales extending far out on the caudal and anal rays. Cheeks with about ten rows of scales. Opercles scaly. Dorsals separate, IX-I, 14; anal rays III, 12. Bluish or greenish above. Sides silvery, with dark longitudinal bands, four or five above the lateral line. Those below the lateral line often not continuous. Length ten to twelve inches.

Upper Mississippi Valley south to Ohio River, and in the region of the Great Lakes; common northward; abundant in Lake Michigan. It is rarely taken in the Ohio River. It was found in the Wabash River by Le Sueur (17, III, 448, *Perca multilineata*). Some years ago I took a specimen five inches long in the Wabash River at New Harmony.

This species is frequently seen in the markets of Chicago. Its flesh is sweet and well flavored. The fish prefers the quiet waters of the lakes and of the larger streams. Bean (25, 133) states that it spawns in deep water during May and June. Forbes found the food to consist to a great

extent of the larvæ of mayflies. A fifth part of the food consisted of other fishes. Some isopod crustaceans had also been eaten. The young fishes live principally on the larvæ of dipterous insects.

Genus MORONE Mitchell.

Body deep and compressed. No teeth on the base of the tongue, but with teeth near the tip. Jaws about equal. Dorsal fins joined at the base. Anal rays, III, 9.

MORONE INTERRUPTA Gill.

- *Yellow Bass.*

Roccus interruptus, Jordan and Gilbert, 1882, 8, 530; 1884, 12, 431, pl. 172.

Body deep and compressed. Depth in the length two and one-half. Head pointed, the slope from the front of the dorsal to snout steep and nearly straight. Head in the length three and one-fifth. Tongue with a patch of teeth on each side and meeting at the tip; no teeth at the base. Scales 7-52-11. Dorsal rays IX-I, 11; anal rays III, 8 or 9. The color is brassy yellow, with seven dark longitudinal stripes. Below the lateral line and below the soft dorsal the dark bands cease abruptly and are replaced by others which begin between the ends of those which have just stopped. Anal and caudal fins dusky. This species differs from *Roccus chrysops* not only in the generic characters given, but in having the dark bands more distinct, and in the general color being yellow instead of white. Length about one foot.

Lower Mississippi Valley north to southern Indiana. Wabash River in Vigo County (23, '88, 55); Brookville, Franklin County (7, 137). Forbes (14, No. 3, 37) states that in Southern Illinois this species replaces the *Roccus chrysops* of the northern portion of the State. Its food was found to consist, in the case of the adults, principally of the larvæ of neuroptera, especially of mayflies. The young had eaten about equally of *entomostraca* and small fishes (hickory shad).

Family SCIÆNIDÆ.

Body elongate, our species compressed. Scales weakly ctenoid. Lateral line present; continued far out on the caudal rays. No supplementary bone behind the maxillary, which slips under the preorbital. Head scaly. No teeth on vomers, palatines, pterygoids or tongue. Anal fin with one or two spines. A large family, mostly of marine species. Represented in our waters by a single species.

Genus APLODINOTUS Rafinesque.

Body deep and compressed. Snout blunt. Mouth slightly inferior. No barbels. No canine teeth. Gill-rakers short and blunt. Lower pharyngeal teeth large and rounded. Second anal spine large and strong.

APLODINOTUS GRUNNIENS (Raf.).

Drum; Sheeps-head; Croaker.

Haploidonotus grunniens, Jordan and Gilbert, 1882, 3, 567; Jordan, 1884, 12, 370, pl. 123. *Aplodinotus grunniens*, Smith, 1892, 4, 49.

Body rather elongated and compressed, the back high-arched. Head blunt, the snout rounded, and the mouth nearly inferior. Head in the length three and one-half to four. Depth in the length about three. Lateral line arched and running back on the caudal rays. Scales 11-55-11. Whole head covered with scales. Dorsal rays IX-I, 30, the eighth and ninth spines low; anal, II, 7; the first spine very short, the second long and strong. Color bluish silvery above and white below. Fins mostly plain. Length as great sometimes as four feet and the weight fifty pounds (4, '92, 49); but such size and weight are unusual.

Region of the great lakes southward to Georgia and Texas; common in larger waters of Indiana. Vigo County (23, '88, 55); Franklin County (5, No. 2, 11); White River, at Indianapolis (1, 77, 44); Ohio and Wabash rivers and Great Lakes (10, '74, 216); Gibson and Posey counties (4, '88, 165); Evansville (4, '88, 166); Vigo County (16, 96); Ohio River, at Madison.

Professor Forbes has investigated the food of this fish (14, No. 3. 64). The adults examined by him had eaten only mollusks, 46% of the contents of the stomach consisting of the remains of the thick and heavy water-snail *Melantho decisa*. The shells are crushed by means of the pavement-like teeth on the enormous pharyngeal bones of this fish. The young fish devour the larvæ of diptera and neuroptera. Forbes states that this fish is abundant in Lake Michigan and that it is usually regarded as unfit for food. Dr. H. M. Smith (4, '92, 49) also says that it is not much esteemed as a food fish and is one of the cheapest fishes sold. The smaller fish are regarded as the most palatable.

This fish has the curious habit of making a croaking sound beneath the water. Dr. Holbrook thought that the fish accomplished this by forcing the air from one division of the air-bladder to the other. Mr. W. R. Hamilton (4, '87, 63) thinks that it is done by grinding together the pharyngeal teeth.

Family COTTIDÆ.

The Sculpins.

Form elongated, the head broad and rather flat. Body naked, with prickles, or with a few scales or bony plates; never covered with regularly arranged scales. Teeth on jaws, usually also on vomer and palatines. A narrow bony stay running beneath the eye from the suborbital to the preopercle. Spines of the dorsal fin usually slender. Lateral line continuous. Ventral rays usually less than I, 5.

A family which contains a large number of genera and species living mostly along the sea-shores of northern regions. In our rivers and the Great Lakes are found a few species of small fishes placed under two genera of this family.

Gill membranes broadly united with the isthmus. Slit behind the last gill very small or wanting. *Cottus*, p. 290.

Gill membranes nearly free from the isthmus. A small but evident slit behind the fourth gill. *Triglopsis*, p. 292.

Genus COTTUS Linn.

Head and anterior part of the body heavy. Body naked or nearly so. Dorsal spines slender, six to nine in number. Ventral rays I, 3 or I, 4. Head armed with feeble preopercular spines. Gill opening widely separated by the intervening isthmus. Palatines usually, but not always, without teeth.

1. Palatine teeth present; ventrals I, 4, the spine being obscure.
 - a. Skin of upper surface with coarse prickles. *ricei*, * p. 290.
 - aa. Skin smooth, or with a few prickles in the axil only. *bairdi*, p. 291.
2. No palatine teeth; ventrals I, 3.
 - Dorsal rays VII, 19; anal rays 13. *pollicaris*, p. 292.
 - b. Dorsal rays VIII, 17; anal rays 13. *spilotus*, p. 292.
 - Dorsal rays VI, 15; anal rays 11. *hoji*, p. 292.

The species of fresh-water sculpins have not been sufficiently studied. Some of them are extremely rare and the finding of additional specimens may result in reducing the number of nominal species.

* COTTUS RICEI Nelson.

Uranidea spilota, Jordan and Gilbert, 1882, s. 694 (not of Cope.), *U. ricei*, op. cit. 953.

Head rather wide and flat above. Eyes directed upward. Width of mouth three in length of head. Teeth on palatines. Body contracted at the base of the tail. Head in length three and three fifths; depth five and one-third. Opercular spine strong, as long as the diameter of the eye and curved upwards like a cow's horn. Bones of the head cavernous. Dorsal rays VIII, 17; anal rays 12 or 13. Color olive, speckled with darker. Length two and one-half inches. A rare fish living in the deep water of Lakes Michigan and Ontario. Taken at Evanston, Illinois. Has not actually been yet taken in Indiana waters. Some of these deep water species may be thrown up on shores after storms, or may be found

COTTUS BAIRDI Girard.

Miller's Thumb; Blob; Muffle-jaw.

Uranidea richardsoni, Jordan and Gilbert, 1882, 8, 696.

Body stout anteriorly, tapering backward from the shoulders. Depth in the length four to six. Head very broad and considerably depressed, the lateral outlines converging to the narrow snout. Head in the length three to three and one-half. Mouth large, the maxillary reaching to the back of the eye. Teeth on the palatines. An upwardly directed spine on the preopercle; behind it two other smaller spines directed downward. Eyes close together and directed more or less upward. Pectoral fins broad and long, reaching nearly or quite to the anal. Dorsal rays VI or VII, 16; anal, 12 or 13. General color, olive or grayish. Dorsal region barred with black. Some yellow on the head and on the sides. The spinous dorsal with a band of orange along the upper border. Some of these brighter colors may belong only to the males during certain seasons. Length six inches.

Canada to Arkansas and Georgia. A common fish in Indiana streams. Carroll County (23, '88, 52); Franklin County (5, No. 2, 11); Monroe County (1, '85, 4, 11); White River at Indianapolis (1, '77, 376); Lake Michigan, deep water (1, '77, 64); Marshall County (4, '88, 156); Whitley County (4, '88, 160); Cass County at Logansport; caves of Southern Indiana (W. P. Hay); Eel River System (4, '94, 39); Wabash County (Ulrey 24, '93, 107); Decatur County (Shannon).

This species lives in clear streams, preferably those with cool waters. It is frequently found in streams issuing from caves, and even at some distance within the caves, where it can receive no light. It is in such localities that the largest and finest specimens have been obtained. In streams it lurks under stones, where it may conceal itself and be on the lookout for its prey. The eggs are laid, according to Professor S. H. Gage (2, 992), during April. They are of a beautiful salmon color, and are attached in masses to the under side of stones in water from five to twenty inches deep. They are cared for by one of the parents, which will return after being frightened away. The eggs are said to hatch in July. The eggs are cemented firmly to one another. Those on the outside of the masses hatch first. Another writer, J. Percy Moore (Science, 1893, p 319), says that the eggs are laid in masses of from one hundred and twenty to five hundred. They cohere firmly, but there are open spaces between them, allowing the circulation of water and the escape of those young from the interior eggs, which this observer says may hatch first. From his account, the eggs must hatch during the month of May. He states that it is the male fish which guards the eggs.

Forbes (14, No. 6, 68) found that his specimens had eaten only animal food, one-fourth of it consisting of fishes; larvæ of aquatic insects and isopod crustaceans constituted the rest.*

**COTTUS POLLICARIS* (J. and G.).

Uranidea pollicaris, Jordan and Gilbert, 1882, 8, 954.

Body heavy forwards. Depth in the length, about four and one-half. Head broad and depressed, the snout narrow. The opercular spines rather large and directed upward. No palatine teeth. Dorsal VII, 19; anal rays, 13; ventrals said to be I, 3. Olive, with splotches and spots of brown. Fins barred with dusky. Eyes small. Length four and one-half inches.

Lake Michigan; taken at Racine, Wisconsin. Not known from Indiana waters.

COTTUS HOYI Putnam.

Uranidea hoyi, Jordan and Gilbert, 1882, 8, 699.

Form slender. Head narrow and pointed, convex above. Eyes not so much directed upward as in the other species; the interorbital space narrow, seven or eight in the length of the head. Jaws about equal. Opercular spine slender, directed backward; smaller one below it. No palatine teeth. Dorsal rays VI, 15; anal rays 11. Color olivaceous, barred and speckled with darker. Length about two inches. Upper surface of the male prickly.

Lake Michigan, in deep water off Racine and Milwaukee. Has not yet been taken in Indiana waters. Dr. Jordan states (2, 968) that only two specimens of this species were known at the time of writing. Probably no others have since been taken. The female taken June 4, 1875, twelve miles off Racine, was so distended with eggs that the depth of the body was a third the length.

COTTUS SPILOTUS (Cope).

Uranidea spilota, Jordan and Gilbert, 1882, 8, 954, not of 694.

This species has been described from Grand Rapids, Michigan. It may be looked for in Northern Indiana. It is most closely related to *C. pollicaris*. The length of head is contained in the length of the fish three and one-third times. Depth in length five times. The eye is said to be larger than in *C. pollicaris*, four and one-half instead of five and one-third times. The preopercular spine is like that of the last mentioned species. The color is olive above, closely speckled with darker; the sides somewhat barred. Belly pale. Length about three inches.

Genus *TRIGLOPSIS* Girard.

Form of head and body rather slender. Slit behind the last gill evident. Gill-membranes not quite free from the isthmus and forming a broad fold across it. No palatine teeth. Preopercular spine straight.

TRIGLOPSIS THOMPSONI Girard.

Jordan and Gilbert, 1882, 8, 709.

Body elongated. Depth in the length six times. Head long, but of moderate width; contained in the length three and one-third times; its width in the length of the fish four and one-half to five and one-half times; flat or concave above; behind the eye turning down with an evident angle. Snout long, three and one-half in the head. Eye in head four. Mouth very large, the maxillary reaching back to the hinder border of the pupil. Opercle with four sharp and nearly straight spines; the uppermost directed backward, the others downward. Bones of the head cavernous. Dorsal rays VII, 18; anal rays 15. Skin smooth. Color olivaceous, with blotches of darker.

Lakes Michigan and Ontario, in deep water.

Specimens of this fish have been secured by opening the stomachs of the ling (*Lota lota*), and are always more or less digested.

Family GADIDÆ.

THE COD-FISHES.

This family differs from all the other Acanthopteri described in this work in having the fins without spines. The dorsal is long and is often divided into two or three portions. The anal is also long and may be divided. The ventrals are jugular in position. The scales are small and cycloid.

A large family, most of whose members are confined to the seas of the Northern Hemisphere. Represented in our waters by a single species.

Genus LOTA Cuvier.

Body elongated, low, somewhat compressed behind. Covered with small, imbedded scales, which extend up on the vertical fins. Head depressed: Chin and each anterior nostril with a barbel. Teeth on the vomer, but none on the palatines. Dorsal fins two, the first short. Anal single

LOTA MACULOSA (LeS.).

Burbot; Ling.

Jordan and Gilbert, 1882, 3, 802; T. H. Bean, 1888, 12, 235; pl. 61; Smith, 1892, 4, 215, pl. 50; *Lota lota*, Jordan, 1888, 7, 162.

Body long and slender, compressed behind, low in front. Depth in the length about six times. Head small, rather flattened and broad; contained in the length about four and one-half to five times. Mouth large, the maxillary reaching to the posterior border of the orbit. Eye small. Scales very small and imbedded. Pectoral fins broad, nearly twice the length of the head. Ventrals reaching half-way to the vent, composed of about six rays. Dorsal rays 13-76; anal rays 68. Caudal rounded. Color dark olive, with mottlings of blackish, the latter more distinct in the younger specimens. The lower surface dusky or yellowish. Length about two feet.

Artic seas southward in diminishing numbers to the Ohio River. It is probably moderately common in Lake Michigan. Ohio River (Jordan, 10, '74, 226); New Albany (Jordan, 2, 996).

Forbes (14, Vol. II, 433) states that the Ling has made its way from Lake Michigan into the Illinois and Mississippi rivers since the opening of the canals between the lake and the rivers. It is said to feed on various small fishes and crustaceans which frequent the bottoms. It is extremely voracious and has wonderfully distensible stomach. It captures such active fishes as the pike and the perch. The most commonly taken fish is the yellow perch. It is said also to swallow stones at times. Milner (11, '72-3) says that this fish is sometimes found at a depth

of eighty fathoms, but occurs at all depths above this. As an article of food the Ling does not rank very high. Dr. Jordan (2, 996) says that the flesh is fairly good, although rather tough and destitute of richness. He regards it as ranking with that of the cat-fishes, and decidedly better than that of the suckers. Smith (*loc. cit.*) quotes a writer who has experimented with the ling and finds that when salted and dried, it develops the smell of the salt-water cod-fish. This writer believes that if properly treated the ling might be made a valuable source of food. The breeding season seems to be during the winter months. The eggs, which are very numerous, are deposited loose at the bottom of the water.

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