

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 vertebrae. 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 *Petromyzontidae*:

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 AMMOCEITES 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 denticated, 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 *jugal*. 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. CHONDROSTEI.

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. HOLOSTEI.

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 *Lepisosteidae*.

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 osified. 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 *Scomberesocidae*; 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 vertebrae 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 (*Amblyopsidae*). 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 La-porte 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, 8, 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 algæ. 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.

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, 8, 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, v-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; *Carpionodes 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.

Carpion 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, *Carpionides selene*); Logansport (4, '94, 36); Wabash County (24, '93, 82).

ICTIOBUS DIFFORMIS Cope.

Jordan and Gilbert, 1882, 8, 883; *Carpionides 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.
Hybopsis, 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 (2, 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).

Chiola 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 Winamac, 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.).

Chiola 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. PHENACOBUS 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) (*Chiola 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 vertebrae; 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).

Ceraticthys 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.*

Ceraticthys 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 OPSOPŒODUS 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.

OPSOPŒODUS EMILŒ 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 *Trychèrodon 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 CRYSOLEUCUS (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 preopercle 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. *Hiodontidae*, p. 223.
 - bb. No lateral line; teeth feeble or wanting. *Clupeidae*, p. 225.
 - aa. An adipose fin present. *Salmonidae*, p. 227.
- AA. Lateral margin of the upper jaw formed by the premaxillaries. *Percopsidae*, 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, 8, 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 precoracoid 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 PATRUELI (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, 8, 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 preopercle 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 oesophagus 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.

Percosoces, 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. *Scienidae*, 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, 6-48-14. 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.
eurycorus, 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.

LEPOMIS 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-barred. 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*). *histrion*, 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, 8, 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, 8, 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. *ouachite*, p. 274.
- cc. Cheeks and opercles scaled.
Scales of lateral line fifty-five; dorsal rays XII, 13. *ouachite*, 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. *jessie*, 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. *flabellare*, 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. *jessie*, 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. pettatum*, a species found east of the Alleghany Mountains. *E. ouachita* 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.

Alvordius 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.

Alvordius macrocephalus, Jordan and Gilbert, 1882, 8, 501.

This species has been taken in Western Pennsylvania and may be looked for in southeastern 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.

Alvordius 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 SCIURUM (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 NIANGUE 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-barred. 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 caddis worms.

ETHEOSTOMA JESSIE Jordan and Brayton.

Poecilichthys 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).

Poecilichthys 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 Linnaeus.

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 Mitchell.

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.

Rocceus 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 *Rocceus 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 *Rocceus 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.

Haplodonotus 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.

BIBLIOGRAPHY.

For the following list of scientific works and papers, dealing more or less extensively with the ichthyo-fauna of Indiana, I am indebted to Dr. B. W. Evermann, of the United States Fish Commission. It is, I believe, Dr. Evermann's intention to publish elsewhere a paper in which he can give in greater detail the titles and the scope, so far as concerns Indiana fishes, of all writings which concern this subject.

1820. Rafinesque, S. C. *Ichthyologia Ohiensis*; Western Review and Miscellaneous Magazine. Lexington, Ky.
- 1828-49. Cuvier and Valenciennes. *Histoire Naturelle des Poissons*. Paris.
1865. Duméril, Aug. *Histoire Naturelle des Poissons*. Paris.
1869. Cope, E. D. Synopsis of the Cyprinidæ of Pennsylvania. Transactions Amer. Phil. Soc., 1869, Article XIII.
1875. Jordan, D. S. The Sisco of Lake Tippecanoe. Amer. Naturalist, 1875, IX, pp. 135-138.
1875. Jordan, D. S. The Sisco of Lake Tippecanoe and its Relations. Report of State Geologist of Indiana for 1874, pp. 187-196; reprint pp. 1-10.
1875. Jordan, D. S. Synopsis of the Genera of Fishes to be looked for in Indiana. Report of State Geologist of Indiana for 1874, pp. 197-228; reprint pp. 11-42.
1876. Nelson, E. W. A Partial Catalogue of the Fishes of Illinois. Bulletin Ill. Lab. Nat. Hist., Vol. I, No. 1, pp. 33-52.
1876. Jordan, D. S. On the Distribution of the Fresh-water Fishes of the United States. Annals N. Y. Acad. Sci., Vol. I, No. 4.
1877. Jordan, D. S. On the Fishes of Northern Indiana. Proc. Acad. Nat. Sci., Philadelphia, 1877; pp. 42-104.
1877. Jordan, D. S. Review of Rafinesque's Memoirs on N. A. Fishes. Bulletin U. S. Nat. Mus. No. 9.

1877. Jordan, D. S. A partial Synopsis of the Fishes of Upper Georgia. *Annals of N. Y. Lyceum Nat. Hist.*, Vol. XI, pp. 307-377. Contains a list of fishes taken at Indianapolis.
1877. Jordan, D. S. Contributions to N. A. Ichthyology, No. 2. *Bulletin U. S. Nat. Mus.* No. 10.
1878. Jordan. A Catalogue of the Fishes of Illinois. *Bulletin Ill. Lab. Nat. Hist.*, Vol. I, No. 2, pp. 37-70, 188.
1882. Jordan, D. S. Report on the Fishes of Ohio. *Geological Survey of Ohio*, Vol. IV, pp. 735-1002.
1883. Swain, Joseph. A Description of a New Species of *Hadropterus* (*Hadropterus scierus*) from Southern Indiana. *Proc. U. S. Nat. Mus.*, p. 252.
1883. Forbes, S. A. The Food of the Smaller Fresh-water Fishes. *Bulletin Ill. Lab. Nat. Hist.*, Vol. I, No. 6, pp. 65-94.
1884. Gilbert, Chas. A. A List of Fishes Collected in the East Fork of White River, Indiana, with Descriptions of Two New Species. *Proc. U. S. Nat. Mus.*, pp. 199-205.
1884. Gilbert, Chas. A. Notes on the Fishes of Switz City Swamp, Indiana. *Proc. U. S. Nat. Mus.*, pp. 206-210.
1885. Forbes, S. A. Descriptions of New Illinois Fishes. *Bulletin Ill. Lab. Nat. Hist.*, Vol. II, pp. 135-139.
1886. Eigenmann, C. H., and Fordice, M. W. A Catalogue of the Fishes of Bean Blossom Creek, Monroe County, Indiana. *Proc. Acad. Nat. Sciences, Philadelphia*, 410-411.
1886. Jordan, D. S., and Evermann, B. W. The Food-Fishes of Indiana. *Thirty-sixth Annual Report of the Indiana State Board of Agriculture*, Vol. XXVIII, pp. 156-173.
1887. Shannon, W. P. A List of the Fishes of Decatur County, Indiana. Printed privately. Greensburg, Indiana.
1888. Forbes, S. A. On the Food Relations of Freshwater Fishes; a Summary and Discussion. *Bulletin Ill. Lab. Nat. Hist.*, Vol. II, pp. 475-538.
1888. Forbes, S. A. Studies of the Food of Freshwater Fishes. *Bulletin Ill. Lab. Nat. Hist.*, Vol. II, pp. 433-473.
1888. Evermann, B. W., and Jenkins, O. P. Notes on Indiana Fishes. *Proc. U. S. Nat. Mus.*, pp. 43-57.
1889. Jenkins, O. P. List of Fishes Collected in Vigo County, Indiana. *The Hoosier Naturalist*, Vol. II, pp. 93-96.
1889. Jordan, D. S. Report of Explorations made during 1888 in the Alleghany Region of Virginia, North Carolina and Tennessee and in Western Indiana, with an account of the Fishes found in each of the River Basins of those Regions. *Bulletin U. S. Fish Commission* Vol. XIII, pp. 97-173.

1890. Jordan, D. S., and Evermann, B. W. Description of a New Species of Fish from Tippecanoe River, Indiana. Proc. U. S. Nat. Mus., p. 304 (*Etheostoma tippecanoe*).
1894. Kirsch, Philip H. Report Upon Explorations made in Eel River Basin in the Northeastern Part of Indiana in the Summer of 1892. Bulletin U. S. Fish Commission for 1894, pp. 31-41.
1894. Eigenmann, C. H., and Beeson, C. H. The Fishes of Indiana. Proceedings of the Indiana Academy of Science, III, pp. 76-108. This paper is preceded by a bibliography of Indiana fishes.

LIST OF PUBLICATIONS REFERRED TO BY ARABIC NUMERALS IN THIS PAPER.

1. Proceedings of the Academy of Natural Sciences of Philadelphia.
2. Report on the Fishes of Ohio, by Dr. D. S. Jordan. Volume IV of Ohio Geological Survey, 1882.
3. Histoire Naturelle des Poissons, by Aug. Duméril. Paris, 1865-69.
4. Bulletins of the United States Fish Commission.
5. Journal of the Cincinnati Society of Natural History.
6. Proceedings of the American Philosophical Society.
7. Jordan's Manual of Vertebrates. Edition 5, 1888.
8. Synopsis of the Fishes of North America. Jordan and Gilbert, 1882.
9. Bulletins of the United States National Museum.
10. Geological Survey of Indiana.
11. Annual Reports of the United States Fish Commission.
12. Fisheries Industries of the United States. Washington, D. C.
13. Annals of the New York Academy of Science.
14. Bulletins of the Illinois Laboratory of Natural History.
15. Fishes of Lorain County, Ohio, by L. H. McCormick, 1892.
16. List of Fishes Collected in Vigo County, by Dr. O. P. Jenkins. Published in the "Hoosier Naturalist," Valparaiso, Ind., Vol. II, pp. 93-96, 1889.
17. Cuvier and Valenciennes' "Histoire Naturelle des Poissons." Paris, 1828 to 1849.
18. Cyprinidae of Pennsylvania. E. D. Cope, in Trans. of Amer. Phil. Society, 1869.
23. Proceedings of the National Museum, Washington, D. C.
24. Proceedings of the Indiana Academy of Science.
25. Fishes of Pennsylvania. T. H. B. 1882.