2.—REPORT OF EXPLORATIONS MADE DURING THE SUMMER AND AUTUMN OF 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.

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INTRODUCTION.

Under the instructions of the U. S. Commissioner of Fish and Fisheries, Hon. Marshall McDonald, the writer undertook to make a series of examinations of the different streams of the Alleghany region of Virginia, North Carolina, and Tennessee, and the streams of western Indiana. This examination had two general purposes: first, to ascertain the general character of the streams in question, their present stock of food-fishes and their suitability for the introduction of species not now found there; second, to catalogue the fishes native to each stream, whether food-fishes or not, in order to complete our knowledge of the geographical distribution of each species, and to throw light on the laws which govern geographical distribution.

In the present paper is given an account of each stream, a list of the fishes found in it, and such notes, zoölogical or economic, on each species as add to our knowledge of it.

In the work of the summer the writer had the very efficient help of his former students, Prof. Oliver P. Jenkins, of De Pauw University, Greencastle, Ind.; Prof. Barton W. Evermann, of the State Normal School, Terre Haute, Ind.; Prof. Seth E. Meek, of Coe College, Cedar Rapids, Iowa; and Mr. Charles H. Bollman, museum assistant in the Indiana University. The prosecution of the work was also materially aided by the help given by Mr. Richard Rathbun, assistant in charge of the work of scientific inquiry in the U. S. Fish Commission.

The discovery of new species of fishes, which amounted to fourteen in number, was a secondary feature of the work of the summer. These, with the permission of the Commissioner, I have described in a preliminary paper[1] in the Proceedings of the U. S. National Museum. The new species are as follows:

1. **Noturus gilberti** Jordan & Evermann. Roanoke River at Salem and Roanoke.
2. **Noturus furiosus** Jordan & Meek. Neuse River at Millburnie; Tar River at Rocky Mount.
3. **Moxostoma rupiscartes** Jordan & Jenkins. Catawba River at Marion and Morganton; Buck's Creek at Pleasant Garden; Pacollet River near Spartanburgh, S. C., etc.

[1] Description of fourteen species of fresh-water fishes collected by the U. S. Fish Commission in the summer of 1888. Proceedings U. S. Nat. Mus., 1888, p. 351.

4. **Notropis macdonaldi** Jordan & Jenkins. Shenandoah River at Waynesborough; North River at Loch Laird; Buffalo Creek near Lexington.

5. **Notropis kanawha** Jordan & Jenkins. Reed Creek near Wytheville.

6. **Hybopsis watauga** Jordan & Evermann. North Fork of Holston at Saltville; Watauga River at Elizabethtown, Tenn.

7. **Chologaster avitus** Jordan & Jenkins. Dismal Swamp outlet near Suffolk, Va.

8. **Fundulus rathbuni** Jordan & Meek. Allemance Creek; Reedy Fork of Haw River; Buffalo Creek near Greensborough, N. C.; South River near Salisbury, N. C.

9. **Etheostoma rex** Jordan & Evermann. Roanoke River at Roanoke, Va.

10. **Etheostoma roanoka** Jordan & Jenkins. Roanoke River at Salem, Roanoke, and Alleghany Springs; Neuse River at Millburnie; Tar River at Rocky Mount.

11. **Etheostoma podostemone** Jordan & Jenkins. Roanoke River at Salem and Roanoke; Mason's Creek at Salem; Bottom Creek at Alleghany Springs.

12. **Etheostoma swannanoa** Jordan & Evermann. South Fork of Swannanoa River at Black Mountain, N. C.; Middle Fork of Holston at Marion; South Fork of Holston at Holstein Mills.

13. **Etheostoma verecundum** Jordan & Evermann. Middle Fork of Holston at Glade Spring.

14. **Etheostoma.** *Species nova.* Tippecanoe River at Marshland, Ind.

The streams examined may be grouped as follows:

A.—Potomac River:
1. East Fork of Shenandoah River, Luray, Va.
2. Hawksbill Creek, Luray, Va.
3. East Fork of Shenandoah River, Waynesborough, Va.

B.—James River:
1. James River at Lick Run, Va.
2. Elk Creek near Natural Bridge, Va.
3. Cedar Creek at Natural Bridge, Va.
4. Buffalo Creek near Lexington, Va.
5. North River at Loch Laird, Va.
6. Swift Creek near Petersburgh, Va.

C.—Dismal Swamp (Elizabeth River):
1. Jericho Canal (outlet to Lake Drummond), Suffolk, Va.
2. Shingle Creek near Suffolk, Va.
3. Spring Creek, Suffolk, Va.
4. Canal feeder, Wallaceton, Va.
5. Dover farm (ditch), Wallaceton, Va.

D.—Chowan River:
1. Blackwater River, Zuni, Va.

E.—Roanoke River:
1. Bottom Creek near Alleghany Spring, Va.
2. Roanoke (Staunton) River at Roanoke and at Salem, Va.
3. Mason's Creek near Salem, Va.
4. Back Creek at Poage's Mill, Va.

F.—Pamlico River:
1. Tar River at Rocky Mount, N. C.

G.—Neuse River:
1. Neuse River at Millburnie, near Raleigh, N. C.
2. Little River at Goldsborough, N. C.
3. Moccasin Swamp near Goldsborough, N. C.

H.—Cape Fear River:
1. Reedy Fork of Haw River at Fulk's Mill.
2. Spring Branch.
3. South Buffalo Creek near Greensborough, N. C.
4. Little Allemance Creek near Greensborough, N. C.

I.—Great Pedee River:
1. Little Yadkin River, or South River, at South River Post-office, near Salisbury, N. C.
2. Second Creek near Salisbury, N. C.
3. Jumping Run near Salisbury, N. C.

J.—Santee River:
1. Catawba River at Marion, N. C.
2. Buck's Creek at Pleasant Garden, N. C.
3. John's River near Morganton, N. C.
4. Catawba River at Morganton, N. C.
5. Pacollet River at Clifton, near Spartanburgh, S. C.
6. Tiger River near Spartanburgh, S. C.
7. Forest Creek near Spartanburgh, S. C.

K.—Kanawha River:
1. Peak Creek, Pulaski, Va.
2. Little Peak Creek, Pulaski, Va.
3. Reed Creek, Wytheville, Va.
4. Hatchery Stream, Wytheville, Va.

L.—Holston River:
1. South Fork, Holstein Mills, Va.
2. Middle Fork, Marion, Va.
3. Middle Fork, Glade Spring, Va.
4. North Fork, Saltville, Va.
5. Beaver Creek, Bristol, Tenn.
6. Watauga River, Elizabethtown, Tenn.
7. Doe River, Elizabethtown, Tenn.

M.—French Broad River:
1. French Broad River near Asheville, N. C.
2. French Broad River at Hot Springs, N. C.
3. Spring Creek at Hot Springs, N. C.
4. North Fork Swannanoa River near Black Mountain, N. C.
5. South Fork Swannanoa River, Black Mountain, N. C.
6. Swannanoa River near Asheville, N. C.

N.—St. Joseph's River:
1. At Mishawaka, Ind.

O.—Illinois Basin (Kankakee River), Yellow River:
1. At Plymouth, Ind.

P.—Upper Wabash River:
1. Blue River, Columbia City, Ind.
2. Eel River at Logansport, Ind.
3. Lake Maxinkuckee, Indiana.
4. Tippecanoe River, Marshland, Ind.
5. Deer Creek, Camden, Ind.

Q.—Lower Wabash River:
1. Wabash River at Vincennes, Ind.
2. Wabash River at New Harmony, Ind.
3. Black River at New Harmony, Ind.
4. Gresham's Creek at New Harmony, Ind.
5. Patoka River, Patoka, Ind.

Q.—Lower Wabash River—Continued.
6. Big Creek, Lynn Township, Posey County, Ind.
7. Wabash River at Mackey's Ferry, Ind.

R.—Lower Ohio River:
1. Big Pigeon Creek, Evansville, Ind.
2. Cypress Swamp, Mount Vernon, Ind.

S.—White River:
1. White River (West Fork), Spencer, Ind.
2. Eel River, Cataract, Ind.

The following is, in brief, the itinerary of the summer's work:

July 24.—Left Washington, in company with Prof. O. P. Jenkins, for Luray, Va.
July 25, 26.—At work about Luray.
July 27.—At Waynesborough and Loch Laird; joined at Lexington by Prof. B. W. Evermann.
July 28.—At Lexington; drove to Buffalo Creek.
July 29, 30.—At Natural Bridge; drove to Elk Creek.
July 31.—Roanoke.
August 1.—At Salem; drove to Poage's Mill.
August 2.—At Salem.
August 3.—At Alleghany Springs; drove to Bottom Creek.
August 4, 5.—At Pulaski.
August 6.—At Wytheville.
August 7.—At Marion; drove to Holstein Mills.
August 8.—At Glade Spring, Va.
August 9.—Drove to Saltville, Va.
August 10.—At Bristol; drove to Beaver Creek, N. C.
August 11, 12.—At Johnson City; drove to Elizabethtown, N. C.
August 13, 14.—At Hot Springs, N. C. Prof. Seth E. Meek takes the place of Professor Evermann, who is compelled to return home.
August 15, 16.—At Asheville, N. C.; drove to Long Shoals and Swannanoa River.
August 17, 18.—At Spartanburgh, S. C.; drove to Clifton and to Tiger River.
August 19, 20, 21.—At Black Mountain; drove to North Fork.
August 22.—At Marion, N. C.; drove to Pleasant Garden.
August 23.—At Morganton; drove to John's River.
August 24.—At Salisbury; drove to South River.
August 25, 26.—At Greensborough; drove to Reedy Fork and Allemance Creek.
August 27.—Was compelled to return home, leaving Professors Jenkins and Meek to complete the work. Jenkins and Meek go to Raleigh and drive to Millburnie.
August 28.—At Goldsborough, N. C.
August 29.—At Rocky Mount, N. C.
August 31, *September* 1.—At Suffolk, Va.
September 2, 3.—At Wallaceton, Va.
September 4, 5.—At Norfolk, Va. (Marine collections.)
September 6.—At Zuni, Va.
September 7.—At Petersburgh, Va.
September 8.—At Clifton Forge, Va. At this time, floods on the James and Kanawha Rivers made the completion of the work impossible, and Professors Jenkins and Meek returned home.
September 7.—Professor Evermann and Mr. Bollman began work in Indiana, at Spencer and Cataract, Ind.
September 10.—At Evansville and Mount Vernon, Ind.
September 11.—At Mackey's Ferry, Ind.
September 12, 13.—At New Harmony, Ind.
September 14.—At Patoka, Ind,
September 15.—At Vincennes, Ind.
September 16.—Mr. Bollman returned home, giving place to Mr. Albert J. Woolman, a student of Professor Evermann.

September 17.—At Mishawaka, Ind.
September 18.—At Plymouth, Ind.
September 19.—Lake Maxinkuckee.
September 20.—At Marshland, Ind.
September 21.—At Logansport, Ind.
September 22.—At Camden, Ind.

Here cold weather caused the relinquishment of the work for the present season. On November 5 a small collection was made by Mr. W. E. Clapham in Blue River, Columbia City, Ind., and by him turned over to the U. S. Fish Commission.

A.—THE POTOMAC RIVER.

The Shenandoah River is one of the chief tributaries of the Potomac, into which it flows from the southwest at Harper's Ferry. The Shenandoah is a comparatively clear, swift stream, having its rise in cold springs. It flows between two parallel ranges of mountains, chiefly over limestone rocks. In dry weather the waters of the Shenandoah are decidedly bluish in hue, like those of most limestone streams, but after rains they are stained with the red color of the soil.

Collections were made at three points in the Shenandoah Valley, as follows:

1. *Shenandoah River* (*East Fork*) at the ford and ferry, 5 miles west-northwest of Luray Village.—At this point, below the mill-dam, the stream is rather broad and shallow, with considerable current. The bottom is covered with loose rocks and pebbles, with occasional outcrops of rocks in place. In some quiet spots the bottom is rather muddy, and there are numerous water weeds. This is a good locality for seining, but fishes are somewhat scarce, and not many kinds were found. The temperature July 26 was 78° Fahr.[1]

2. *Hawksbill Creek* from Luray to a point about one-half mile below the town.—A rather swift, shallow stream, 8 or 10 feet in width, the bottom very stony, and slimy in the quiet places. The water is warm and far from clear, being stained yellow by clay. Temperature July 25 was 80° Fahr.

3. *Shenandoah River* (*East Fork*) at Waynesborough, Va.—At this point, near its source, the river is clear, flowing over a rocky or gravelly bottom. The water is cold, most of it coming from a few large springs, some of them near Waynesborough, all within 4 or 5 miles of the town. The temperature July 27 was 69° Fahr.

In the following list of species those found in the Shenandoah River near Luray are marked S, those in Hawksbill Creek H, and those at Waynesborough W.

1. Ameiurus nebulosus (Le Sueur). S., H.

Small specimens common in mud and weeds. A. 21.

2. Noturus insignis (Richardson). "*Mad-Tom.*" S., H.

Rather common among weeds. Well known to the negroes here, as elsewhere in Virginia, by the appropriate name of Mad-Tom. Color, light yellowish brown; the dorsal, anal, caudal, and pectorals edged with black in the adult.

3. Anguilla anguilla (L.). "*Eel.*" H.

Frequently taken.

4. Catostomus teres (Mitchill). S., H., W.

Very common in sluggish waters.

[1] All of the temperatures mentioned in this report relate to the water in the streams.

5. Catostomus nigricans (Le Sueur). S., H, W.

Equally common, but in swift waters.

6. Hybognathus nuchalis Agassiz. W.

Three rather small specimens. Compared with examples from Parke County, Indiana, these are a little less elongate and darker in color, with a plumbeous lateral band, and back and sides thickly punctate.

7. Notropis megalops (Rafinesque). H., W.

Common only at Waynesborough.

8. Notropis macdonaldi, Jordan & Jenkins. W. (Jordan & Jenkins, Proc. U. S. Nat. Mus., 1888, p. 354).

Five specimens. The types of this interesting new species were obtained in the cold waters at Waynesborough.

9. Notropis analostanus (Girard). S., H., W.

Common. Compared with specimens of the western species or variety, *N. whipplei* from White River, Indiana, the Virginia examples are less elongate (depth of adult male $3\frac{1}{2}$ in length instead of 4) and the scales are larger (lat. l. 34 or 35 instead of 38 to 40). These characters, already noticed by Professor Cope, seem to be reasonably constant. For the present, therefore, I retain *N. analostanus* as a species distinct from *N. whipplei*.

10. Notropis amœnus (Abbott). S., W.

Common, especially at Luray. This species is closely related to *N. rubrifrons*, but deeper in body, more compressed, and with notably smaller scales before the dorsal. These specimens vary a good deal among themselves, those from the river at Luray being larger, much paler in color, and with decidedly larger eye as compared with those from Waynesborough. The latter resemble *N. rubrifrons* more closely than the former, but all probably belong to the same species.

The largest specimens approach in form the rather poor figure given by Abbott of his *Alburnellus amœnus*,[1] and they are probably specifically identical with the latter, as Abbott's description agrees in all essential respects. Head, 4; depth, $5\frac{1}{3}$ ($4\frac{3}{4}$ to $5\frac{1}{2}$). D. 8, A. 10. Scales, 6–39–3. Length (Luray), $3\frac{3}{6}$-inches. Body elongate, compressed, the form varying somewhat. Head sub-conic, more or less compressed; eye large, rather longer than snout, about $3\frac{1}{3}$ in head, its size largest in Luray specimens. Mouth large, oblique, the maxillary reaching to just past front of eye, the jaws about equal when the mouth is closed. Scales of back smaller than in related species, there being 22 to 25 (rarely 18 to 20) rows between the occiput and the dorsal fin. Lateral line much decurved. Dorsal fin inserted behind ventrals, rather high, and rather large, its free edge concave; pectorals moderate, scarcely reaching ventrals, which extend to vent. Color translucent green; sides silvery, in some specimens a faint plumbeous band ending in an obscure plumbeous spot. Some specimens with dark points along lateral line. Fins plain.

This species is abundant in the river channels, both at Luray and at Waynesborough. Numerous specimens were taken. Specimens from the Potomac similar to these have been formerly identified by me as *Notropis photogenis* (Cope). It may be

[1] Abbott's Amer. Nat. VIII, p. 334. Delaware and Raritan Rivers.

that this identification is correct, but as yet I have not found a genuine *photogenis* in Atlantic waters.

11. Notropis procne (Cope). S.

Rather common in the river. These specimens agree very well with Professor Cope's description of *Hybopsis longiceps*, except in the form of the preorbital bone, which is but little longer than deep. Compared with *N. microstomus* (Rafinesque)=(*N. deliciosus stramineus*) from White River, Indiana, *N. longiceps* differs chiefly in the higher fins, more elevated back, slenderer tail, and more rapidly ascending profile. The scales are a little larger in *N. longiceps* (lat. l. 34), and the dark punctulations along side and at base of caudal are more conspicuous. There is a striking difference in the height of the dorsal fin, its longest ray being about as long as head in *N. longiceps* adult, and about three-fourths head in *N. microstomus* of the same size. The lateral line is also less decurved in *N. longiceps* than in the other.

I have no specimens of *Notropis procne* for comparison. My specimens agree with Cope's description of the latter and with my own notes on it. I therefore regard *longiceps* as a synonym of *procne*.

I may here note that *Hemitremia vittata* Cope, from the Holston, seems to be the same as *Phoxinus flammeus* Jordan and Gilbert. The teeth are described by Cope as 4–5 instead of 2, 4–5, 2, but in other respects Cope's description agrees with our specimens. The species may stand as *Phoxinus vittatus*.

12. Phoxinus margaritus (Cope). S.

A single specimen. Head, 4 in length; depth, 4¼; A. I 9 (not I 8); dorsal low; scales, 58; lateral line incomplete, the pores mostly ceasing not far behind middle of body; body dusted with black specks; a narrow lateral streak of plumbeous on caudal peduncles.

13. Hybopsis kentuckiensis (Rafinesque). S.

Common in the river.

14. Semotilus bullaris (Rafinesque). S.

One small specimen.

15. Semotilus atromaculatus (Mitchill). H., W.

Scarce. Lat. l. 53 to 60.

16. Rhinichthys atronasus (Mitchill). S., H., W.

Very common in brooks and springs, scarce in the river. Lat. l. 63. A black lateral band, with yellow or orange below it. Scales of back more or less mottled.

17. Rhinichthys cataractæ (Cuv. & Val.). S., H., W.

Very common. Lat. l. 62; snout much projecting; insertion of dorsal midway between anterior nostril and base of caudal.

18. Exoglossum maxillingua (Le Sueur). "*Nigger-Dick.*" S., H., W.

Very common in the river. Lat. l. 52.

19. Fundulus diaphanus (Le Sueur). S.

Two large specimens from the river. Lat. l. 44. Body in one specimen with about 15 silvery cross-bands, most of them narrower than the dark interspaces; back and fins unspotted. The second specimen has about 11 very narrow dark cross-bars,

not one-third the width of the interspaces, which are of the color of the body; back with some dark spots.

20. Micropterus dolomieu (Lacépède). S., W. Seen also at Harper's Ferry.

Common. The black bass is not a native of this river, but was introduced from the Ohio into the Potomac some thirty[1] years ago.

It is evident that the species finds congenial surroundings in the Shenandoah.

21. Lepomis auritus (L.). S., H., W.

Common, especially in deep eddies and below logs. Scales on the cheek small, in 7 or 8 rows; scales on breast small. These correspond to the typical variety *auritus* in McKay's arrangement. (See Jordan and Gilbert, Synopsis, p. 477.)

22. Lepomis gibbosus (L.). W.

One large specimen taken at Waynesborough.

23. Etheostoma flabellare (Rafinesque). S., H., W.

Very abundant. These specimens are similar in color to others from Indiana and from Cayuga Lake, New York. The only difference noticeable is that the pectoral fins of the male are faintly barred in Virginia specimens, not in the others. The body in the Virginia specimens is on the average a trifle deeper, and the tubes of the lateral line are developed slightly farther on the average than in western specimens, but these differences do not justify separate names.

24. Etheostoma nigrum (Rafinesque). Var. *effulgens* Girard. S., H.

Very common, especially in shallow water among weeds; not found in the colder waters at Waynesborough.

These specimens seem to correspond to the *Arlina effulgens* of Girard, described from a tributary of the Potomac. The coloration is that usual in this species and the dark bar below eye is very well marked. The males have the dorsals extremely high, the membranes largely black, the rays spotted with white; seven dark cross-blotches on back; eight faint dark marks on side; a small spot at base of caudal. D. IX–13, A. 1, 9. Scales 43, 43, 44, 47, 49, in five specimens. Length of largest, $3\frac{2}{5}$ inches. Opercles scaly; cheeks, nape, and breast naked; usually one or two scales on cheek behind eye.

An extended comparison of specimens of "*Boleosoma*" from various parts of the country has convinced me that *olmstedi*, *effulgens*, *atromaculatum*, *vexillare*, and *maculaticeps* must all be regarded as forms, or at the most, subspecies under *Etheostoma nigrum*. Individual variations are numerous and perplexing and in large series; intergradations of all sorts appear.

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[1] Common report at Luray places the introduction of the black bass at about 1876. This date, however, is certainly incorrect, for Professor Cope says in 1869 (Journ. Ac. Nat. Sci. Phila., 1869, p. 217): "It appears from statements made to me by J. Delaplaine, of Wheeling, and Prof. J. B. Davis, of Roanoke College, Virginia, that the *Micropterus* [*dolomieu*] was introduced from sixteen to twenty years ago into the headwaters of the Potomac from the Ohio, and that they have greatly increased since that time. They are now said to be very abundant in the Shenandoah. By subsequent reference to the Smithsonian Report for 1854 (p. 290), I find that this fact has been recorded there by Mr. John Eoff, of Wheeling, who states that this transfer, which has been so successful in its results, was made by Mr. William Schriver, of the same place."

Comparing specimens of *E. nigrum* from Raccoon Creek, Parke County, Ind., with the Luray fishes, I note that the western *E. nigrum* is a slenderer fish, with the dark spots smaller; the black bar below eye almost obsolete, the snout longer and less blunt, a little longer than eye in Indiana specimens, a little shorter in those from Luray. Mouth in *E. nigrum* a little larger and less oblique. Scales 48 to 50 in *E. nigrum*, the cheek always naked. D. IX, 12. *Boleosoma maculatum* Agassiz and *B. brevipinne* Cope are identical with *B. nigrum*.

25. Cottus bairdi Girard. H. W.

Common about springs; very abundant at Waynesborough. Our specimens correspond to var. *carolinæ*, Gill. It seems to me that the name *Cottus* should be retained for this group, rather than for the marine forms.

The original application of the word *Cottus* was to the *Miller's Thumb* of Europe, *Cottus gobio* L. The genus *Cottus* of Linnæus, however, included the marine sculpins as well as the *Miller's Thumb*. Six species are placed in *Cottus* by Linnæus in the tenth edition of the Systema Naturæ, *cataphractus*, *quadricornis*, *grunniens*, *scaber*, *scorpius*, and *gobio*. Of these species, the first, third, and fourth were early removed as types of other genera, and do not belong to the *Cottidæ* as now understood. The question at present relates only to *C. scorpius* and *C. gobio*, as to which should be considered the type of the genus *Cottus*.

The name *Cottus* is taken from Artedi, the author who first used the word in a properly generic sense. The species described by him form the bases of the Linnæan names, and were *gobio*, *quadricornis*, *scorpius*, and *cataphractus*. From the synonymy given by Artedi it appears that the name *Cottus* was adopted by him from Gaza and other early writers, all of whom used it only for the *Cottus gobio*. The word is followed back by Artedi to the *Βολτσς* of Aristotle, which he says is written *Κοιτδς* (*Κόττος*) in old manuscripts in the Vatican library. So far as ancient usage goes, the name *Cottus* would belong to *Cottus gobio*. But under our present rules ancient usage would count for nothing in determining the type of a modern genus. Each of the species called *Cottus* by Linnæus would have an equal right to be regarded as the type of the genus. We should therefore ascertain which species was so selected by later authors who have subdivided the genus *Cottus*.

About 1735, Steller discovered one of the species of this group, apparently the one since called *polyacanthocephalus* (Pallas) and *jaok* (Cuv. & Val.), a near relative of *C. scorpius*. The description left by Steller was published by Tilesius in 1811 (Mém. Acad. Petersb., 1811, IV, 273) under the name of "*Myoxocephalus stelleri*."

The word "*Stelleri*," as is evident from the usage of Tilesius elsewhere, is not intended as a specific name, but as the authority for the generic name *Myoxocephalus*. No specific name is given by Steller, who was a non-binominal writer, previous to Linnæus, and none is supplied by Tilesius. The name *Myoxocephalus* may therefore be disregarded.

The next authors concerned are Cuvier and Valenciennes (Hist. Nat. Poiss., IV, 1829, 142), who make this remark of the genus *Cottus*, restricted by them to the "Chabots" *gobio*, etc.), and the "Chaboisseaux" (*scorpius*, etc.): "Ce genre avait pour type primitif un petit acanthopterygien de nos rivières" (*i. e.*, *C. gobio* L.). This statement should apparently be regarded as a selection of *Cottus gobio* as the type of *Cottus* in the modern sense of the word "type."

In 1842 DeKay gave the generic name *Uranidea* to an American species (*quiescens=gracilis*), congeneric with *C. gobio*. Evidently DeKay was unacquainted with *C. gobio*, and regarded his *Uranidea* as a new type in the family.

In 1850 Girard, recalling that the type of *Cottus* of Gaza, Artedi, and Cuvier was *C. gobio*, proposed to separate the genus *Cottus* as then understood into smaller genera, retaining the name *Cottus* for the "Chabots" of Cuvier, and giving to the "Chaboisseaux" the new name of *Acanthocottus*.

Girard remarks: "Had the name of *Cottus* belonged to the marine species of the group, instead of being founded on the fresh-water *C. gobio*, the new name *Acanthocottus* would have been unnecessary. In that case we might have called the fresh-water species *Uranidea*, and the marine ones *Cottus*, with equal propriety, although the original idea of the genus *Uranidea* was a mistake of the author." (Girard, Mon. Cottoids, 1850, 9.)

In 1863 Putnam remarks:

"We do not see the necessity of the name *Acanthocottus*, proposed by Girard for the marine species of the old genus *Cottus*, when DeKay, many years before, by giving the name of *Uranidea* to one of our fresh-water species, recognized the two genera. It may be that DeKay did not have the *Cottus gobio* in view when he proposed the name of *Uranidea*, but his *U. quiescens* is the American representative of the *Cottus gobio* of Europe; and, therefore, as he was the first to distinguish the two genera included under the name of *Cottus*, his name should be retained for the fluviatile species, and that of *Cottus* for the marine, called by Girard *Acanthocottus*.

"If the principle adopted by Girard were followed it would involve the change of such a large number of generic names as to create the greatest confusion in nomenclature." (Bull. Mus. Comp. Zoöl., 1, 2, 1863.)

Later American writers have adopted these views of Putnam, while European authors, without exception, have left the two groups together under the name of *Cottus*. It seems to the writer most natural to regard the two groups as separate genera.

To decide which of these genera should be known as *Cottus*, we may now recapitulate the evidence.

(1) If we take ancient usage as our guide, the type of *Cottus* is *C. gobio*, and the *scorpius* group should stand as *Acanthocottus*, the earliest generic name applied by a binomial author.

(2) If we take the first definite and explicit assignment of a type to *Cottus* (Cuvier, 1829, or Girard, 1850), we have the same result.

In my opinion the view stated under (2) should be adopted, and *Cottus* should stand for *Cottus gobio*, and *Acanthocottus* for *C. scorpius* and its marine congeners.

The following is an outline of the synonymy of the two groups:

COTTUS (Artedi), Linnæus.

(Miller's Thumbs; Chabots.)

Cottus Gaza, Rondelet, and of the ancients.

<**Cottus** Artedi, Genera Piscium, etc., 1738.

<**Cottus** Linnæus, Systema Naturæ, 1758, 264 (including diverse elements besides *gobio*, *scorpius*, etc.).

Cottus Cuvier, Règne Animal, II, 1827 (restricted to the "Chabots" (*gobio*, etc.) and the "Chaboisseaux" (*scorpius*, etc.).

Cottus Cuvier & Valenciennes, Hist. Nat. Poiss., IV, 1829, 142 (*gobio*, mentioned as "type primitif").
Uranidea DeKay, N. Y. Fauna, Fishes, 1842, 61 (*quiescens=gracilis*).
Cottus Girard, Proc. Bost. Soc. Nat. Hist., 1850, III, 183, 303 (*gobio*).
Cottopsis Girard, Proc. Bost. Soc. Nat. Hist., III, 1850, 303 (*asper*).
Uranidea Putnam, Bull. Mus. Comp. Zool., I, 1863, 2 (*gracilis*), and of recent American writers.
Potamocottus Gill, Proc. Bost. Soc. Nat. Hist., VIII, 40, 1861 (*punctulatus*).
Tauridea Jordan & Rice, Jordan, Man. Vert. E. U. S., ed. 2, 1878, 255 (*ricei*).

ACANTHOCOTTUS, Girard.

(Sculpins; Chaboisseaux.)

<**Cottus** Artedi, Genera Piscium, etc., 1738.
<**Cottus** Linnæus, Systema Naturæ, 1758, 264 (in part).
Myoxocephalus Steller MSS, Tilesius, Mém. Acad. Petersb., 1811, IV, 273 (non-binomial; no specific name; description from *M. polyacanthocephalus*, Pallas).
<**Cottus** Cuvier, Règne Animal, II, 1827 (Chaboisseaux).
Acanthocottus Girard, Proc. Bost. Soc., III, 1850, 183, 303 (*variabilis, scorpius*, etc.).
Cottus Putnam, Bull. Mus. Comp. Zool., I, 1863, 2 (*scorpius*).
Boreocottus Gill, Proc. Acad. Nat. Sci. Phila., 1859, 166 (*axillaris*).
Porocottus Gill, Proc. Acad. Nat. Sci. Phila., 1859, 166 (*quadrifilis*).
Megalocottus Gill, Proc. Acad. Nat. Sci. Phila., 1861, 166 (*platycephalus*).
Oncocottus Gill, Proc. Nat. Sci. Phila., 1862, 13 (*quadricornis;* possibly a valid genus).

The oldest name possibly applicable to this species is *Cottus cognatus* of Richardson, based on specimens from Great Bear Lake. As our species is very abundant in Lake Superior, it is not unlikely that this *cognatus* is the same. Richardson's description agrees well with our Lake Superior specimens, but it is too brief to give certainty of identification. The *Cottus richardsoni* of Agassiz, from Lake Superior, seems to be not specifically different from specimens from Virginia, Kentucky, and Missouri. The name *richardsoni* should not be used, as the earlier *Trachidermis richardsoni* of Heckel is also a *Cottus* (=*Cottus asper*, Richardson). The oldest unquestionable name is apparently that of *Cottus bairdi* Girard.

For the present, then, the commonest American *Cottus*, the miller's thumb, blob, mull-head, bull-head, or muffle-jaws, may stand as *Cottus bairdi*.

Crayfishes were abundant at Waynesborough, but none were seen at Luray. The fish fauna of the Shenandoah, as a whole, does not seem to be a rich one, notwithstanding the favorable character of the waters. This fact accords with the view already stated by me (Science Sketches, p. 114), that connection with a large hydrographic basin is one of the chief elements in giving to a river a varied fish fauna. A large number of the species found in the Kanawha or the Holston would doubtless live and multiply in the Shenandoah if they could get there. Probably the channel cat (*Ictalurus punctatus*) could be as profitably and as successfully introduced as the black bass has been.

B.—THE JAMES RIVER.

The James River has its rise in the Alleghany Mountains in West Virginia. It breaks through the Alleghany Chain and the Blue Ridge, and then, a considerable river, flows eastward to the sea. Its waters for the most part are clear, and in its upper course comparatively cold. Most of its tributaries are swift, spring-fed mount-

ain streams; even those of the lower part of the course have the same general character, although most of these streams become muddy and yellow after rain. Heavy rains and consequent floods in the early part of September prevented the completion of our work in the basin of the James River. All our collections were made in streams of the hill country. It is known, however, that the fauna of the lowland course of the James resembles that of the Blackwater and of the Tar, described farther on. Collections were made in the James River basin at the following points:

1. *James River* at Lick Run, six miles east of Clifton Forge, at a point near where the river breaks through the Alleghany Mountains. Collections made September 8. The locality is a good one for collecting, but the heavy rains had so raised the river that little work could be done. The same cause prevented any work being done at Gala Water, a station below Clifton Forge. This point will probably be found, in favorable weather, to be the best point for making collections in the upper course of the James. It should be visited again. Species collected at Lick Run are marked L.

2. *Elk Creek* opposite Natural Bridge station, 4 miles southeast of the Natural Bridge. Collections made July 30; temperature about 68°. Elk Creek or "Dry Run" flows into James River from the south, its mouth being a short distance below a point opposite the railroad station of Natural Bridge. It is one of the most attractive streams examined by us; a very clear, cold trout-brook, running over rocks and shingle, and having at intervals deep pools, some of them 4 to 8 feet deep, and most of them shaded by alders and other trees. The stream is remarkably well stocked with fall-fish, some of them in the larger pools reaching a length of more than a foot. Trout are also very abundant, as is shown by the fact that five were caught with the Baird seine. A few specimens (*Lepomis gibbosus*, *Boleosoma nigrum*, *Notropis amœnus*, *Micropterus dolomieu*) were caught in James River, at the mouth of this creek. Species from Elk Creek are marked E in the following list. In our work about Natural Bridge, we are under especial obligations to Colonel Parsons, proprietor of the hotel at Natural Bridge. Colonel Parsons accompanied us himself to Elk Creek, and freely offered us the use of his team.

3. *Cedar Creek* at Natural Bridge.—Cedar Creek is a small brook fed by springs, with cold and rather clear water. Across its gorge stands the famous Natural Bridge. Below the bridge it flows to the James River through a rocky ravine. Our collections were made July 30 in a pool underneath the Natural Bridge. The stream being small and swift, contains but few species. By far the most abundant of these is *Squalius vandoisulus*.

4. *Buffalo Creek* at and above Buffalo Mills, about 5 miles south of Lexington, Va. Collections made July 28; temperature 74°. Buffalo Creek is a rather clear, very swift stream, flowing over a very rocky bottom, and containing many broad shallows, deep pools, and some small water-falls. The north side of the stream is largely abrupt and rocky, the south side shaded by sycamores and willows. The water is warm, but in most respects the stream is well adapted for collecting, especially below the dam at Buffalo Mills. Buffalo Creek is a tributary of North River, joining the latter near its mouth. Species from this stream are marked B.

5. *North River* at Loch Laird Station, about 6 miles northwest of Balcony Falls, Va. Collections made July 27; temperature 76°. North River is a rather clear, swift hill-stream, rising near Lexington, Va., and flowing into the James River above

Balcony Falls. It was in earlier times converted into a canal by an elaborate system of dams and locks. Our collections were made at a point a few rods above the wagon bridge at Loch Laird. The dam below this point is now broken through. The stream is shallow and rather swift, running over gravelly bottom. The banks are covered with willows, and along the shore is a thick growth of *Ruellia*. Not much time was spent here, and the space fit for seining which can be worked is small. Species taken in the North River are marked N.

6. *Swift Creek*, about 5 miles north of Petersburgh, Va. Collections made September 6. The collections in this stream were made during a heavy rain and under unfavorable circumstances. Immediately below the dam in Swift Creek the stream is very rocky; lower, its current is less rapid, with deep holes here and there. Although this stream is one of the tributaries of the lower course of the James, its fauna is essentially that of the upland streams. The noteworthy difference consists in the presence of the shad, rockfish, gizzard shad, and pike. The shad and rockfish come up the stream to spawn in spring and the young remain in the stream through the summer. In the lowland course the large-mouthed black bass takes the place of its more active congener. The species from Swift Creek are marked S.

1. **Ameiurus albidus** (Le Sueur). N., L. "Channel Cat."

Not rare. A. 21, 23. Color rather dark in young specimens.

2. **Ameiurus nebulosus** (Le Sueur). B., N.

Not rare, in sluggish places in the larger streams.

3. **Noturus insignis** (Richardson). B. "Mad-Tom."

Not rare in weedy places.

4. **Catostomus teres** (Mitchill). B., L., E.

Common in sluggish waters.

5. **Catostomus nigricans** (Le Sueur). B., L., N., E.

Common in swift waters.

6. **Moxostoma cervinum** (Cope). B., E.

Very common in swift waters, especially in water-falls and in the pools at the foot of dams.

Young specimens in life have the back dark brown, mottled with black blotches which extend on the sides; side with a well-defined coppery band, broader than the eye; belly below this band abruptly silvery, a blackish blotch on tail before base of caudal; base of caudal pale orange; caudal dull orange, the membranes black; nostril and edge of opercle pale orange. Older specimens lose the orange lateral band, and in still older ones light stripes follow the rows of scales on the back.

This little sucker is too small to be of much economic value. It rarely exceeds 8 to 10 inches in length.

7. **Hybognathus nuchalis** Agassiz. L.

Scarce in the river channels.

8. **Exoglossum maxillingua** (Le Sueur). C., B., N. "Nigger-Dick."

Very common, though not in cold nor very swift water. A rather sluggish species, living on the bottom.

9. Notropis procne (Cope). S., B.

Common, especially in the creeks, in water not very cold. Specimens from Swift Creek have the back rather broader and less elevated than in those from Luray. Scales 35; scales of back dark-edged; a lateral streak made of dark points; two faint dark spots, one behind the other, at base of caudal. This is a very characteristic color-mark, at least traces of it being found in all specimens.

10. Notropis saludanus (Jordan & Brayton). S., E.

Common in Swift Creek only. Color pale; a dark caudal spot in young only. Interorbital width, 3 in head; head, $4\frac{2}{3}$ in length.

11. Notropis rubrifrons Cope (var.?). B., E.

Common in the creeks, especially in Buffalo Creek. Color silvery; snout, chin, and bases of all the fins rosy in the males only; twenty scales before dorsal. Usually no black at base of anal. This species shows much variation in form. Some are very slender, the depth 6 in length, but most have the depth $5\frac{1}{2}$. These all have the dorsal about two scales nearer in its insertion to snout than to fork of caudal.

Two specimens from Buffalo Creek agree in most respects, but are decidedly deeper and more compressed, the depth $4\frac{3}{4}$ in length; the lateral line proportionately more curved and the dorsal further forward, only a scale nearer base of caudal than to tip of snout. In these the pectoral is also longer, almost reaching base of ventrals. The eye in all is 3 to $3\frac{1}{2}$ in head. Probably all belong to one species, but, if so, the variations in form are unusual. Compared with Indiana specimens of *N. rubrifrons* these have the eye a little larger and the head a little shorter (eye $3\frac{1}{3}$ to $3\frac{1}{2}$ in head, not $3\frac{2}{3}$ to 4). *Notropis dilectus* (Girard), Arkansas to Texas, is very close to *N. rubrifrons*.

Specimens from Red River, Arkansas, are more compressed, with shorter snout, bluntish and not as long as the small eye, which is 3 in head. Head $4\frac{1}{4}$ in length, twenty scales before dorsal.

12. Notropis amœnus (Abbott). L., S., N.

Common in the channels of the larger streams. This species is quite variable, and some examples are scarcely distinguishable from *N. rubrifrons*. It reaches, however, a larger size. It is usually deeper in body, with smaller scales before dorsal and no red even in the males. A. 11. In Swift Creek specimens are usually but nineteen scales before dorsal. One of these specimens has a much deeper body, nine anal rays, and twenty-four scales before dorsal. Its appearance suggests a possible hybrid of *amœnus* and *megalops*, though it may prove to be the young of the variety of *N. megalops*, which is common in the Roanoke.

13. Notropis analostanus (Girard). L., S., B., N., E.

Common; specimens vary a good deal in form, but most are deeper in body than western specimens (depth $3\frac{3}{5}$ to $4\frac{1}{3}$), and the scales in the lateral line are usually but thirty-five.

14. Notropis macdonaldi Jordan & Jenkins. B., N.

One specimen from Buffalo Creek; another from Loch Laird.

15. Notropis megalops (Rafinesque). L., S., B., N., E.

Common; similar to northern and western examples.

16. Hybopsis kentuckiensis (Rafinesque). L., S., B., N., E.

Common.

17. Semotilus bullaris (Rafinesque). E., L., S. Fall-fish.

Common in clear streams, in deep pools below swift water. Extremely abundant in Elk Creek, where it reaches a length of 15 inches or more.

18. Semotilus atromaculatus (Mitchill). B.

Scarce; in small streams only. Scales 50 to 52.

19. Rhinichthys cataractæ (Cuv. & Val.). B.

Not rare, in swift waters. Scales 68.

20. Rhinichthys atronasus (Mitchill). E., C., B.

Common, especially in cold, swift waters. Very abundant and brilliant in Elk Creek. Males in life sulphur yellow below the dark lateral band, this color fading to silvery on belly. Lower fins, especially pectorals, scarlet; a scarlet dash at base of caudal. Black lateral band very distinct in all cases, not giving place to a red band as is usually the case in males northward.

21. Squalius vandoisulus (Cuv. & Val.). C., E., B., L.

Abundant, especially in swift brooks. The chief species found in Cedar Creek.

The larger specimens are more elongate than the others (depth $4\frac{1}{4}$ in length). These have also a more or less distinct black lateral streak with a paler streak above it, both belly and pale streak being crimson in life. The smaller specimens have the lateral streak very obscure and confined to the caudal peduncle. These are deeper in body (depth about $3\frac{3}{4}$). The number of scales ranges from 49 to 54 in both forms, and in both, the eye is longer than snout, 3 to $3\frac{1}{4}$ in head. All specimens except the very young have the lower parts, especially forward, flushed with crimson. This color is much deeper in the larger and more elongate specimens, which are also frequently beset with small tubercles. These are evidently the males, and the others the female and young of the same species.

It is probable that the nominal species *funduloides*, *affinis* (=*vandoisulus*) are all based on sexual or other variations of one species. *Squalius estor*, from the Cumberland River, is according to Dr. Gilbert not distinct from *S. vandoisulus*.

22. Clupea sapidissima (Wilson). S. "Shad."

Young shad were taken in Swift Creek.

23. Dorosoma cepedianum (Le Sueur). S.

Common in Swift Creek and lowland streams, not ascending to the uplands.

24. Salvelinus fontinalis (Mitchill). E.

Brook trout are found in all suitable tributaries of the James in the Blue Ridge and Alleghany Mountains. Some half dozen specimens were taken with the seine in Elk Creek about a mile above its mouth.

25. Lucius reticulatus (Le Sueur).[1] S.

Specimens were taken in Swift Creek, but the species does not ascend to the mountains.

[1] In the earliest subdivision of the Linnæan genus *Esox*, that made by Rafinesque in 1810, *Esox belone* was selected as the type of *Esox*, while to the genus of pikes the name *Lucius* was given. This arrangement must apparently stand. The pikes and pickerels will then constitute the genus *Lucius* Rafinesque and the family *Luciidæ*.

26. Micropterus salmoides (Lacépède). S.

The Large-mouthed Black Bass is found only in the lowland streams. It is common in Swift Creek.

27. Micropterus dolomieu (Lacépède). L.

The Small-mouthed Black Bass abounds in all suitable places in the upland tributaries of the James. Several localities, as Eagle Rock, Gala Water, Craig's Creek, etc., are noted among anglers for the abundance of bass. The species seems to be indigenous in this river, though not in the Potomac. It rarely ascends the small creeks like Buffalo or Elk.

28. Lepomis auritus (L.). L., B., N., S. "Yellow Belly."

This species is generally common in the tributaries of the James. It ascends streams further than the next species.

29. Lepomis gibbosus (L.). L., S., N.

Generally common, especially in the Lower James.

30. Roccus lineatus (Bloch). S. "Rock."

Young specimens taken in Swift Creek.

31. Etheostoma flabellare (Rafinesque). B.

Generally common, especially in swift shallow brooks.

32. Etheostoma nigrum (Rafinesque) var. *vexillare* Jordan. B., L., N., S.

Extremely common, except in the trout-brooks; very variable.

Many specimens from Buffalo Creek and the specimens from Loch Laird and Elk Creek apparently belong to the form called *Boleosoma vexillare*. None of these exceed 2 inches in length. The female of this form has the ordinary speckled coloration; the male is gray with the edges of the scales above more or less dusky, and the head is nearly black; spots on back and sides faintly marked. First dorsal very high, chiefly black, especially anteriorly; second dorsal and caudal spotted; ventrals and anal dusky or black.

Cheeks and nape naked, opercles scaly. D. VIII–12, IX–11, IX–11, IX–12, IX–12, in five specimens. Scales 38, 39, 40, 40, 41, 42, 38, 38, 39, in nine specimens. Lateral line usually not quite complete.

The original type of *vexillare* (from Rappahannock River at Warrenton) had D. VIII–10, scales 35, but was otherwise similar to these. *Vexillare* doubtless represents a slight variety of *E. nigrum*, which may be called *E. nigrum vexillare*.

The three specimens from Swift Creek are a little more slender, with smaller scales and the usual pale, speckled coloration. Scales 43, 45, 47, in three specimens. One of these has the cheek well scaled as in var. *olmstedi*. The others have the cheek naked as in vars. *nigrum*, *effulgens*, and *vexillare*.

33. Etheostoma longimane Jordan. B., N., E.

This graceful little darter is very abundant in the tributaries of the Upper James, especially in weedy places where the current is swift. In Buffalo and Elk Creeks it was found to be the commonest of the darters.

34. Etheostoma aspro (Cope & Jordan). L.

A single specimen, similar to those found in the Roanoke, was taken in the James River at Lick Run. Scales 64; cheeks scaly.

35. **Etheostoma peltatum** Stauffer. S. (*Hadropterus maculatus* Girard, not *Alvordius maculatus* Girard, which is *E. aspro*, and not *Etheostoma maculatum* Kirtland. *Etheostoma nevisense* Cope; *Alvordius crassus* Jordan & Brayton.)

A renewed comparison of large series of examples has convinced me that the nominal species, *nevisensis*, *peltatus*, and *crassus* are identical, notwithstanding the differences in coloration and in the squamation of the head.

The two specimens from Swift Creek have the coloration of *E. nevisense* with the almost naked head of *peltatum*. The largest is $2\frac{1}{4}$ inches in length.

Light straw color, the markings are all very dark, verging on jet black. Back with dark cross-blotches and irregular wavy and longitudinal markings above lateral line, much as in *E. aspro*. Sides with six large conspicuous square black blotches, about as broad as the interspaces and alternating with fainter bars of black. A faint dusky streak along lateral line. Top of head black; a black bar below eye; snout and opercle mostly black; nape with a pale spot surrounding a dark one; a dark band in axil; 6 to 8 round spots on back; first dorsal with a submedian black band and some black spots toward tip; second dorsal and caudal obscurely barred; ventrals and pectorals dusky.

General form of *E. aspro*, from which this species scarcely differs except in the larger size of its scales. Head rather heavy, the snout bluntish in profile and about as long as eye; lower jaw slightly included, maxillary reaching just past front of eye, $3\frac{2}{5}$ in head. Gill membranes scarcely connected.

Cheeks wholly naked; opercle with about 3 small scales above, sometimes naked on one side. Caducous ventral shields large and few in number; nape and breast naked; scales 6–52–9. D. XIII, 12. A. II, 10. Head 4 in length; depth $5\frac{2}{3}$. Eye 4 in head.

Fins all comparatively low and small; pectoral a little shorter than head, barely reaching tips of ventrals, and nearly as large as second dorsal, its second spine a little slenderer and longer than first; caudal lunate.

Specimens from Carlisle, Pa., agree with these specimens, except that the black lateral spots are smaller and rounded. Scales 56.

Etheostoma ouachitæ (Jordan and Gilbert), (specimens from Saline River, Benton, Ark., and from the Wabash River at New Harmony, Ind.), is extremely close to *E. peltatum*. *E. ouachitæ* has the head a little more slender, the pectorals longer, reaching past tips of ventrals, and four distinct black cross-blotches on back.

Both species might be regarded as varieties of *E. aspro* were it not for the larger scales.

36. **Cottus bairdi** Girard. E. "Mull-head."

Very abundant in clear streams and spring runs. A mischievous fish; very destructive to the eggs of trout.

C.—THE DISMAL SWAMP (ELIZABETH RIVER).

The Dismal Swamp, which lies in the southeastern part of Virginia and the adjacent portion of North Carolina, is a large marshy area, most of it heavily timbered with cypress and other trees. Near the center of the swamp is Lake Drummond, nearly circular in form, with a diameter of 5 or 6 miles. The waters of the swamp and the lake are free from sediment, but stained of a dark-brown color by the vegetable matter of the swamp. The lake water, in fact, is regarded as excellent for drinking purposes.

The fish fauna of the Dismal Swamp is essentially that of other marshy lowlands of the Southern States, in which the underlying clays are covered by vegetable deposits. Some of the species characteristic of the Florida fauna seem to find here their northern limit. Collections were made in the following localities within the borders of the Dismal Swamp.

1. *Jericho Canal* near Suffolk, Va.—August 31; temperature, 73°. This canal is the outlet to Lake Drummond. At the time of collecting, the water was low, and the bottom of the canal had a dense growth of aquatic plants. The water was clear, but of the color of cider. The region seined extended from the point where the main road leading from Suffolk crosses the canal, down to its mouth in Shingle Creek. Species found here are marked J.

2. *Shingle Creek* near Suffolk, Va.—August 31. This stream is a tributary of the Elizabeth River. Tides enter the stream, the waters of which are consequently brackish. It was seined during low tide at the place where the Jericho Canal enters it. Species found in this stream are marked S.

3. *Spring Creek* near Suffolk, Va.—August 31. This is another tributary of Elizabeth River, similar in its character to Shingle Creek. Fishes from this locality are marked P.

4. *Canal and canal feeder* near Wallaceton, Va.—September 2. The Dismal Swamp Canal passes north and south through the swamp just east of Lake Drummond. It is connected with Lake Drummond by a short canal or "feeder," which joins the canal just south of the large farm of Mr. Wallace, or Wallaceton post-office. Both canal and feeder were found to be so full of snags that seining was almost impossible, the feeder especially so. For the same reason no work could be done in the lake. The water in the canal is clear, but very dark; the bottom is full of black muck, formed of decaying vegetation, which fills the seine. It is said that the gar (*Lepisosteus osseus*) and *Amia calva* reach a very large size in the lake. No specimens were taken, however. Species taken in this locality are marked D.

5. *Ditch on Dover farm* at Wallaceton.—September 2. "Dover farm" is a square district of about 700 acres, which has been "carved out" of the swamp. The whole farm is surrounded by an embankment, which keeps out the water of the swamp.. It is drained by ditches, which join into one, and this is led off by a tunnel under the canal. The water in the ditches is several feet lower than that of Lake Drummond or the canal. The main ditch was seined at its outlet after its waters had passed under the canal. Species from this locality are marked W.

1. Ameiurus nebulosus (Le Sueur). D.

Three specimens, quite dark; caudal somewhat concave. A. 22.

2. Ameiurus erebennus Jordan. J., S.

Rather common. Color black everywhere; anal high and long, its rays 25 to 27. The commonest catfish in the swamp, although not before noticed north of Florida.

3. Noturus insignis (Richardson). S.

Scarce.

4. Anguilla anguilla rostrāta (Le Sueur). D., S.

Probably common.

5. Erimyzon sucetta (Lacépède). S.

Common. In life ventrals and pectorals bright red, tipped with blue, a bright blue patch on opercle; rays of dorsal reddish, the membranes blackish; body with a black lateral shade. Scales 45, but regularly arranged. These specimens seem referable to the northern var. *oblongus* rather than to the true *sucetta*.

6. Moxostoma papillosum (Cope). S.

A few specimens.

7. Hybognathus nuchalis Agassiz. S., P.

Most of these specimens correspond to the *Hybognathus regia* of Girard. The largest specimens (4½ inches in length) are larger than any western specimens of *nuchalis* which I have seen. The body in these large examples is deeper (depth 4 to 4¼ in length) than in *nuchalis* (depth 4¾), and the caudal peduncle is stouter. A comparison of numerous specimens reduced these and other supposed differences to a minimum, and only the larger size and proportionately greater depth of body remain to distinguish *regia* from *nuchalis*.

8. Notemigonus chrysoleucus (Mitchill). S., P., D., W.

Very common. A. 13, scales 49; A. 14, scales 51; A. 15, scales 51; A. 14, scales 47; A. 13, scales 50; A. 15, scales 54, in six specimens. These specimens should be referred to the northern or typical var. *chrysoleucus*.

9. Notropis saludanus (Jordan & Brayton). S.

One specimen, dark in color.

10. Notropis procne (Cope). S.

Rather scarce; lateral stripe jet black, this stripe extending through eye around snout. Scales 35. Back high; caudal peduncle slender; dorsal high.

11. Notropis amœnus (Abbott). S.

Common. Color dark; 18 scales before dorsal; base of anal with dark dots.

12. Notropis niveus (Cope). S., P.

The specimens differ considerably from the typical *niveus* (Catawba River), and may belong to a different species.

The mouth in these specimens is rather less included below the snout, the eye is larger (3⅛ in head, 3⅖ in *niveus*) and the color is much darker, there being a distinct plumbeous lateral band. The body in these specimens is rather more elongate. A. 8, scales 37.

Compared with *N. whipplei*, these specimens are much more slender, with notably larger eye, slenderer head, and considerably lower dorsal. Probably the specimens from Shingle and Spring Creeks represent a lowland variety of *Notropis niveus*.

13. Stolephorus mitchilli (Cuv. & Val.). S.

Many young anchovies were taken in Shingle Creek.

14. Clupea pseudoharengus (Wilson). S.

A few young alewives were taken in Shingle Creek.

15. Dorosoma cepedianum (Le Sueur). S., P.

Common.

16. Fundulus diaphanus (Le Sueur). S.

Color very dark; body with 14 narrow, black cross-bands. D. 13; A. 19. One specimen.

17. Gambusia patruelis (Baird & Girard). J., D., W., S., P.

Very common.

18. Chologaster avitus Jordan & Jenkins. J.

Very common in the Jericho Canal; not seen elsewhere.

19. Umbra pygmæa (De Kay). J.

In view of the constant differences in pattern of coloration shown by the eastern form, the latter may perhaps stand provisionally as a distinct species. The characters are well given by Blatchley (Proc. Ac. Nat. Sci. Phila., 1885, 12).

20. Lucius americanus (Gmelin). J., S.

Common.

21. Lucius reticulatus (Le Sueur). J., S., P.

Common.

22. Aphredoderus sayanus (Gilliams). J., D., W.

Common. D. III, 10; A. II, 6; scales 39 to 42; 23 scales before dorsal; color very dark; a pale streak along lateral line; a dark streak above base of anal and parallel with it.

Specimens from Delaware River have scales 47 to 48, 24 before dorsal, but are otherwise similar.

Specimens from Illinois River have the color much paler, the streak above anal obsolete, and the scales very much smaller, about 58 in a lengthwise series; 36 before dorsal. These certainly form a tangible variety or subspecies, *gibbosus* Le Sueur. (*Aphredoderus gibbosus* Le Sueur = *Sternotremia isolepis* Nelson = *Aphredoderus cookianus* Jordan = *Asternotremia mesotrema* Jordan. The last three synonyms represent different stages of growth). Other specimens, Wabash River, show 48 to 51 scales, and are apparently intermediate between *gibbosus* and *sayanus*.

23. Centrarchus macropterus (Lacépède). J.

D. XII, A. VII; scales 41. Common.

24. Pomoxis sparoides (Lacépède). J.

Common.

25. Acantharchus pomotis (Baird). J.

Two specimens; scales 45.

26. Enneacanthus obesus (Baird). J., W.

Common. Compared with the next species (*E. gloriosus* or *simulans*, from Trenton, N. J.), *E. obesus* is more elongate, the forehead above eye less depressed, the lateral line less arched, the eye smaller, the black lateral bands very distinct. The most striking character is in the size of the opercular spot. This, in *obesus*, is as wide as long in the adult, and four-fifths diameter of eye. In *gloriosus* it is longer than wide, and little more than half diameter of eye. Both species have pale spots on the body and fins, but in *obesus* those on the body are smaller and farther apart.

27. Enneacanthus gloriosus (Holbrook). S.

Rather scarce. Depth, 2½ in length; ear flap not larger than pupil; a faint trace of cross-bands. I see no reason to doubt the identity of *Bryttus gloriosus* Holbrook, with *Hemioplites simulans* Cope, and *Enneacanthus margarotis* Gill & Jordan. The ear flap is small in *gloriosus* as in *simulans*, and no difference of any importance is shown in the descriptions.

28. Lepomis auritus (L.). S.

Scarce.

29. Lepomis gibbosus (L.). S.

Not rare.

30. Lepomis holbrooki (Cuv. & Val.). J., D., W., S.

Not rare. This species differs from *L. gibbosus* in its plainer color; greenish, with faint bronze spots; breast yellow; dorsal unspotted. Its snout is sharper and longer than in *L. gibbosus*, scales 44; 4 rows on cheek. Dorsal higher than in *L. gibbosus*; longest spine, 1⅞ in head, as long as snout and eye. Eye about as long as snout.

Lepomis notatus (Lower Mississippi) seems to be a different species, distinguished by the larger scales (lat. l. about 35).

31. Micropterus salmoides (Lacépède). S.

Common.

32. Roccus lineatus (Bloch). S., P.

Young specimens common.

33. Morone americana (Gmelin). S., P.

Common.

34. Etheostoma vitreum (Cope). S.

Common in sandy places.

35. Etheostoma nigrum olmstedi (Storer). S., P.

Very common. Cheeks closely scaled in all specimens examined. D. IX–15.

36. Etheostoma peltatum Stauffer. S.

One specimen.

37. Etheostoma fusiforme (Girard). W.

One specimen. Body very slender, the depth 6¼ in length. Scales 53; two rows of scales above lateral line; tubes on 16 scales. D. IX–10. Top of head naked; cheeks, opercles, nape, and breast scaly; scales on cheek large. Base of caudal with four dark spots in a vertical row; body with dark markings in the form of a faint interrupted dark lateral band with dark shades above and below it.

This specimen seems to agree with the type of Girard's *fusiforme*. *Hololepis erochrous* Cope also agrees fairly with it, and may be regarded as the same.

Throughout the entire lowland region, from Dakota to Texas, Michigan, Massachusetts, and Florida, small darters are found, which agree more or less closely with this specimen, so closely, indeed, that I do not know how to draw specific distinctions among them. To these have been given the specific names of *eos* (N. Indiana); *palustris* (S. Indiana); *exilis* (Dakota); *warreni* (Dakota); *gracilis* (Texas); *elegans* (Texas);

butlerianus (Mississippi), and *barratti* (South Carolina). Some of the results of a recent examination of material may be here given.

a. Clam Lake, Michigan (*eos*): These specimens are a little stouter and darker in color, the scales on the cheeks obscure. Scales, 55.

b. Thayer Lake, Michigan (*exile*): Still stouter, more barred, the cheeks naked.

c. Northern Illinois (*eos*): Stouter, the depth 5 in length; scales 56, 4 rows above lateral line; scales on cheeks evident; three spots at base of caudal.

d. Southern Illinois (*barratti*). Still stouter, depth 4½; scales 49, 3 rows above lateral line; cheeks well scaled; color nearly plain; sides with faint bars and a single spot at base of caudal.

e. Terre Haute, Ind. (*palustre*). Depth 5; scales 50, 3 rows above lateral line; snout rather short; cheeks well scaled; a single faint caudal spot; markings obscure; bluish bars in life.

f. Trinity River, Dallas, Tex. (*gracile*). Similar to *e* in color and form, a little stouter; cheeks well scaled; scales 50, 3 rows above lateral line; three spots at base of caudal.

g. Saline River, Benton, Ark. (*gracile*). Very similar to *f*. Scales 49; three spots at base of caudal.

h. Mount Vernon, Ind. (*palustre*). Stout, depth 4⅛; scales 53, one row above lateral line; one caudal spot; snout bluntish; no dark lateral stripe.

Possibly these several varieties may be separated by the following characters:

a. Cheeks naked; body faintly barred ..... *exile.*
aa. Cheeks scaly.
  b. Body stoutish; no lateral stripe; depth 4½ to 5½ in length.
    c. Snout moderate; scales on cheek small; sides with crimson spots ..... *eos.*
    cc. Snout bluntish; no bright red; sides with greenish cross-shades ..... *palustre.*
    ccc. Snout rather sharp; no red.
      d. Body more or less barred and spotted ..... *gracile.*
      dd. Body nearly plain greenish ..... *barratti.*
  bb. Body very slender; depth 6 in length; a dark lateral band and more or less of red markings ..... *fusiforme.*

But the value and constancy of each of the above characters are yet to be proved.

38. Achirus fasciatus Lacépède. S., P.

This small sole ascends the streams from the sea and is abundant on sandy bottoms in the creeks.

D.—THE CHOWAN RIVER.

The Chowan River opens by a broad shallow mouth or estuary into the north side of Albemarle Sound. Its principal tributary is the Blackwater, which rises in the southeastern part of Virginia and takes its way southward through densely wooded swamps of cypress, pine, etc., flowing into the head of the estuary of the Chowan. The water of the Blackwater is clear, but, as the name indicates, it is stained to the color of coffee by the drainage from the cypress swamps.

1. *Blackwater River* at Zuni.—This stream was seined at Zuni, a little town on the railway west of Suffolk. Collections were made above and below the railroad bridge at Zuni. The river at this point is very full of snags, but in the shallow places the bottom was sandy. Temperature 73°, September 6.

The fish fauna is essentially that of the neighboring Dismal Swamp.

1. Noturus insignis (Richardson).

Not rare.

2. Anguilla anguilla rostrata (Le Sueur).

Common.

3. **Notropis amœnus** (Abbott).

A few large specimens very dark in color and looking as though starved.

4. **Notropis niveus** (Cope).

Very abundant, similar to specimens from the Dismal Swamp, the color darker, the snout sharper, the mouth more oblique and more terminal than in specimens from Cape Fear River.

5. **Notropis procne** (Cope).

Specimens quite slender, the back less elevated than in upland examples, the color very dark, but the markings similar. Chin always pale (black in the next species).

6. **Notropis chalybæus** (Cope).

Very close to *N. anogenus* Forbes, differing chiefly in the more backward dorsal and smaller ante-dorsal scales, the general form, markings, size of eye and form of mouth the same in the two species. Head $4\frac{1}{5}$ in length; depth 5; D. 8; A. 7 to 9. Scales 33, 16 to 17 series before dorsal. Length, 2 inches.

Body moderately elongate, compressed, the back a little elevated, the tail contracted; top of head not very broad: scales before dorsal small; lateral line nearly straight, somewhat interrupted. Snout short, not two-thirds the large eye, rather blunt, mouth short, very oblique, the chin projecting. Eye 3 in head. Dorsal inserted behind ventrals, at a point one and one-third times length of head, behind the nape. Dorsal and anal very short and high; pectorals and ventrals short. Color quite dark, a jet black lateral band, which passes around the snout and includes the chin; a darker spot at base of caudal; a dark streak along base of anal.

Compared with specimens of *Notropis anogenus* taken by Professor Meek in Cayuga Lake, the latter differs in the paler color, broader head, more anterior dorsal (only a head's length behind nape), and in the larger size (13 in number) of the scales before the dorsal.

7. **Clupea sapidissima** (Wilson). *Shad.*

Young, abundant.

8. **Gambusia patruelis** (Baird & Girard).

Few taken.

9. **Lucius reticulatus** (Le Sueur).

A few taken.

10. **Micropterus salmoides** (Lacépède).

Common.

11. **Lepomis auritus** (L.).

Common.

12. **Lepomis gibbosus** (L.).

A few.

13. **Perca flavescens** (Mitchill). *Raccoon Perch.*

Two taken.

14. **Etheostoma vitreum** (Cope).

Abundant.

15. **Etheostoma nigrum olmstedi** (Storer).

Abundant; cheeks covered with small, partly imbedded scales.

16. Etheostoma aspro (Cope & Jordan). (Var.)

Several specimens, similar to those from the Roanoke. Scales 62, 62, 64. Compared with *E. peltatum* from the Neuse, these specimens have smaller scales, and the blotches on the sides coalesce into a nearly continuous black band, nearly as wide as eye, its edges uneven. In some the cheeks are naked, in others scaly.

17. Etheostoma quiescens (Jordan).

The original type of this species came from Allapaha River, a tributary of the Suwanee River in southern Georgia. The four specimens taken at Zuni agree with this type except in the form of the body. This is very slender in the Suwanee specimen, but rather stout in those from the Blackwater.

Head $3\frac{2}{3}$ in length ($4\frac{1}{2}$ with caudal); depth $4\frac{2}{3}$ ($4\frac{4}{5}$). D. XI–12, A. II, 7. Scales 3–54–8. Pores on 27 scales. Length $1\frac{2}{5}$ inches. Body not greatly elongate, compressed, the back elevated, the back higher and the tail shorter than in *E. eos*. Maxillary extending to front of pupil; jaws equal; preopercle a little crenulate above. Cheeks, opercles, and whole top of head closely scaled: breast and nape scaled; snout, jaws, and preorbital naked; lateral line running very high as in *E. fusiforme*, from which this species is chiefly distinguished by the scaly crown, a character seen also in *E. tuscumbia*, a species not closely related to *E. quiescens*. Caudal $1\frac{1}{3}$ in head; pectoral as long as head. Color dark brown, the pale parts chiefly bright red in life; back with some dark markings; side with a broad black lateral band, mottled and interspersed with red; an area of red along lateral line; some black spots on lower part of side; a black spot at base of pectoral; three black bars about eye; four black spots in a cross-series at base of caudal, the middle ones largest. Fins checkered; dorsal, anal, and caudal finely barred; ventrals, anal, and pectorals plain.

E.—THE ROANOKE RIVER.

The Roanoke River has its sources in the Blue Ridge Mountains in southwestern Virginia, from which region it flows southeastward through the uplands, and ultimately passes into the lowland region of east North Carolina. Its mouth is a broad estuary, Roanoke Sound, which opens into Albemarle Sound. The general character of the river basin is similar to that of the James. Our examinations of this river were all made near the source of its main branch, the Staunton River, in Montgomery and Roanoke Counties, Virginia. The work was here done under very favorable circumstances, and it is probable that so far as the fishes of the upland course are concerned, our list is nearly complete. The water of most of the tributaries of the Upper Roanoke is very clear, and the streams are extremely picturesque. Collections were made at the following points:

1. *Bottom Creek*, about 5 miles south of Alleghany Springs, August 3; temperature 77°.

The infant Roanoke is formed by the union of two mountain streams, Bottom Creek and Lick Fork, which come together on the west side of Bent Mountain, some 4 miles above Alleghany Springs. Of these streams the larger, Bottom Creek, was examined by us. Its waters are very clear, forming a succession of rapids and deep pools, the swift places having the bottom lined with a river weed (*Podostemon ceratophyllus*). The water is, however, warm, scarcely colder than that of the river. The fishes are substantially the same as those in the river below. The only difference

worthy of note is in the much greater abundance of *Chrosomus oreas*, *Squalius funduloides*, *Etheostoma podostemone*, and *Notropis megalops cerasinus*. Even the eel and the rock bass are found in Bottom Creek. It is said that brook trout are occasionally taken here, but none were seen.

2. *Roanoke (Staunton) River* at Salem and Roanoke, Va., July 31, August 1, August 2; temperature 82°.

The Roanoke or Staunton River from Salem to Roanoke is comparatively clear, with alternations of shallow, swift places, where the river flows over shingle and rocks, and long, still stretches where the bottom is more or less muddy. The shoal areas, many of which are used as fords, are about one-half mile apart, and some of them are excellent as collecting grounds. Collections were made below the mill, southwest of Salem; about the mouth of Mason's Creek, 2 miles below Salem; at the bridge, 2 miles southwest of Roanoke, and at various places within 3 miles of this bridge, in the direction of Salem. All these localities are good. The shoal immediately under and below the bridge at Roanoke is probably the best.

3. *Mason's Creek*, 2 miles east of Salem. August 1; temperature 82°. A small, clear stream, its water scarcely colder than that of the river. It was seined near its mouth. Its fishes are the same as those found in the river.

4. *Back Creek* at Poage's Mill, 10 miles south of Salem. August 1; temperature 77°. This is a small, clear, sandy stream, its waters quite warm. It rises on the eastern side of Bent Mountain opposite the source of Bottom Creek. The following species were found here:

1. **Moxostoma cervinum** (Cope).
   Under the mill-dams.
2. **Campostoma anomalum** (Rafinesque).
   Common.
3. **Chrosomus oreas** (Cope).
   Very common. Some of the specimens remarkably brilliant in color.
4. **Notropis megalops cerasinus** (Cope).
   Very abundant and very brightly colored.
5. **Hybopsis kentuckiensis** (Rafinesque).
   Specimens very short and deep; abundant in the mill-pond; scales 41.
6. **Rhinichthys atronasus** (Mitchill).
   Common.
7. **Squalius vandoisulus** (Cuv. & Val.).
   Scarce.
8. **Etheostoma flabellare** (Rafinesque).
   Scarce.

The following is a list of the species found in the river:

1. **Noturus insignis** (Richardson). *Mad Tom.*

Very common, especially in grassy places in the river. In life, pale yellow, nearly uniform; all specimens, large and small, with the dorsal, anal, and caudal broadly edged with jet-black, the basal part of the fin pale. Caudal long, rounded at tip.

There is considerable variation in the width of the head and in the length of the pectoral spines ($1\frac{2}{3}$ to $2\frac{1}{4}$ in head). A. 16. Pectoral spine retrorse-serrate on the outer margin, the inner margin with coarse teeth near the base.

2. Noturus gilberti Jordan & Evermann.

About two-fifths of the specimens of "Mad Tom" obtained at Roanoke and Salem belong to this species, well distinguished by its color, and by the form of its adipose fin, caudal fin, and pectoral spines.

3. Moxostoma papillosum (Cope).

A few young specimens taken at Roanoke.

4. Moxostoma cervinum (Cope).

Common at the foot of mill-dams and in swift waters.

5. Catostomus nigricans (Le Sueur). "Dutchman."

Common; specimens dark in color. Lat. l. 47.

6. Catostomus teres (Mitchill).

Common.

7. Campostoma anomalum (Rafinesque).

Not rare. Lat. l. 49 to 52.

8. Exoglossum maxillingua (Le Sueur). "Nigger Fish."

Very common; a sluggish fish living near the bottom. Lat. l. 57.

9. Chrosomus oreas (Cope).

Very abundant in the clear brooks; rare in the river; the most ornate of all our *Cyprinidæ*. In life head, belly, and lower parts deep scarlet; fins bright yellow, with scarlet at base; back with black vertical bars; a black band from snout through eye to the anal fin, very broad and very distinct in males; another band beginning above this one, separate from it at a point before the vent, and going straight to caudal. These markings are quite distinct from the two nearly parallel black bands seen in *C. erythrogaster*. *C. oreas* also differs in having a slightly longer snout, longer preorbital, and longer maxillary, which extends nearly to the eye. It should probably be ranked as a distinct species.

10. Notropis procne (Cope).

Not rare; a few specimens are extremely pale, having no black on scales on sides of head. These, however, have the same form as the others and show traces at least of the spots at base of caudal.

11. Notropis megalops (Rafinesque).

Common. Of this species two distinct forms or varieties, possibly distinct species, are found, neither of them quite like any form of *N. megalops* which I have met in any other stream. The two forms are very different from each other and may be distinguished even when very young. The one called var. *cerasinus* by Professor Cope abounds in the small streams, the other which I call var. *albeolus* is found in the river.

Notropis megalops cerasinus is small in size, seldom exceeding 4 inches. In life it is steel-blue above, the body flushed with pink and the fins all bright red. The sides are always marked by irregular blackish cross-blotches and bars, formed by a broad,

dark edging on some of the scales. This marking seems to be constant, but the size and arrangement of the bars vary much. Eye rather small, $3\frac{1}{2}$ in head; snout rather short and blunt; body rather deep (depth $3\frac{3}{5}$). Lat. l. 37. 15 scales before dorsal. Dorsal and anal rather high, the free edges concave.

Notropis megalops albeolus reaches a larger size; it is olivaceous above, the sides and fins pure silvery white, the tip of the snout pinkish in the male. The snout in var. *albeolus* is sharper than in var. *megalops*, and the caudal peduncle and fin are especially longer. Depth of adult, 4 in length; eye $3\frac{1}{2}$ in head; lat. l. 38; 14 scales before dorsal. The dorsal and anal are high, their free edges concave. The form of the mouth in both varieties is the same as in the typical *megalops*. The young of var. *albeolus* resembles *N. macdonaldi*, but the mouth is larger in the latter and the body still more slender.

12. Notropis ardens (Cope).

Very common. Male steel blue in life, with more or less of bright red on fins, head, and anterior part of body; base of dorsal anteriorly black; females very pale. I have compared this species with its western analogues *N. atripes*, Cache River, Illinois; *N. lythrurus*, Raccoon Creek, Parke County, Indiana; and *N. umbratilis*, Hundred and Two River, Iowa. It differs from all these in the much more slender body (the depth $4\frac{2}{3}$ in the length, even in the adult males), and in the larger eye ($3\frac{1}{2}$ in head). It should, I think, be regarded as a different species, although the difference is but slight. *N. umbratilis* is well distinguished by its different coloration and large eye. The three remaining nominal species of this type found in the Upper Mississippi region (*N. cyanocephalus*, *N. lythrurus*, and *N. atripes*) differ very little from each other, and may be regarded as varieties of one, for which the oldest tenable name is *N. cyanocephalus* (Copeland).

13. Notropis niveus (Cope).

Common.

14. Hybopsis kentuckiensis (Rafinesque).

Very common.

15. Rhinichthys atronasus (Mitchill).

In brooks. Barbel a little more conspicuous than usual.

16. Squalius vandoisulus (Cuv. & Val.).

Rare; in Back Creek only.

17. Anguilla anguilla rostrata (Le Sueur).

Common.

18. Micropterus dolomieu (Lacépède).

Scarce.

19. Ambloplites rupestris cavifrons (Cope). "Red Eye."

Two specimens taken; one very large example, 9 inches long, in a pool of Bottom Creek, and a small one in the river. The stomach of the large specimen was filled with minnows and "Mad Toms." The smaller corresponds to the description of *Ambloplites cavifrons* Cope. On comparing the adult examples with *Ambloplites rupestris* from Rawson Lake, Michigan, I find but a single tangible difference. In *A. cavifrons* the scales on the cheek are minute and imbedded, wholly invisible over most of the

area. In *A. rupestris* the cheek scales are well developed, usually in about nine rows. The scales on the breast are also more obscure in *A. cavifrons*, but the scales on the body are alike in the two forms. There is no tangible difference in the profile, but the different squamation of the head seems to justify the recognition of *A. cavifrons* as a slight geographical variety.

20. Lepomis auritus (L.).

Common. The specimens belong to the northern variety, with small scales on breast and cheeks. *Lepomis ophthalmicus* (Cope), from some tributary of the Roanoke, is probably the same species.

21. Lepomis gibbosus (L.).

Scarce.

22. Etheostoma podostemone Jordan & Jenkins.

Very common, especially in swift waters among river weeds. Most abundant in Bottom Creek.

23. Etheostoma nigrum (Rafinesque).

One specimen of var. *vexillare* (scales 40, 41,) from Salem; many from Bottom Creek, above Alleghany Springs.

24. Etheostoma roanoka Jordan & Evermann.

Very common in swift and grassy waters; one of the most elegant of the darters.

25. Etheostoma aspro (Cope & Jordan).

Several specimens, the longest 4⅛ inches in length; most common in Bottom Creek in rather deep water. D. XII–13, XIV–13 in two specimens; A. II–9, scales 60, 64, 64 in three specimens. These specimens agree fairly with *E. aspro* from Illinois River. The dark blotches on the sides are smaller, less broadly confluent, but rather resembling widenings of a narrow black band. The scales are a little larger, those on the cheeks faint and imbedded, and in one specimen wanting altogether.

26. Etheostoma rex Jordan & Evermann.

Two specimens of this superb darter were taken in the Roanoke River. The larger of these (5½ inches long) was taken in the rapids under the bridge 2 miles southwest of Roanoke.

27. Etheostoma flabellare (Rafinesque).

Common; scales 46. These specimens are not different from others from Indiana.

F.—THE PAMLICO RIVER.

The Pamlico River is a broad, tide-water estuary opening into the southern part of Pamlico Sound. Its principal tributary is known as Tar River, a stream which rises near the Virginia line, and flows southeast through pine forests into the head of the Pamlico. Collections were made in the Tar River, at a point 2 miles below the village of Rocky Mount. August 29; temperature 73°.

In the Tar River, at the point referred to, a large dam crosses the stream. This dam rests on a ledge of granite, and for a long distance below the dam the bottom of the river is very rocky. There are a few deep holes in the river, and some other points suitable for collecting. The rocks are covered with water-plants. The water in the river was muddy, although it had not been raised by rains.

1. **Lepisosteus osseus** (L.).

Two small specimens, about a foot long, and many large ones were taken.

2. **Noturus furiosus** Jordan & Meek. "Tabby Cat."

A single specimen, similar to the types of the species from the Neuse River.

Numerous very large examples of this species were taken some twelve years ago in the Tar River, near Tarborough, by Mr. James W. Milner. These are now in the U. S. National Museum. They were at first identified by me as *Noturus eleutherus*, and afterwards as *Noturus miurus*. They are closest to *N. miurus*, but apparently distinct from both species, having a stronger armature and a more strongly marked coloration than either.

3. **Noturus insignis** (Richardson).

Abundant. Color very dark; edges of fins little darker.

4. **Ameiurus erebennus** Jordan.

Two small specimens.

5. **Ameiurus nebulosus** (Le Sueur).

Common. Anal rays 22; caudal slightly concave.

6. **Catostomus nigricans** (Le Sueur).

Common.

7. **Moxostoma papillosum** (Cope).

Common. Body rather elongate; the back low; lower lip small, deeply incised; its surface plicate, but the folds broken up into papillæ. D. 13.

8. **Moxostoma cervinum** (Cope).

Common. Color strongly marked; back purplish black; belly abruptly white; a pale streak along the centers of each row of scales; dorsal, anal, and caudal dark, the tips inky black.

9. **Hybognathus nuchalis** Agassiz.

Common. Specimens all small.

10. **Notropis procne** (Cope).

Common.

11. **Notropis megalops albeolus** Jordan & Meek.

Two small specimens, similar to those from the Roanoke; lower jaw not shorter than upper.

12. **Notropis matutinus** (Cope).

Common. This species is a member of the group called *Lythrurus*, and it is closely related to *Notropis lirus*. In spirits it is very pale, with a lateral band of dark points and a small black spot at base of dorsal in front, preceded by a dark streak along the middle line of the back. Head $4\frac{1}{4}$; depth $5\frac{1}{2}$ in length; scales 44; 20 to 25 scales before the dorsal.

In life, snout, tip of lower jaw, iris, and membranes of upper half of dorsal red.

13. **Notropis niveus** (Cope).

Abundant. Similar to that found in the Dismal Swamp.

14. Notemigonus chrysoleucus (Mitchill).

Common. Anal rays 16; scales 48; hence referable rather to the southern variety *bosci*.

15. Hybopsis kentuckiensis (Rafinesque).

Common. Scales 44.

16. Semotilus atromaculatus (Mitchill).

One young specimen approaching *S. thoreauianus*. Color dark; a small black spot at base of dorsal, a larger one at base of caudal; a distinct black lateral band from snout to base of caudal; head rather broad and flattish above; mouth moderate, slightly oblique, the maxillary extending to the front of the very large eye; jaws equal; dorsal inserted behind ventrals; lateral line decurved, only three or four pores developed in this (young) specimen. Head $3\frac{4}{5}$ in length; depth $4\frac{1}{2}$; A. 8; scales 48, 30 before dorsal.

17. Gambusia patruelis (Baird & Girard).

18. Umbra pygmæa (De Kay).

Rather scarce.

19. Lucius reticulatus (Le Sueur).

Common.

20. Aphredoderus sayanus (Gilliams).

Rather scarce. Scales 45.

21. Pomoxis sparoides (Lacépède).

Common.

22. Enneacanthus gloriosus (Holbrook).

A few specimens.

23. Acantharchus pomotis (Baird).

Black lengthwise stripes numerous and very distinct in the young.

24. Lepomis auritus (L.).

Common.

25. Etheostoma nigrum effulgens (Girard).

Common. All the specimens examined have the cheeks naked. Scales 42.

26. Etheostoma vitreum (Cope).

Very abundant.

27. Etheostoma peltatum Stauffer.

One specimen.

28. Etheostoma roanoka Jordan & Jenkins.

Two specimens; head naked; scales 45.

The fauna of the Tar River is essentially that of the Neuse. Probably an extended exploration would show that every species of the one is found also in the other.

G.—THE NEUSE RIVER.

The Neuse River is one of the largest streams of eastern North Carolina. It rises in the middle-northern part of the State and flows east through the pine woods, discharging its waters through a broad estuary into Pamlico Sound.

Collections were made at three points in the basin of the Neuse.

1. *Neuse River* at Millburnie, near Raleigh, N. C., August 27. A dam built upon a ledge of granite crosses the river at Millburnie. Below the dam the river flows rapidly over rocks, with falls and rapids, and among the rocks are many deep holes and pools. The rocks are in many places covered with river-weeds (*Podostemon*, etc.). Below the rocky district are deep holes, with shoals and ripples, the bottom being largely sandy or gravelly. The water in the river, although low, was quite muddy. This is an excellent locality for collecting. Specimens taken in Neuse River, at Millburnie, are marked N in the following list:

2. *Little River* at Goldsborough. August 29; temperature 78°. Collections were made in Little River, near its junction with the Neuse, at points above and below where it is crossed by the railroad from Raleigh. The stream flows through a level region. It consists of deep holes with intervening shoals, the former with bottom of mud or sand, the shoals sandy or gravelly. The bottom of the river is full of submerged logs and snags. The water is clear, but stained somewhat brown from the drainage of cypress swamps. Specimens from Little River are marked L.

3. *Moccasin Swamp.*—Moccasin Swamp is a stream flowing through a cypress swamp and emptying into the Neuse below Goldsborough. The Swamp was not visited, but numerous specimens of food-fishes were obtained from a fisherman who had seined the Swamp at a point about 15 miles from Goldsborough. The species obtained are marked M in the following list:

1. Amia calva Linnæus. M. "Black Fish."

Common in the swamps.

2. Noturus furiosus Jordan & Meek. L., N. "Tabby Cat;" "Mad Tom."

Common in the Neuse River at Millburnie, where fifteen specimens were taken. One specimen taken in the Little River and one in the Tar.

Specimens were taken at Goldsborough in 1877 by Brayton and Gilbert.

This species is closely allied to *Noturus miurus*, from which it differs in its much larger spines and more pronounced coloration.

3. Noturus insignis (Richardson). L., N.

Very abundant, especially in the Neuse. Coloration pale, black margins to caudal narrow and faint, none at all on dorsal and anal; base of dorsal dusky, the fin otherwise pale.

4. Ameiurus natalis (Le Sueur). L., M.

Color black; body very plump, the head broad and the spines quite short.

5. Ameiurus erebennus Jordan. M.

Common in the swamp. Very close to *A. natalis*, the head becoming broader with age and thus resembling the latter. The pectoral and dorsal spines are however much longer than in the latter.

6. Ameiurus niveiventris (Cope). L. N. "Fork-tailed Cat."

Only young specimens. The body seems slenderer, the caudal more deeply forked than in the young of *A. albidus*. A. 21 to 23. Color silvery, the fins darker.

7. Catostomus nigricans (Le Sueur). N.

Common.

8. Erimyzon sucetta (Lacépède). M., L., N.

Very common; scales 46.

9. Moxostoma papillosum (Cope). L., N.

Very common. Snout projecting beyond the very small mouth; head short and broad, with large eye. D. 14, the edge of the fin straightish; caudal lobes equal. Pharyngeal bones weak.

10. Moxostoma conus (Cope). L.

A single young specimen. Head very short and small, the short, narrow snout projecting beyond the small mouth; lips full, the posterior truncate. D. 12, the fin high, its free border concave, the first rays being much produced. Caudal deeply forked, the upper lobe a little longer. This species is very closely related to the species found in the Ohio River and Lake Erie, which is apparently *Moxostoma breviceps*[1] (Cope).

11. Moxostoma crassilabre (Cope). L.

One large specimen. Body robust, the back elevated; head short, broad, flattish above; mouth moderate, the lips full, the lower truncate behind; snout short, little projecting beyond mouth. Head 5 in length; depth $3\frac{1}{3}$. D. 13. Caudal lobes equal; dorsal with its free edge much incised, the anterior lobe about as long as head. Pharyngeals weak. Color rather dusky; many of the scales with a dusky shade at base; top of head, humeral bar, and especially a broad shade across dorsal fin, blackish. Some red on anal and caudal fins.

Compared with *Moxostoma breviceps* from Cincinnati, this species is much more robust, with larger, broader, and much more flattened head. The eye is larger, the snout much shorter, and the preorbital is much broader. This bone is quite narrow in *M. breviceps*. In *M. breviceps* the top of the head is very convex transversely, the dorsal lobe is $1\frac{1}{4}$ times length of head, and the upper lobe of the caudal is much prolonged.

The resemblance of *M. crassilabre* to *M. aureolum* from Toledo is much greater, the only prominent difference being that *M. aureolum* has the upper outline of the dorsal slightly convex.

M. macrolepidotum (the true eastern form, as distinguished from the western, *M. duquesnei*), from Potomac River, is also very close to *M. crassilabre*. The two have the same general form and coloration and the same form of the mouth and of the dorsal fin. In comparing a single specimen of each, I find that *crassilabre* has a still shorter and blunter head and higher back. The eye in *crassilabre* is $1\frac{1}{2}$ in snout, the head 5 in body. In *macrolepidotum* the eye is $1\frac{2}{3}$ in snout, the head $4\frac{2}{3}$ in body. It is probable that *M. crassilabre* will prove to be a slight variety of *M. macrolepidotum*. *M. duquesnei*, the western red-horse, may differ in the slightly longer head, and in not

[1] This species is described in the fifth edition of Jordan's Manual of the Vertebrates as *Moxostoma crassilabre* (Cope), which is, however, a different species.

having the free edge of the dorsal concave. Its claims to stand as a distinct species are, however, open to much doubt.

12. Moxostoma cervinum (Cope). N. "Crawl-a-bottom."

Common. Specimens similar to those from the Roanoke and James, but larger.

13. Hybognathus nuchalis Agassiz. N., L.

Very common. Some large specimens taken in the Neuse.

14. Notropis procne (Cope). L., N.

Common. The two specimens taken in the Neuse are very pale, with only traces of lateral band and caudal spot.

15. Notropis hudsonius (Clinton). L.

One taken.

16. Notropis megalops albeolus Jordan & Meek. N.

Scarce.

17. Notropis niveus (Cope). L., N.

Very common. The form variable; some specimens almost as deep as those of *N. whipplei*, of which species this may prove to be a variety.

18. Notropis amœnus (Abbott). N.

Common in the Neuse. This is apparently the species recorded by Cope (Proc. Am. Philos. Soc., 1870) as *Photogenis leucops=Notropis photogenis*. I am not sure, however, of its identity with the species to which the name *photogenis* was originally given.

19. Notropis matutinus (Cope). N.

Rather scarce in the Neuse.

20. Hybopsis kentuckiensis (Rafinesque). L., N.

Very common.

21. Notemigonus chrysoleucus (Mitchill). N., L.

Common. Scales 48; anal rays 15.

22. Clupea sapidissima (Wilson). L., N. Shad.

Young common. A large plant of shad was made in the Neuse at Millburnie about five years ago.

23. Gambusia patruelis (Baird & Girard). L., N.

Common. *Haplochilus melanops* Cope, from the Neuse, and *Zygonectes atrmatus* Jordan & Brayton, from Little River, are both based on this species.

24. Lucius americanus (Gmelin). L.

25. Lucius reticulatus (Le Sueur). M., L.

Common.

26. Anguilla anguilla rostrata (Le Sueur). N.

Eels abound in every stream in Carolina east of the Blue Ridge.

27. Aphredoderus sayanus (Gilliams). L.

Not rare.

28. Pomoxis sparoides (Lacépède). L., M., N.
Common.

29. Centrarchus macropterus (Lacépède). M., L. "Flyer."
Common in still waters.

30. Enneacanthus gloriosus (Holbrook). L.
Not very common. The large specimens described by me in 1877 under the name of *Enneacanthus pinniger* came from Neuse River, at Kinston, N. C.

31. Acantharchus pomotis (Baird). M. "Mud Perch."
Common in the swamps.

32. Chænobryttus gulosus (Cuv. & Val.). M., N.
Not rare.

33. Lepomis auritus (L.). L., N. "Yellow-belly."
Common. All of the typical northern form.

34. Lepomis holbrooki (Cuv. & Val.). L.
Scarce.

35. Lepomis gibbosus (L.). M. "Sand Perch."
Common.

36. Micropterus dolomieu (Lacépède). M., N.
Common in the streams.

37. Micropterus salmoides (Lacépède). M., L., N. "Chub."
Common, especially in the swamps.

38. Etheostoma vitreum (Cope). N., L.
Very abundant. Scales 57.

39. Etheostoma nigrum (Rafinesque) var. *olmstedi*. N., L.
Very abundant in Little River; less so in the Neuse. Nearly all of these specimens have the upper part of the cheeks partly covered with scales. Some of them are very slender in form, and some are stout; some have the middle line of the belly largely naked. Scales 50; D. IX–15.

40. Etheostoma peltatum Stauffer. N., L.
Common. There are among these specimens all gradations in coloration, from that of the specimens taken in Swift Creek, to the markings of the ordinary *peltatum*. Some specimens have a black lateral stripe scarcely widened at intervals. Some of the specimens have smooth imbedded scales on cheeks, opercles, and nape (=*nevisense* Cope), but most of them, including some of each of the patterns of coloration, have the nape and cheeks wholly naked, the opercle nearly so. *E. aspro* and *E. ouachitæ* are both extremely close to *E. peltatum*.

41. Etheostoma roanoka Jordan & Jenkins. N.
Very abundant in the Neuse River at Millburnie. The specimens are rather smaller than those from the Roanoke, and the ground color is paler, which leaves the markings more sharp.

H.—THE CAPE FEAR RIVER.

The Cape Fear River rises in the uplands of northern North Carolina, its two chief tributaries being the Haw and the Deep Rivers. It flows southward, entering the sea near the cape from which it takes its name. Its tributary streams for more than half its course flow over a soil of red clay, produced by decomposition of granite. Most of these streams are full of yellow clayey sediment all the year around, and hence are not favorable for fish life. No collections of any extent had been made in the Cape Fear Basin previous to our visit. The fauna is evidently substantially identical with that of the Santee and Great Pedee, streams which enter the sea not far from the mouth of the Cape Fear. In several respects its fauna differs from that of the Neuse River, which is more nearly like that of the Roanoke. Our collections in the Cape Fear Basin are all from tributaries of Haw River, in Guilford County, N. C.

1. *Reedy Fork of Haw River* at Fulk's Mill, 11 miles north-northeast of Greensborough. August 25; temperature 74°. This is a rather sluggish stream, stained gray by sediment, its bottom covered with gravel and mud, with many snags. The stream is not a good one for collecting, but this locality is probably as favorable as any, for below the mill the stream shows some current. Species taken here are marked R.

2. A small very clear brook or spring-run, without name, one mile south of Fulk's Mill. August 25; temperature 70°. This stream is full of small fishes; those taken here are marked S.

3. *South Buffalo Creek*, about 5 miles southeast of Greensborough. August 25; temperature 70°. This is a small creek, with rather clear water, and well stocked with small fishes. It contains some long deep pools, on a bottom of gravel. Fishes from this stream are marked B.

4. *Little Allemance Creek*, at a point about 9 miles southeast of Greensborough. August 25; temperature 69°. This is a small stream, very clear, and fed by springs. It has a bottom of gravel. Fishes from this stream are marked A.

1. **Noturus insignis** (Richardson). B., R.

Some very large specimens.

2. **Ameiurus platycephalus** (Girard). B., R.

Very abundant in the river. This species swarms in all the river bottoms from the Cape Fear to the Ocmulgee, reaching a length of something more than a foot. Unlike the other catfishes, it feeds almost exclusively on vegetation, its long intestines being always found crowded with the remains of river weeds. This fact may render it desirable for introduction into streams not adapted for any better fish. It is largely used for food in the regions where it occurs.

I am unable to distinguish *Ameiurus brunneus* Jordan, from *A. platycephalus*. The species varies considerably, and in old examples the head becomes very flat and broad. Excessively abundant as is this species in the Cape Fear, and in the streams further down the coast, it has not yet been noticed in the Neuse or the Roanoke.

3. **Moxostoma papillosum** (Cope). R.

Common. These specimens are quite elongate, and vary somewhat among themselves; fins all red in some, in others the caudal only; edge of dorsal concave. Head 4 to $4\frac{1}{2}$ in length; depth $4\frac{1}{3}$. D. 12 to 14.

4. Minytrema melanops (Rafinesque). R. "Black Winter Sucker."

Two specimens similar to northern examples; a distinct broad lateral stripe of purplish red in male; snout and anal tuberculate. Scales 44.

5. Erimyzon sucetta (Lacépède). R., A., B., S.

Common; scales 39 to 40.

6. Hybognathus nuchalis Agassiz. R.

Common.

7. Notropis procne (Cope). R., A., B., S.

Extremely common. Specimens larger than any taken farther north; the jet-black lateral band distinct; fins slightly yellowish.

8. Notropis altipinnis (Cope). A., B., S.

Very common in the clear streams. This species does not belong to the *atherinoides* or *rubrifrons* type, but it is a very near ally of *N. chiliticus*, *rubricroceus*, *chlorocephalus*, etc. It is most closely related to *N. chalybæus* (Cope), so closely that I am not at all sure that it is distinct from the specimens from Blackwater River, which I have referred to the latter species. The specimens of *N. altipinnis* are, however, much deeper in body, the back more elevated, and the lateral line more decurved; head a little more robust; dorsal fin high; depth $3\frac{1}{2}$ in length; lateral line complete; eye large; scales before dorsal small; color in life greenish, a burnished lateral band formed of black points passing from snout to base of caudal; young with a black caudal spot; no black at base of anal; dorsal, anal, and caudal faintly reddish; snout yellowish in life; lower lip always dusky. Anal rays 9.

9. Notropis saludanus (Jordan & Brayton). R.

Scarce.

10. Notropis niveus (Cope). R.

Common in the river. These specimens show much variety of form of body and in form of snout. If *N. chloristius* (Jordan & Brayton), and *N. niveus* are really distinct species, both are represented in this collection, the *chloristius* form being more abundant. Dorsal and caudal light brownish yellow in life; snout slightly yellowish.

11. Notropis scepticus Jordan & Gilbert. R.

Not rare. Very pale green, the sides silvery. Eye very large, 3 in head. Head and body less elongate than in *N amœnus*, the eye still larger. Scales before dorsal larger, 13 to 15, depth $4\frac{1}{2}$; A. 10. This is apparently the species recorded by Cope as *Photogenis leucops* var., but it can not be the original *Notropis photogenis*. The specimens from the Saluda referred by Jordan & Brayton to *N. photogenis* seem to belong to *N. scepticus*.

12. Semotilus atromaculatus (Mitchill). A., B., S.

Very common in the brooks. These North Carolina specimens are almost intermediate between the ordinary species and the more southern *S. thoreauianus*. Scales 48 to 55, usually about 49, less crowded anteriorly than in *S. atromaculatus*. The head is longer and less blunt than in *S. thoreauianus;* $3\frac{2}{3}$ in length, 4 in *thoreauianus* (from Tuscaloosa, Ala.), of the same size, the scales in the latter 45. In life the black dorsal spot surrounded by scarlet; base of anal, ventrals, and pectorals pinkish; caudal yellowish.

13. Notemigonus chrysoleucus (Mitchill). B.

A. 16. Scales 46, hence of the var. *bosci.*

14. Lucius reticulatus (Le Sueur). B.

One specimen. (*Esox affinis* Holbrook.)

15. Lucius americanus (Gmelin). B., A., S.

Common in clear brooks. Body with 18 to 20 dark green cross-shades; lower fins all scarlet; upper fins edged above with carmine. Snout extremely short and broad, $2\frac{2}{3}$ in head. Scales 88. Stomach packed full of small minnows. This is *Esox raveneli* Holbrook.

16. Fundulus rathbuni Jordan & Meek. R., A., B., S.

Common in the small brooks; scarce in the river.

17. Anguilla anguilla rostrata (Le Sueur). R., B.

Common.

18. Chænobryttus gulosus (Cuv. & Val.). R.

One specimen. I find no difference except in shade of color, on comparison of this specimen with *Chænobryttus antistius* McKay.

19. Lepomis auritus (L.). R., A., B.

Common. These specimens belong to the northern or typical *auritus.*

20. Etheostoma peltatum Stauffer. B., A.

Scarce. Colors very bright; a few scales on opercle, none on cheeks.

21. Etheostoma nigrum (Rafinesque.) R.

Very abundant in river. Scales 46; some specimens much spotted, especially on head and pectoral. One male with the head black.

I.—THE GREAT PEDEE RIVER.

The Great Pedee, called in North Carolina the Yadkin, rises in the north of the central part of North Carolina and flows nearly southward to the sea, its mouth being in the eastern part of South Carolina. The whole upper course of the stream is through the red clays of the "Piedmont" region. The river itself and most of its tributaries are therefore, for the whole year around, discolored by sediment and unfavorable to fish life. A number of large species of sucker (*Moxostoma*) occur in the river, ascending the smaller streams to spawn in the spring. Large collections of these were made by Professor Cope at the time of his visit in 1869, when they were taken in numbers on the weirs. No specimens of these are, however, obtainable in August, at which time both old and young have retreated to the main rivers. Collections were made by us only in the neighborhood of Salisbury.

1. *Little Yadkin River* (or *South River*) at Lindsay's Mills (South River P. O.). August 24; temperature 72°. This point is about 8 miles north of the city of Salisbury, and not far from the junction of the South River and the Yadkin. The South River is a large and rather shallow stream, flowing swiftly over a gravelly bottom. Its water is grayish yellow, full of sediment. The number of species found is small.

2. *Second Creek*, a tributary of South River, 1 mile further south. August 24; temperature 71°. A very muddy stream, its waters red with clay. Fishes few, similar to those in the river.

3. *Jumping Run*, a small clear "spring branch," 6 miles north of Salisbury. August 24; temperature 69°. In this stream were found *Fundulus rathbuni* and *Notropis chiliticus.*

1. **Noturus insignis** (Richardson).

Common, as everywhere.

2. **Ameiurus platycephalus** (Girard).

Very abundant in the river.

3. **Ameiurus albidus** (Le Sueur).

One specimen. A. 22. Caudal forked.

4. **Hybognathus nuchalis** Agassiz.

Common.

5. **Notropis saludanus** (Jordan & Brayton).

Not rare. Very pale; head 4 to 4¼ in length; most specimens with a black caudal spot.

6. **Notropis chiliticus** (Cope).

Not rare. In life, light green, a distinct silvery lateral band. Lips, snout, and middle of dorsal, anal, and caudal vermilion. Whole body flushed with red in males; usually a black caudal spot. A strongly marked species, allied to *N. chlorocephalus*, *N. chalybæus*, *altipinnis*, etc. It is less robust in form than *N. altipinnis*, the head more slender, and the mouth larger.

7. **Notropis niveus** (Cope).

Common. These specimens seem to be of the typical *N. niveus*. One old male has the body very elongate, the dorsal high. In life more or less bluish, silvery below; a black dorsal blotch; male with dorsal and caudal pale yellowish brown; the tips of the fins and the anal milky.

8. **Notropis pyrrhomelas** (Cope).

Common. This species is well distinguished at all ages by the large eye and mouth and the long anal (of 10 rays) in connection with the black dorsal blotch. Most specimens show a black blotch at base of caudal.

9. **Hybopsis labrosus** (Cope).

Common. Males dark steel-blue, with black markings on back, and especially at base of dorsal; snout and fins all orange. Females very pale silvery, with a bluish streak along sides of tail. Barbel very long. *Ceratichthys zanemus* (Jordan & Brayton), from Saluda River, is identical with *H. labrosus.*

10. **Hybopsis kentuckiensis** (Rafinesque).

Common. This is probably the species described from the Yadkin River, at Salem, N. C., as *Ceratichthys leptocephalus* Girard.

11. **Fundulus rathbuni** Jordan & Meek.

Numerous young specimens taken in Jumping Run.

12. **Lepomis auritus** (L.).

Scarce.

13. **Etheostoma nigrum** (Rafinesque).

Not rare.

14. **Etheostoma peltatum** Stauffer.

Frequent. Scales 55.

J.—THE SANTEE RIVER.

The Santee River is formed by the confluence of a number of large rivers all of which rise on the eastern slope of the Blue Ridge. The headwaters of nearly all these streams are clear and cold, many of them abounding in trout. As these rivers flow southeastward through the red and yellow clays of the "Piedmont" region, the waters become yellow with sediment and the river ultimately formed is scarcely less muddy than the Great Pedee or the Cape Fear. The mouth of the Santee is near that of the Great Pedee, just north of Cape Romain. The name Santee is given to the lower course only of the river, below the junction of the two great branches, the Wateree and the Congaree. The Wateree, called in North Carolina the Catawba, rises in western North Carolina near Swannanoa Gap. It is the largest and the clearest of the tributaries of the Santee. The Congaree is in turn formed by the junction of the Saluda and the Broad. The Saluda, rising in Saluda Gap, South Carolina, is a comparatively clear stream, and its fauna has been investigated by Jordan & Brayton (Bull. U. S. Nat. Mus., XII 1878). The Broad River, rising in North Carolina, is comparatively muddy, as are most of its tributaries, in three of which—the Pacollet, Tiger, and Ennoree—collections have been made. Although the basin of the Santee covers a wide extent of country, with considerable variation in its physical characters, its fish fauna is quite uniform. For the most part the same species were found by us at Marion, Morganton, and Spartanburgh that had previously been found by Cope at Marion, and by Jordan and Brayton at Greenville. In the past summer collections were made at each of the following localities:

1. *Catawba River* near Marion, N. C. August 22; temperature 73°. Collections made at the upper ford, 3 miles northwest of Marion, about a mile below the mouth of Buck's Creek. The character of the river is similar to that of the upper Roanoke; gravelly bottom on shallows, alternating with deep stretches in which the bottom is muddy. The water is warm and somewhat muddy, of a light yellowish color. This is a good region for making collections. Species from this locality are marked C.

2. *Buck's Creek* at Pleasant Garden. August 22; temperature 69°. About 4 miles northwest of Marion, near the post-office of Pleasant Garden, Buck's Creek rises in mountain springs and flows into the Catawba. It is a very clear, strong, swift mountain stream, flowing over gravel and bowlders, the rocks in its bed being covered by river weed (*Podostemon*). It is extremely well stocked with small fishes, the darters especially being very abundant. Species found in this stream are marked B.

3. *John's River* near Morganton. August 23; temperature 74°. John's River flows into the Catawba at a point about 4 miles northeast of Morganton. It is a large, clear stream, having its source in the mountains. Its waters are warmer and less clear than those of Buck's Creek, and its bottom is gravelly rather than rocky. In its upper course it is, however, probably similar to Buck's Creek. Both these streams and the Linville River, which comes into the Catawba midway between them, are suitable for trout. The California rainbow trout, *Salmo irideus*, has been placed in the John's and the Linville, but I have not heard of any results from this plant. Species found in John's River are marked J.

4. *Catawba River* at Morganton. August 23; temperature 74°. The river at the bridge at the northeast of Morganton is broad and shallow, with rocky bottom; the

water very muddy. Catfishes (*Ameiurus platycephalus*) are extremely abundant in the river here. The other fishes obtained are the same as those taken at Marion; the latter locality is more favorable for collecting.

5. *Pacollet River* at Clifton Factory. August 17; temperature 87°. The Pacollet, a large tributary of Broad River, was examined at a point 7 miles northeast of the town of Spartanburgh, S. C. Collections were made below the dam of the Clifton Cotton Factory. The bottom in most places is excessively rocky and the river flows swiftly over the rocks, which are bare of vegetation. In the deep still places, however, the bottom is muddy. The water is very muddy and warm and the river is one altogether unfavorable for the production of fishes. A few specimens (*Moxostoma rupiscartes*, *M. papillosum*, *Ameiurus platycephalus*, *Lepomis auritus*) were obtained from a fisherman who had drawn a coarse seine at a point farther up the river. *Moxostoma rupiscartes* and *Ameiurus platycephalus* are the chief food-fishes in the markets of Spartanburgh. Species found in Pacollet River are marked P.

6. *Tiger River* at Cleveland Shoals. August 18; temperature 76. The Tiger River is a deep, sullen, muddy stream, running through woodland with little current, and ultimately flowing into Broad River. Our collections were made in the North Fork of the Tiger, at a point 6 miles west of Spartanburgh. The river flows in a deep valley, almost a ravine, in the woods. It is crossed by a natural dam of granite making a perpendicular waterfall some 5 feet high, known as Cleveland Shoals. Below the fall the water flows swiftly over angular rocks which are not covered with river weed. The water is rather cold but very muddy, almost red. It contains few fishes and these are of few kinds. These species are marked T.

7. *Forest Creek* near Spartanburgh. August 18; temperature 72°. Forest Creek is a small, clear "spring branch," running swiftly over sand and gravel, and flowing into Tiger River. It was seined at a point 1½ miles west of Spartanburgh. It contains darters and the rare *Notropis lutipinnis*, hitherto known only from the Oconee River.

It is probable that the following list includes almost every species that belongs to the upper waters of the Santee. In the lower course species of *Esox*, *Lepidosteus*, *Amia*, and other lowland fishes doubtless occur. I have *Notemigonus chrysoleucus bosci* from the Congaree at Columbia, S. C., and, according to Dr. Bean, the U. S. National Museum has received *Labidesthes sicculus* from the same locality.

1. Noturus insignis (Richardson). B., J., C., T.

Common. The specimens from the Catawba are quite dark in color, the edge of the caudal darker; body less elongate, and the head less depressed than in specimens from further north, the back a little elevated, the pectoral spines a shade shorter than usual.

2. Ameiurus platycephalus (Girard). C., J., P.

Very abundant in all the larger streams. Variable in form and color, the range of variation apparently including *A. brunneus*.

3. Catostomus teres (Mitchill). C., B.

Rather common.

4. Moxostoma papillosum (Cope). C., P.

Rather scarce.

5. Moxostoma rupiscartes Jordan & Jenkins. B., C., J., P., T.

The specimens from the Catawba, Saluda, Ocmulgee, and other rivers south of the Neuse, hitherto referred to *Moxostoma cervinum* by Cope and by the writer, seem to belong to a distinct species, for which we have proposed the name of *Moxostoma rupiscartes*, the latter name in allusion to the vernacular name of "Jump Rocks," by which the species is known in Georgia. It is closely allied to *M. cervinum*, differing chiefly in its smaller scales and more uniform coloration. It reaches a larger size; its lips are larger, and the form of its dorsal fin is somewhat different. It is very abundant in the Catawba, Pacollet, and all other large streams in the Santee Basin. It is less strictly confined to rapids, shoals, and waterfalls than is the case with *M. cervinum*.

6. Campostoma anomalum (Rafinesque). B., J., C.

Rather common; scales 52.

7. Hybognathus nuchalis Agassiz. C., J.

Common.

8. Notropis saludanus (Jordan & Brayton). J., P.

Not rare. It may be that the southern form of this fish is a species distinct alike from the northern *hudsonius* and from the *amarus* of the Potomac. Comparison of numerous specimens shows the following results:

The southern form, *saludanus*, James River to Ocmulgee River, has the head notably longer ($4\frac{1}{6}$ in length in specimens from John's River; $4\frac{2}{5}$ in specimens from Swift Creek); the snout is especially longer, projecting over the inferior mouth; the snout about as long as eye, which is about 4 in head. Teeth 1, 4–4, 0.

Var. *amarus* from the Potomac has head shorter and deeper ($4\frac{1}{2}$ to $4\frac{3}{5}$ in length); eye larger ($3\frac{1}{2}$ in head); caudal spot faint; teeth 1, 4–4, 0.

Var. *hudsonius* (specimens from Michigan City, Ind.), has the head still shorter ($4\frac{2}{3}$ in length); eye $3\frac{2}{5}$ in head, as long as snout; snout blunt; mouth a little more oblique than in *amarus* or *saludanus;* maxillary not to front of eye; teeth 2, 4–4, 1. Caudal spot jet black.

Var. *selene* from Keweenaw, Lake Superior, has the head still shorter ($4\frac{4}{5}$ in body); mouth quite oblique, the premaxillary on level of lower part of pupil; snout $\frac{3}{5}$ eye; maxillary reaching front of eye; caudal spot jet black. Teeth 2, 4–4, 1 or 2.

The extremes, *selene* and *saludanus*, certainly look like very distinct species, but the intergradations are such that it seems safest to regard the whole series as varieties of one species, *N. hudsonius*.

9. Notropis procne (Cope). C.

Abundant in the Catawba, in the river channels; not noticed in the other streams.

10. Notropis chlorocephalus (Cope). B.

Abundant in the clear, swift waters of Buck's Creek. Green in life; dorsal and caudal red at base; sides of head and lateral band on sides red. Adult males with the whole body cherry-red, the back green, lower jaw not black. Allied to *N. rubricroceus*.

11. Notropis lutipinnis (Jordan & Brayton). F.

Six specimens taken in the clear waters of Forest Creek; hitherto known only from a similar locality on the headwaters of the Oconee, in Georgia. In life, pale

olive; broad metallic lateral band; iris red; body in male flushed with brownish red; head and fins all bright yellow, without red; scales before dorsal smaller than in related species.

12. Notropis niveus (Cope). J., C., P., T.
(Including *N. chloristius* (Jordan & Brayton.)

Abundant. This species is one of the most puzzling in its variations, and I am not yet sure whether it is really distinct from *N. whipplei*, or whether, on the other hand, I have not confounded two species under the name *niveus*.

All the specimens taken in the Catawba, and most of those from the Pacollet, are the typical *chloristius*. This form is very close to *N. whipplei*, the eye a little smaller, the head more slender, the blue stripe on side of tail more distinct. In these the eye is 4 in head, and the body short and deep, the depth $3\frac{3}{4}$ to $4\frac{1}{4}$; scales 36. Two of the specimens from the Pacollet, and most of those from the rivers farther eastward, correspond best to the descriptions of *N. niveus*. In this form the body is elongate, compressed, with the back more elevated. Eye $3\frac{1}{2}$ in head; depth of body $4\frac{1}{2}$ to 5; scales 39. The blue stripe on caudal peduncle is less distinct, and there is a trace of a caudal spot. Head subconic, the thickish snout projecting. The species from the Dismal Swamp region, identified by us as *N. niveus*, is not quite like either of these forms. It is certainly quite unlike *chloristius*. Our collection shows so many intermediate or indeterminable examples that I am compelled to record all under a single name, *Notropis niveus*.

13. Notropis pyrrhomelas (Cope). B., C., J., P., T., F.

The most abundant fish in the Santee basin, and one of the most showy of the *Cyprinidæ*, the male retaining its bright colors through the summer.

14. Notropis scepticus Jordan & Gilbert. J., C., T.

Not rare. Close to *N. amœnus*, but with the snout shorter and blunter, the eye larger. Specimens show considerable variation in form, but all belong to one species. Scales before dorsal 14 to 16 (Catawba) to 18 (Pacollet). Green in life; sides silvery; no red.

15. Squalius vandoisulus (Cuv. & Val.). B.

Abundant in Buck's Creek. Dark lateral stripe very obscure; depth $4\frac{1}{3}$ in length.

16. Hybopsis hypsinotus (Cope). P.

One specimen from Pacollet River. An ally of *H. amblops*. A dusky lateral band through eye and snout, ending in a faint caudal spot. Resembles *N. procne*, but with an evident barbel.

17. Hybopsis labrosus (Cope). B., J., P.
(*Ceratichthys zanemus* Jordan & Brayton.)

Common in clear water. Male steel-blue; a black spot on back at base of dorsal in front; a dark shade under middle of dorsal; a black blotch on membranes of dorsal, as in *Notropis whipplei* and *niveus;* a dark caudal spot; a plumbeous shade on sides; caudal with a dusky shade on membranes; a dark shade on opercle; snout and all fins bright red; female pale, with faint black blotch on dorsal, and with no red.

This species is in form and coloration remarkably unlike all the others in the genus.

18. Hybopsis kentuckiensis (Rafinesque). P., F., B., C., J., T.

Very common; body short and deep; scales 39.

19. Anguilla anguilla rostrata (Le Sueur). C., T., P.

Everywhere common.

20. Salvelinus fontinalis (Mitchill). B.

Brook trout abound in the headwaters of Buck's Creek, and doubtless also in the Linville and John's Rivers. None were taken by us.

21. Lepomis auritus (L.). B., J., C., P.

Common. The specimens from this region belong to var. *solis*, characterized by the slightly larger scales. Usually a dark shade at base of last rays of dorsal.

22. Etheostoma nigrum (Rafinesque). B., C., J.

Common in the river channels; scarce in the smaller streams. Scales 44.

23. Etheostoma peltatum Stauffer. B., C., J., P.

Frequent. Especially common in John's River. Head usually naked. Scales 52 to 54. Dorsal low, with median black band; second dorsal, caudal, and pectoral sharply banded. D. XI, or XII–14.

24. Etheostoma thalassinum (Jordan & Brayton). B., J., F., P.

Much the commonest of the darters, especially abundant among the weed-grown rocks of Buck's Creek. Scales 40. Caudal distinctly lunate. In life, green; mottled in various shades; body with 6 or 7 cross-bars of bluish-green; ventrals and anal bluish-green; fins mottled, not barred; orange on belly and on bases of pectoral and caudal; spinous dorsal edged with orange; a dark spot and a yellow area at base of pectoral; a pale oblique streak below and behind eye.

25. Etheostoma flabellare (Rafinesque). B., J.

Common in clear waters. Most specimens have but seven dorsal spines. The number of scales is unexpectedly variable. I count 40, 39, 41, 43, 44, 50, in six specimens.

K.—THE KANAWHA RIVER.

The Kanawha River, called in Virginia the New River, rises on the western slope of the Blue Ridge in western North Carolina, and flows nearly north through Virginia and West Virginia into the Ohio River. Its tributaries are generally clear mountain streams, though the river itself is more or less stained by the yellow clays over which it flows. The fauna of the Kanawha is essentially that of the Ohio, although it contains a few species (as *Exoglossum maxillingua*) not found in any other western waters.

Our collections include but a small part of the fauna of the Kanawha, as the high waters of the middle of September made it necessary to abandon work both on the Kanawha and the James. The three streams examined are all unsuitable for successful collecting.

1. *Peak Creek* at Pulaski, Va. August 4; temperature about 67°. A clear, cold stream with very rocky bottom and many deep holes among rocks. This stream was carefully seined for a distance of about half a mile above Pulaski. It contains great numbers of black bass (*Micropterus dolomieu*) and absolutely nothing else, two small

minnows (*Pimephales notatus*) being the only other fishes obtained. It would seem that dry weather often reduces this creek to a succession of pools. The bass live in these and devour everything else.

2. *Little Peak Creek*, Pulaski, Va. August 4; temperature about 79°. A small tributary of the preceding, into which it flows, in the village of Pulaski. It is a shallow, warm, clear stream, with gravelly bottom, full of little minnows and darters, thus presenting a striking contrast with the preceding creek. The species found here are marked P.

3. *Reed Creek* near Wytheville, Va. August 6; temperature 79°. This stream was seined at various points about 4 miles east of Wytheville. It is a warm, muddy stream, the water gray in color. It flows through cultivated fields and pastures. The bottom is rocky in the shallows, elsewhere muddy. The character of the water makes this an unfavorable stream for collecting.

4. *Hatchery Stream.*—The U. S. Fish Hatchery Station is located on a tributary of Reed Creek, about 5 miles west of Wytheville. The water in this little brook is very cold, the temperature being about 55°.

1. Catostomus teres (Mitchill). P., R.

Common.

2. Catostomus nigricans (Le Sueur). P., R.

Common in swift waters.

3. Campostoma anomalum (Rafinesque). P., R.

Common.

4. Pimephales notatus (Rafinesque). P., R.

Common; the only minnow found in Big Peak Creek.

5. Exoglossum maxillingua (Le Sueur). R.

Scarce in Reed Creek. The occurrence of this eastern species in the basin of the Kanawha is an interesting fact in geographical distribution.

6. Notropis microstomus (Rafinesque). R. *Hybopsis stramineus* Cope.

Rather scarce. Compared with specimens of *stramineus* from the White River at Gosport, Ind., these specimens have the back considerably elevated, the eye a little smaller, the form of the snout and mouth the same, sides silvery, with scarcely a trace of black specks along the lateral line. Scales 36; teeth 4–4.

7. Notropis kanawha Jordan & Jenkins. R.

Not rare in Reed Creek.

8. Notropis scabriceps (Cope). R.

A single specimen, the first which I have recognized as belonging to this species. The species from Arkansas referred by Jordan and Gilbert to *N. scabriceps* belong to *N. boops* Gilbert, which is probably identical with *N. illecebrosus* (Girard).

Body formed as in *Hybopsis amblops;* head broad, blunt anteriorly; eye very large, longer than snout, 3 in head; snout obtusely rounded in profile; mouth moderate, little oblique, the jaws about equal; the maxillary extending a little past front of eye; scales large, 13 before dorsal; fins small; dorsal over ventrals. A. 8. Color pale greenish above.

9. Notropis photogenis (Cope). R.

A species which I identify with Cope's description is not rare in Reed Creek. It closely resembles *N. rubrifrons* (specimens from White River, at Indianapolis); size, form, and color similar. The eye, however, is larger (3 in head), and there are 25 scales before the dorsal instead of 16. Compared with *N. amœnus*, from Luray, the eye is smaller, the body is more slender, and there are no black specks along the base of the anal fin. Color pale, a bluish streak along side of caudal peduncle; some dark points along lateral lines. Scales 40.

10. Notropis atherinoides (Rafinesque). P., R.

Common in quiet places; reaching a length of 4 to 6 inches. Color translucent green; sides bright silvery. Head $4\frac{1}{5}$ in length; depth $5\frac{1}{2}$; maxillary $2\frac{1}{5}$ in head; eye $3\frac{1}{3}$ to 3. I refer these specimens to *N. atherinoides* (=*rubellus* Agassiz), without being quite certain whether the latter name includes more than one species. This is evidently the species called by Cope *Alburnellus jaculus*.

Specimens from the Holston River agree fully, except that they are a little more slender in body; depth 6.

Specimens from Deer Creek, Indiana, called by Evermann and Jenkins *Notropis arge*, and evidently *Alburnellus arge* Cope, are a very little more robust, but have precisely the same eye, snout, and mouth.

Specimens from the falls of the Ohio (*N. dinemus* Rafinesque) are a little stouter, the eye a shade smaller; the eye, mouth, and head notably shorter; head $4\frac{4}{5}$ in length; eye equal to snout; $3\frac{1}{2}$ in head; maxillary $3\frac{1}{3}$ in head.

Other specimens (*dinemus*) from Pipe Creek (White River), near Anderson, Ind., are similar, but with the snout and mouth longer, thus approaching *arge*.

Still other specimens from Deer Creek, called *atherinoides* by Evermann and Jenkins, have the eye notably smaller and the snout sharper.

N. amœnus, from Luray, is stouter and more compressed, with stouter head and smaller scales before dorsal. It is also less silvery in color. In form of eye and mouth this species scarcely differs from *N. atherinoides* (*arge*).

11. Hybopsis kentuckiensis (Rafinesque). P., R.

Common.

12. Semotilus atromaculatus (Mitchill). P., R.

Common; scales 55.

13. Rhinichthys cataractæ (Cuv. & Val.). R.

Not common; scales about 70.

14. Phoxinus margaritus (Cope). R.

Rather scarce. Scales smaller than in eastern examples. Perhaps this may prove to be a different species. Head $4\frac{1}{2}$ in length; depth nearly the same; mouth very small, anterior; scales 52 to 54 (58 in *margaritus*); 28 scales before dorsal; dorsal quite low, inserted behind ventrals. Color dark, a very distinct caudal spot, and a well-defined black lateral band. The specimens are all small, the largest 2 inches long.

15. Micropterus dolomieu (Lacépède). P., R.

Extremely common. As already stated, the Big Peak Creek is stocked with black bass, to the exclusion of everything else.

16. **Ambloplites rupestris** (Rafinesque). P.
Abundant in the little mill-pond on Little Peak Creek.

17. **Etheostoma blennioides** (Rafinesque). P., R.
Not rare.

18. **Etheostoma flabellare** (Rafinesque). P., R.
Abundant in clear, shallow waters in Little Peak Creek.

19. **Cottus bairdi** Girard. R.
Not rare.

L.—THE HOLSTON RIVER.

The Holston is one of the three main tributaries of the Tennessee River. Of these three it is the largest and the one most nearly in line with the general course of the river. The Holston is formed by the union of three streams nearly equal in size and similar in physical respects which flow in parallel valleys separated by low mountains or hills. These are the South Fork, the Middle Fork, and the North Fork. All these streams were carefully seined, and it is believed that the present collection includes very nearly all the fishes occurring in the upper tributaries of the Tennessee. Of the large catfish, buffalo-fishes, drums, etc., found in the lower course of the river, no specimens were obtained.

1. *South Fork of the Holston River* at Holstein Mills, Va. August 7; temperature 72°. Holstein Mills lies about 9 miles south of Marion, Va. The river here is very clear, rather cold. Its bottom is rocky and gravelly, and the waters rather swift, there being often an alternation of rapids and deep pools. The stream was fished between the dams in the village, and also below the lower dam. The latter locality is a most excellent one for making collections, one of the very best of all those found by us. Darters (*E. simoterum*) swarm on the bottom, and the swift waters below the dam are literally full of *Notropis rubricroceus* and *N. coccogenis*, both species marked with brilliant red in life. Trout (*Salvelinus fontinalis*) are found above the dams, but the catfish and the black bass do not ascend so far. The California rainbow trout (*Salmo irideus*) has been introduced into this river, and a specimen was lately taken with the hook above Holstein Mills. Species from Holstein Mills are marked S.

2. *Middle Fork of the Holston* at Marion, Va. August 7; temperature 71°. Seined in the town and for about half a mile above the railway station. The stream is similar to the preceding, and equally clear and cold. It has less volume of water, and the bottom is more rocky. The same species were found, and the locality is perhaps equally good for collections. The species obtained are marked M.

3. *Middle Fork of the Holston River* near Glade Spring, Va. August 8; temperature 75°. Seined at a point about 5 miles south of the village of Glade Spring, in and about a ford on the Byers farm. The stream is here considerably larger than at Marion. The water is much warmer and with less current. It flows through pasture land, and the water thereby rendered somewhat gray from clay washed into the river. The bottom is partly rocky, partly gravelly. The locality is not a very good one for collecting, although one species was obtained which has not been seen elsewhere. Species from Glade Spring are marked G.

4. *North Fork of Holston River* at Saltville, Va. August 9; temperature 75°.

The North Fork at Saltville is somewhat larger than either of the other branches at the localities examined. It was seined at the ford, about a mile north of Saltville, and in different places for about one-quarter mile above the ford and nearly a mile below it. The best collecting ground is at the ford itself. Lower down, the river can hardly be seined at all, its bottom being covered with large rocks, which have fallen from a high bluff on a bend of the river. The stream is moderately swift, not very clear, the water warm. In some places large numbers of water plants grow, forming lurking places for small fishes. This is a fair locality for making collections, and two or three new species have been described from this locality by Professor Cope. Species from the North Fork are marked N.

5. *Beaver Creek* near Bristol, Tenn. August 10; temperature 79°. Seined at a point about 4 miles south of the town of Bristol, where the stream approaches the main road. A small, clear tributary called Cedar Creek was also examined, but nothing of special interest found. Beaver Creek is a rather small stream, about 15 feet wide, shallow, and swift. At the locality examined are many smooth, flat rocks inclined at angles. Over these the stream slides in small water-falls interspersed by shallow pools. The stream is warm and rather muddy, flowing mostly through open pastures. Its fauna is scanty, and it was probably less worthy of a visit than any other stream examined by us. Species from Beaver Creek are marked B.

6. *Watauga River* from Elizabethton to Watauga Point, Tenn. August 11; temperature 79°. The Watauga is a large tributary of the Holston, having, like the French Broad, its rise in the plateau of western North Carolina. Its headwaters are cold mountain streams, which abound in trout. At Elizabethton it is a considerable river, with a very rough bottom, often crossed by dam-like ridges of perpendicular rocks. In the shallow places the current is swift, and in the deep still stretches the bottom is so covered with ooze and sawdust that the net can not be used. The water is warm and not very clear, being stained red by the clay soils of the region. It is well stocked with fishes, its channel especially having very large darters. It is, however, a stream not easily worked. Collections were made at all suitable points from the mouth of Doe River, in Elizabethton, to the mouth of Buffalo Creek. Fishes from the Watauga are marked W.

7. *Doe River* at Elizabethton. August 11; temperature 78°. Doe River, near its mouth in Elizabethton, is a very clear stream, having its source in the flanks of Roan Mountain. Its waters are warm, and its bottom is covered with large round bowlders and shingle brought down from the mountains. These rocks have no river weed or other vegetation, and there are but few fishes among them. For so attractive a stream Doe River is a very disappointing one. The absence of darters is doubtless due to the absence of bottom vegetation. Fishes from this stream are marked D.

1. **Noturus miurus** (Jordan). N.

Not rare in the weeds above the ford. The specimens are quite large and the color is rather pale. In general they agree with Indiana examples.

2. **Leptops olivaris** (Rafinesque). W.

Large yellow-cats are taken in the deep channels of all the branches of the Holston. The specimens seen by us were from the Watauga.

3. **Catostomus teres** (Mitchill). S., M., G., B., W.

Common.

4. Catostomus nigricans (Le Sueur). S., M., G., B., W., D.

Common in swift waters.

5. Moxostoma duquesnei (Le Sueur). M., G., N., B., W.

Common in the larger streams. The specimens agree with the common northern red-horse, except that the free edge of the dorsal is decidedly concave. D. usually 13; lower fins red, the caudal pale.

6. Lagochila lacera (Jordan & Brayton). N.

A few specimens taken at Saltville. Scales 45. In life steel-blue; lower fins creamy; snout black; dorsal and caudal creamy, dusky-edged.

7. Campostoma anomalum (Rafinesque). S., M. G., N., B., W., D. "Mammy."

Everywhere common, ascending small streams.

8. Notropis spectrunculus (Cope). M., S., N., G.

A small fish characteristic of the mountain streams. Common at Marion and Holstein Mills; rare at Saltville and Glade Spring. Very pale olive; fins in life pale, dull red or salmon color, no red on snout; black caudal spot always distinct.

9. Notropis microstomus (Rafinesque). N., D.

Scarce. Back rather more elevated than in the specimens called *stramineus*, some dark specks along lateral line; 13 scales before dorsal.

10. Notropis megalops (Rafinesque). S., G., N., B., W.

Common, but confined to the larger streams, not ascending the colder waters. But one taken at Holstein Mills and none at Marion. The specimens belong to Cope's var. *frontalis* (Agassiz), having 17 scales before the dorsal.

11. Notropis lacertosus (Cope). S., N.

Two young specimens only taken. This seems to be a rare species. It has been known hitherto only from a brief description of a specimen taken by Professor Cope at Saltville.

Color green above; sides silvery; a dark speck on front of opercle. Very close to *N. megalops*, the young of which it resembles in form and squamation, almost the only tangible difference being that the mouth is somewhat larger in *N. lacertosus* and the lower jaw projects. Head $4\frac{1}{5}$ in length; depth $4\frac{1}{3}$; eye a little longer than snout, 3. Maxillary reaching to just past front of eye, 3 in head; mouth oblique, the lower jaw prominent. Lateral line decurved. Scales 5–38–3. 17 before dorsal. Fins all low. Dorsal slightly behind ventrals. A. 8. (Specimen $2\frac{3}{4}$ inches long.)

12. Notropis leuciodus (Cope). S., M., G., N., B., W., D.

Very common, but not ascending the spring branches so far as N. *telescopus*.

Closely related to *N. telescopus*, but distinguished by the short anal, rather smaller eye, usually paler coloration and very distinct caudal spot. Snout a little more obtuse than in *N. telescopus*. Anal rather short and high with 8 rays. Eyes 3 in head; mouth rather smaller and less oblique than in *N. telescopus*, the maxillary $3\frac{1}{2}$ in head, the lower jaw slightly included. Insertion of dorsal midway between tip of snout and base of caudal, a little behind base of ventrals; 13 scales before dorsal. Depth 5 in length. These two species make up the bulk of the small minnows of the Holston region.

13. Notropis telescopus (Cope). S., M., G., N., W., D.

Very common; not found in warm creeks (like Beaver Creek), but ascending cold streams farther than the preceding or the next.

Green, silvery below; fins pale; no red, often a faint dusky caudal spot. Scales of back conspicuously dark-edged; the two uppermost rows running into outline of back, the one under the dorsal, the other just behind it. Anal with concave edge and 10 rays. Eye very large, $2\frac{3}{4}$ in head, longer than the sharp short snout; mouth oblique, the jaws equal. Insertion of dorsal midway between snout and base of caudal, a little behind ventrals; 13 scales before dorsal. Depth $4\frac{3}{4}$ to $5\frac{1}{2}$. It reaches a larger size than the preceding, but less than the next.

14. Notropis atherinoides (Rafinesque). G., N., W., D.

Abundant in quiet places in the river channels. Very large specimens, 5 inches long, in the Watauga. Eye as long as snout, $3\frac{1}{8}$ in head. Snout sharp; depth 6 in length; 15 scales before dorsal. The specimens are similar to those from the Kanawha basin, but a little more elongate.

15. Notropis ariommus (Cope). W.

One specimen taken. Very pale; a silvery lateral band; eye excessively large, $2\frac{3}{8}$ in head, nearly twice length of snout, which is evenly rounded; maxillary $3\frac{1}{3}$ in head, reaching front of eye; mouth oblique; fins low; dorsal over ventrals; head $4\frac{1}{4}$ in length; depth 5; 15 scales before dorsal; anal rays 9.

16. Notropis coccogenis (Cope). M., S., G., N., B., W., D.

Everywhere very common, especially in the clear streams, the most abundant of the larger minnows.

Color in life, steel-blue, silvery below; a dash of scarlet on upper lip; axil of pectoral, front of dorsal, and a vertical bar on front of opercle, bright scarlet. Base of caudal milky, tinged with reddish anteriorly; anal and ventrals white.

17. Notropis galacturus (Cope). S., G., N., B., W., D.

Associated with the preceding and reaching a similar size, but less abundant and not ascending the small streams so far. Very large specimens have the tip of snout, dorsal, tip of caudal, pectorals, anal, and ventrals flushed with red. Base of caudal conspicuously yellowish-white.

18. Notropis rubricroceus (Cope). M., S., D.

Excessively abundant in the clear streams, outnumbering all other species at Marion and Holstein Mills; rare in the rivers; a single specimen only taken in Doe River.

In life, bright green, a steel-blue lateral stripe, becoming darker behind and ending in a distinct caudal spot; a silvery streak below the lateral band; below this a red stripe; snout and lips deep brick-red; base of pectoral scarlet; belly and cheeks, and sometimes back also, flushed with red in old males. This brilliant species reaches a length of nearly 4 inches, and even the young and the females show more or less of red.

19. Hybopsis amblops (Rafinesque). S., M., G., N., B., W., D. (*Hybopsis gracilis* Agassiz; *Ceratichthys hyalinus* Cope.)

Rather common in all streams except the coldest; much less abundant than *N. coccogenis*, *rubricroceus*, *leuciodus*, and *telescopus*. No red markings; dark lateral

stripe rather distinct. Eye a little smaller than in Indiana specimens, 3¼ instead of 3 in head; otherwise similar.

20. Hybopsis monachus (Cope). N.

Scarce. Agrees with Cope's description, and well distinguished by the small eye and dark dorsal spot.

21. Hybopsis watauga Jordan & Evermann. N., W.

Rather rare in the river channels. Closely related to *H. dissimilis*, but with smaller scales, lat. l. 52, 22 before dorsal, and with more elongate body and less spotted coloration.

22. Hybopsis kentuckiensis (Rafinesque). S., M., G., N., B., W., D.

Common everywhere.

23. Rhinichthys cataractæ (Cuv. & Val.). S.

In cold streams. But one taken.

24. Rhinichthys obtusus Agassiz. S., M. (*Rhinichthys lunatus* Cope, not type.?)

Very abundant in cold streams, not descending to the larger rivers.

In life, back mottled olive, with many scales blackish; a very faint dark lateral band in most specimens; belly silvery; a broad band of creamy yellowish below the black lateral band, this extending on cheeks and lips; fins all creamy; a dark spot at base of caudal; barbel longer than in *atronasus*, the size larger. Scales 70; caudal little forked; upper jaw considerably projecting; eye 5 in head. Insertion of dorsal midway between caudal and eye.

This seems at first sight to be a species quite different from the ordinary *R. atronasus* of the Atlantic rivers. The difference is, however, chiefly one of color. The eye is larger and the barbel shorter in *atronasus*, while the jet-black lateral band is much more prominent.

Specimens from Torch Lake, Michigan (*R. lunatus* Cope), are much like the Holston examples. The coloration is less mottled, the lateral band is obsolete; the mouth is more inferior with shorter and wider cleft. Eye 5 in head, depth 5 in length, scales 62. Dorsal midway between nostril and base of caudal. To the same species or variety the specimens from Clear Creek, Bloomington, Ind., must be referred. This genus is still in need of careful study in order that its scarcely differentiated species and numerous varieties may be known. The distinctive characters given by Mr. Garman in his revision of the group are not very reliable.

25. Phenacobius uranops Cope. G., N., B., W.

Common in the river channels; not ascending cold streams. Scales 60; caudal spot distinct.

26. Fundulus catenatus (Storer).

Not rare in the river at Saltville; not seen elsewhere.

27. Micropterus dolomieu (Lacépède). G., B., W., N.

Common in the river channels; not ascending the colder streams, hence not found at Marion or at Holstein Mills.

28. Lepomis pallidus (Mitchill). G.

Sunfishes of all kinds are scarce in the upland streams.

29. **Lepomis megalotis** (Rafinesque). N.

Scarce.

30. **Ambloplites rupestris** (Rafinesque). S., M., G., B., W.

Generally common.

31. **Etheostoma caprodes** (Rafinesque). N., W.

Four large specimens taken in the Watauga River. These are exactly like northern examples. Two specimens, the largest 3½ inches long, taken at Saltville. These, as already noticed by Professor Cope, constitute a "marked variety." The difference is one of color only, these having instead of the usual cross-bands a row of 8 blackish rounded blotches, alternating with smaller ones, much as in *Etheostoma aspro*. Pectorals plain.

32. **Etheostoma macrocephalum** (Cope). G., N.

Rather rare; three specimens from Saltville, one from Glade Spring. Head longer and more slender than in *E. aspro;* maxillary reaching front of pupil, 3¼ in head; nape scaly; cheek naked, or with a few rudimentary scales behind eye; opercle with more or less of very small cycloid scales above, never quite naked; eye longer than snout; gill membranes separate; scales on middle line of belly enlarged; scales on body 73, 76, 77, 82, in the four specimens. D. XVI-13. A. II, 10. Head 4 in length. Nine black spots on side, confluent, squarish in form, sharply defined and edged above by a continuous undulating pale streak from eye to base of caudal; fins all, including ventrals, barred; a small, very distinct spot at base of caudal; a median dark shade across spinous dorsal.

33. **Etheostoma squamatum** (Gilbert & Swain). W.

A large species found in the river channels; two taken in the Watauga. In life, dull olive, with eleven obscure dusky spots on side confluent into a narrow dark lateral shade; a black humeral spot and a faint caudal spot; first dorsal orange-shaded anteriorly with a black streak across it. Second dorsal and caudal yellowish orange, barred with dusky; other fins pale yellow. Cheeks, nape, and breast scaly, most of the scales cycloid and not imbricate. Gill membranes united across isthmus, but meeting at an angle. Anal larger than second dorsal; scales 76; those on median line of belly slightly enlarged; lower jaw as long as upper.

This strongly-marked species is a near relative of *E. phoxocephalum* Nelson.

Comparing large specimens of the latter from New Harmony, Ind., with *E. squamatum*, I notice that the color is nearly the same, the lateral band plainer and narrower in *squamatum*. In *phoxocephalum* the spots are more numerous, about fifteen in number, and transverse rather than rounded. The fins are similar in form and color in both, as are also the gill membranes. Head in *squamatum* a little sharper and more depressed, the body slenderer and more compressed. Scales smaller in *squamatum*, 10 to 12 above lateral line, 7 or 8 in *E. phoxocephalum*.

34. **Etheostoma aurantiacum** (Cope). N., W.

Another large species inhabiting river channels. Two young ones taken at Saltville; three large ones in the Watauga.

Color in life olive, tinged with orange; a black lateral band of confluent black blotches; chin and throat deep orange; deep orange on front of spinous dorsal, shad-

ing to yellow behind; orange on front of pectoral; a round yellow spot above each interspace in lateral band; a row of small brown spots on each side of back; nape with orange; gill membranes separate; belly evenly covered with fine scales like those on sides; scales firm and even, 101 in lateral line; cheeks, opercles, and nape finely and closely scaled; head bluntish, the mouth rather large; the eye median.

35. Etheostoma simoterum (Cope). B., S., M.

Very abundant in cold, clear waters, but not found in the larger streams. Excessively common about Holstein Mills, the larger specimens beautifully colored. In life, pale green, the dark markings dark green; various scales on the back bronze-red in the center, the neighboring scales light yellow, the bronze markings forming very irregular streaks; belly pale yellow, more or less flushed with bright orange; spinous dorsal pale at base, then a black streak, then pale, each membrane with an orange spot throughout the pale streak, the first two spots of a brilliant scarlet; edge of the fin snuffy-brown; soft dorsal with the rays pale yellowish, the membranes spotted with bronze-brown, a black spot at base of each ray; caudal yellowish, with three wavy black bars; anal and ventrals pale yellowish; pectoral yellowish, faintly barred; head with various green markings; scales 51; breast naked, or partly scaly.

36. Etheostoma swannanoa Jordan & Jenkins. M., S.

Two large specimens of this beautiful species taken at Marion and two at Holstein Mills. It is evidently a species of the cold, clear waters, as it was found rather abundant in the Swannanoa River, near its source.

37. Etheostoma zonale (Cope). B., G., N.

This species seems to be irregularly distributed, perhaps most abundant in the river channels, where the water is neither cold nor clear. The species seems to be very variable in coloration as well as in squamation. The specimens from Saltville are nearly typical; green, with about eight conspicuous cross-bars of grass-green (fainter in female); a brownish-red band across first dorsal (wanting in female); ventrals and pectorals in both sexes creamy orange, barred with green; other fins yellowish, barred with darker; throat naked in some, partly scaly in others; scales 6–49–9 (erroneously given as 11–50–12 in Jordan and Gilbert, Synopsis).

In the single specimen from Glade Spring the markings are very much sharper, the spots well defined, and the dark cross-bars much narrower and more definite, about twelve in number, narrower than interspaces; coloration otherwise similar; scales 50; a few on upper part of cheek only.

In several examples from Beaver Creek the coloration is that of the specimen from Glade Spring; the opercles are scaly, but the cheeks are naked; the scales are, however, much smaller, 7–60–8 (59–60–61 in three examples).

The specimens taken in the French Broad and its tributaries agree essentially with those from Saltville.

38. Etheostoma verecundum Jordan & Jenkins. G.

The single type of this species was taken at Glade Spring.

39. Etheostoma blennioides (Rafinesque.) G., N., D.

Not rare in the larger streams. Scales 76.

40. Etheostoma rufolineatum (Cope). S., M., G., N.

One of the gaudiest of our fishes, frequenting weed-covered rocks in clear water, especially in streams shaded by trees.

In life, male green, the body with longitudinal stripes, each stripe as wide as one row of scales and formed by darker edges of the scales; some of the scales with center spots of bright orange-brown. In each series, usually from 2 to 6 consecutive scales are orange-brown, then an equal number are olive, the olive and orange areas irregularly alternating. Head with an olive-black band through snout to nape; an interrupted band below this, still lower two blackish spots; usually about five black dashes on each side of head, a characteristic color mark; angle of mouth orange. Lips orange except in front; lower jaw with an orange spot; interopercle, opercle, cheek, and first three branchiostegals each with orange spots. Belly orange-yellow; breast deep blue. Fins all bordered with scarlet; a very narrow blackish edge; a narrow pale streak between it and the scarlet. Spinous dorsal straw-color dotted with black and edged with orange; second dorsal similar, more yellow. Caudal scarlet, its center yellow, its base with a large blue-black spot which extends into the yellow. Base of caudal yellow; an orange spot above and below. Anal bright yellow at base, then scarlet with narrow pale and dark edgings. Ventrals similar. Pectorals yellow, with a blackish and a scarlet crescent at base and a subterminal scarlet band.

Females green with 8 faint dark cross-bars, obscure and interrupted. Scales on sides with yellow streaks arranged like the brown streaks on the male. Fins all yellow. Anal and ventrals tinged with orange. Pectorals tinged with orange anteriorly, all the fins with bars of dark spots. Caudal blackish, its base yellow. Head with black markings similar to those on the male, but without scarlet.

41. Etheostoma flabellare (Rafinesque). S., M.

A species of the springs and other cold, clear waters, not descending to the river channels.

42. Cottus bairdi Girard. M., S., G., N., W., D. "Mull-head."

Very common, especially in cold waters.

Few river basins are more favorable for fish life than those of the Holston and Tennessee. The combination of clear, cold waters, a bottom of rock and gravel, and a warm climate is one extremely favorable to fish development.

M.—THE FRENCH BROAD RIVER.

The French Broad is one of the three great rivers whose union forms the Tennessee. Unlike the Clinch and the Holston its course is at right angles to the direction of the mountain ranges. It is therefore far more swift and turbulent than either of the others, and its course lies mostly over metamorphic rather than limestone rocks. The French Broad has its rise in innumerable mountain springs in the plateau of western North Carolina. Above Asheville, a considerable part of its course is through comparatively level pasture land. The soil is here a red clay produced by the disintegration of metamorphic rocks. The stream is therefore more or less red and discolored after rains. Its tributaries are, however, for the most part clear at all times. Some of these are among the most beautiful trout-brooks in the whole course of the Alleghany chain of mountains. High water interfered somewhat with our work in the French

Broad River itself, but two of its tributaries were very fully and satisfactorily explored. It is evident that in no essential respect is its fauna different from that of the Holston. Collections were made at the following points:

1. *French Broad River* at Long Shoals, about 9 miles southeast of Asheville. August 15; temperature 77°. The river at this point is broad, rather swift, and sufficiently shallow to permit fording in low water. The bottom is mostly sandy, with numerous bowlders. The water at the time of our visit was warm and not very clear. It is a poor locality for collections and not much was obtained, only the common minnows, with *Etheostoma zonale* and *Ambloplites rupestris*. From a farmer in the vicinity (Mr. Alexander) we obtained information of the occurrence of the following species of food-fishes:

"River Trout." *Stizostedion vitreum* (Mitchill).
"Jack." *Esox masquinongy* (Mitchill).
"Drum." ? *Ambloplites rupestris* (Rafinesque).
"Sand Sucker." *Catostomus teres* (Mitchill).
"Hog Sucker." *Catostomus nigricans* (Le Sueur).
"White Sucker." *Moxostoma duquesnei* (Le Sueur).
"Blue Cat." *Ictalurus punctatus* (Rafinesque).
"Yellow Cat." *Leptops olivaris* (Rafinesque).

2. *French Broad River* at Hot Springs.[1] August 14; temperature 79°. The river is here, as elsewhere, deep and swift, with very rocky bottom. In the few quiet places the bottom is covered with soft mud. Several hauls with the large seine were made, but not many fishes were taken. Streams of the character of the French Broad can be worked to advantage only at a time of very low water, when the current is not such as to prevent the seining of pools among the rocks. Probably the neighborhood of Marshall, some distance above Hot Springs, will prove the better for making collections than the place selected by us. Collections were made along the front of the hotel property at Hot Springs on both sides of the river and as far down as the mouth of Spring Creek. Species taken in the river are marked F.

3. *Spring Creek* at Hot Springs, N. C. August 13 and 14; temperature 76°. This is a fine clear mountain stream, very swift, with rocky bottom. The water is warm, too warm in its lower course for trout. Collections were made all along the stream from its mouth at Hot Springs to about a mile above the hotel. Only in the lower course of the stream, from the railroad bridge to the mouth, are the rocks covered with river-weed (*Podostemon*). In this region, darters are very numerous and large, but among the bare, angular rocks farther up, scarcely any are found. Above the dam the stream is full of rock bass (*Ambloplites rupestris*), some being taken in every haul of the net. It is stated that a car-load of these fishes sent out by the U. S. Fish Commission were some years ago planted in this stream. If so, the results have been striking enough. This stream, with the Swannanoa and the three forks of the Holston, are recommended as suitable for the introduction of the rainbow trout. Species from Hot Springs are marked H in the following list. Specimens of the "Hellbender" (*Cryptobranchus alleghaniensis*) were taken both in Spring Creek and in the French Broad.

4. *North Fork of Swannanoa River*, at Burnett's Mill, near the foot of Mount Mitchell. August 20; temperature 68°. A clear, cold mountain stream, clearer than any other mentioned in this paper; water swift, with some deep pools; bottom gravelly or with small bowlders, the rocks mainly granite.

[1] Formerly called Warm Springs.

The seven species found here (*Salvelinus fontinalis*, *Rhinichthys obtusus*, *Notropis spectrunculus*, *N. rubricroceus*, *N. telescopus*, *N. coccogenis*, and *Etheostoma flabellare*) are those especially characteristic of the mountain streams of the west slope of the Alleghanies. On comparing the list of the species found in the Swannanoa River with those found in Buck's Creek on the other side of the Swannanoa Gap, it will be seen to what degree the Blue Ridge has been a barrier to the distribution of species in North Carolina. The higher main chain of the Great Smoky Mountains has been no barrier at all because it is broken for the passage of the Watauga, the French Broad, and, farther west, the Little Tennessee. Species from the North Fork of the Swannanoa are marked N. Collections were made near a point 4 miles northwest of Black Mountain Station on the road to Mount Mitchell, just above the pond at Burnett's Mill.

5. *South Fork of Swannanoa River* (called Flat Creek), at Black Mountain Station. August 21; temperature 69°. Collections were made at a point one-half mile south of the station, and for some distance above and below this point.

This is a swift, clear stream, similar to the preceding, the bottom gravelly rather than rocky, the water rather warmer, and the banks less shaded. The Swannanoa River is formed by the union of these two forks, the colder, North Fork having its source in the flanks of Mount Mitchell, the South Fork in the Blue Ridge at Swannanoa Gap. The stream flows into the French Broad above Asheville. The waters become warmer and less clear lower in its course, but the general character remains the same, and the stream is certainly one of the most picturesque in North Carolina. Its fauna is interesting from the abundance of darters. Their presence is however chiefly confined to the rocks bearing river-weed (*Podostemon*). Species from the South Fork are marked S.

6. *Swannanoa River* near Asheville. August 15 and 17; temperature 77°. Collections were made at various points from near the railway station to a point about two miles higher. The water is warm and moderately clear. Its current is fairly swift with alternations of quiet stretches. The gravelly and rocky shoals are excellent for collecting. The fauna differs little from that of Spring Creek or the upper waters of the Holston. The species here taken are marked A.

1. **Noturus eleutherus** Jordan. F.

One young specimen, with very small eyes, apparently identical with the type of *N. eleutherus*.

2. **Leptops olivaris** (Rafinesque). F., S.

Young, not rare in the river channels.

3. **Ictalurus punctatus** (Rafinesque). F.

Young, abundant in the river channels.

4. **Catostomus teres** (Mitchill). A., S., H.

Common in quiet waters.

5. **Catostomus nigricans** (Le Sueur). A., S., H.

Common in shoal waters.

6. **Moxostoma duquesnei** (Le Sueur). F., H.

Young, not rare. In June large numbers of *Placopharynx carinatus* run in the river, but none were seen by us at this time.

7. **Campostoma anomalum**(Rafinesque). H., A., S.

Common.

8. **Notropis spectrunculus** (Cope). H., S., N.

Exceedingly abundant in the headwaters of the Swannanoa; scarce elsewhere.

Body in life very pale greenish; a bluish lateral band; belly white; caudal spot very distinct; fins in the male all pale yellowish red; snout without red.

9. **Notropis galacturus** (Cope). H., A., S.

Rather common.

10. **Notropis coccogenis** (Cope). H., A., S., N.

Very abundant.

11. **Notropis rubricroceus** (Cope). S., N.

In the mountain streams; abundant. In life green, a bright yellowish green lateral streak; a steel-blue lateral band; snout and lower jaw bright red; head and belly red in males; fins all pale yellowish, not red even in largest males.

12. **Notropis telescopus** (Cope). H., A., S., N.

Common.

13. **Notropis leuciodus** (Cope). H., A., F.

Common, but not ascending mountain streams. Some of the specimens from Hot Springs are extremely pale, the caudal spot almost obsolete.

14. **Notropis atherinoides** (Rafinesque). H., A., F.

In channels of the larger streams; specimens similar to those from the Holston.

15. **Phenacobius uranops** Cope. H., A.

Not rare.

16. **Hybopsis monacus** (Cope). H., A.

Not common.

17. **Hybopsis dissimilis** (Kirtland). H., A.

Not rare; specimens highly colored, the blue black spots on back and sides very distinct.

18. **Hybopsis amblops** (Rafinesque). H., A.

Common in the larger streams.

19. **Hybopsis kentuckiensis** (Rafinesque). H., F., A., S.

Everywhere abundant.

20. **Rhinichthys obtusus** Agassiz. S., N.

In mountain streams only.

21. **Salvelinus fontinalis** (Mitchill). N.

Abundant in the headwaters of the Swannanoa and of most other tributaries of the French Broad. Four specimens, each 6 to 8 inches in length, were taken in a single haul of a short seine near Burnett's Mill.

22. **Micropterus dolomieu** (Lacépède). H., A.

Not rare in the larger streams.

23. **Lepomis pallidus** (Mitchill). H.

Scarce.

24. Ambloplites rupestris (Rafinesque). H., A.

Abundant in the larger streams, ascending the mountain streams farther than other sun-fishes. Most of the species of this group belong properly to the lowland fauna.

25. Etheostoma caprodes (Rafinesque). A.

One specimen taken, of the variety obtained at Saltville.

26. Etheostoma squamatum Gilbert & Swain. H.

Four large specimens, the largest $4\frac{3}{5}$ inches in length.

Body green, with dark green markings. First dorsal yellowish green at base, then a dusky band, above this an orange one and finally a dusky edge. Second dorsal pale olive, with brown rays; caudal similar; both fins spotted; anal dusky, mottled; pectorals dull yellow, mottled; ventrals dusky.

27. Etheostoma evides Jordan & Copeland. H., A., F.

Abundant; only young specimens taken in the river. These agree in essential respects with specimens from White River, Indiana, but the scales are in most specimens larger. The dark bars on sides are more or less connected by black cross-lines above. The pectorals are barred, these fins being plain in *E. evides*. In *E. evides* there are usually 60 to 65 scales in the lateral line. In specimens from the Swannanoa, I count 52, 54, 55, 55, 53, 52, 58, 60, 60, 62, 63, 62–65, in twelve specimens, the last figures, 62–65, being that of opposite sides of the same specimen.

Color in life: Male, olive, with 8 deep blue-green cross-bars; an orange-brown lateral band forming brown squares between the dark cross-bars; belly orange; breast, throat, and lower jaw orange yellow; cheeks, opercles, jaws and snout, deep rusty orange; a blue-black bar behind eye; a very conspicuous golden crescent before this; spinous dorsal deep rusty orange, its last rays black, the median area more yellow; soft dorsal orange at base fading above and more or less speckled; caudal with two orange spots at base; the fin yellow, with two or three faint black bars; pectoral and anal, yellowish, faintly barred. Female, with very pale yellowish instead of orange; the markings on side black; membranes of dorsal orange at base and tip.

28. Etheostoma blennioides Rafinesque. H., A.

Common; specimens from Spring Creek very large, the markings very dark green. D. XIV-13. Scales 67 to 68.

29. Etheostoma zonale (Cope). H., A., F.

Rather common; colored like the specimens from Saltville; cheeks more or less scaly; breast naked. Scales 44, 47, 48, 48, 49, 49, 50, in seven specimens.

30. Etheostoma swannanoa Jordan & Jenkins. S.

Six specimens taken in the South Fork of the Swannanoa.

31. Etheostoma rufolineatum (Cope). H., A.

Common among the river weeds. Scales 45, 47, 48, in three specimens.

32. Etheostoma camurum (Cope). H.

One specimen, $2\frac{3}{5}$ inches long, taken in Spring Creek. D. XI–13. Scales 58. Female: in life, green; many scales brown; fins yellowish olive; caudal red; all the vertical fins edged with blackish.

33. Etheostoma flabellare (Rafinesque). N., A., S.

Common in clear and cold waters.

34. Cottus bairdi Girard. S., H.

Common in cold waters; those from the South Fork paler and more spotted than usual; those from Hot Springs very dark.

N.—ST. JOSEPH'S RIVER.

St. Joseph's River has its rise in southwestern Michigan. It flows southward into northern Indiana. At South Bend it makes an abrupt turn to the northward, flowing back to Michigan, and ultimately into Lake Michigan. Like most of the Michigan streams, its waters are clear and cold, and it is fed largely by springs. Collections were made at a point between Mishawaka and South Bend, about a mile below the former place. September 17 and 18; temperature 60°; air 55°. The stream is here large, flowing over a bottom of coarse gravel, with sand in the deeper and more quiet portions. The rocks are well covered with algæ and other water-plants, *Chara* being abundant in places. The water was too cold for successful work and the species obtained are those characteristic of the Upper Wabash. This shows that the low and often swampy water-sheds separating the Wabash, Kankakee, and St. Joseph's are of little consequence as a barrier to the distribution of fishes.

1. Catostomus teres (Mitchill).

Scarce.

2. Catostomus nigricans (Le Sueur).

Scarce.

3. Moxostoma aureolum (Le Sueur).

Scarce. Young specimens; the head much shorter, the mouth smaller and lower, than in *M. duquesnei.*

4. Campostoma anomalum (Rafinesque).

Common.

5. Pimephales notatus (Rafinesque).

Common.

6. Notropis microstomus (Rafinesque). (*Hybopsis stramineus* Cope).

Not rare. A small dusky blotch on the middle line of the back before the dorsal is a color mark characteristic of this species.

7. Notropis megalops (Rafinesque).

Common.

8. Notropis rubrifrons Cope.

Common.

9. Hybopsis kentuckiensis (Rafinesque).

Common.

10. Semotilus atromaculatus (Mitchill).

Scarce.

11. Ambloplites rupestris (Rafinesque).

Common.

12. Lepomis megalotis (Rafinesque).

Common.

13. **Lepomis gibbosus** (L.)
Common.

14. **Micropterus dolomieu** (Lacépède).
Common.

15. **Etheostoma nigrum** (Rafinesque).
Scarce; cheeks naked.

16. **Etheostoma aspro** (Cope and Jordan).
Scarce; cheeks naked; opercles scaly. Scales 69.

17. **Etheostoma cœruleum** Storer.
Abundant. Scales 47.
Unios were found very abundant, but cray-fishes were scarce.

O.—KANKAKEE RIVER (ILLINOIS BASIN).

The Kankakee River, the easternmost tributary of the Illinois, rises at a point not far from South Bend, and flows in a southwestward direction, largely through swamps and lakes, into the State of Illinois. One of its chief tributaries in Indiana is Yellow River, which enters it from the east. This stream was seined near Plymouth, Ind., September 18, 1888; temperature, 62°. At Plymouth, the river is rather large, its water very clear, flowing over a bottom chiefly of coarse gravel. The rocks and stones are covered with *Chara*, algæ, and other water-plants. There are also deep pools with stretches of sand and of black mud. Collections were made from the flouring-mill at Plymouth up the stream to the dam. Few streams have been found so well stocked with darters as this, although the number of species is small. Cray-fishes were also excessively abundant.

1. **Noturus flavus** Rafinesque.
Abundant.

2. **Ameiurus natalis** (Le Sueur).
Common in the pools.

3. **Catostomus teres** (Mitchill).
Common.

4. **Catostomus nigricans** (Le Sueur).
Scarce.

5. **Erimyzon sucetta** (Lacépède).
Common.

6. **Minytrema melanops** (Rafinesque).
Scarce.

7. **Moxostoma duquesnei** (Le Sueur).
Scarce.

8. **Campostoma anomalum** (Rafinesque).
Common.

9. **Pimephales notatus** (Rafinesque).
Scarce.

10. Notropis microstomus (Rafinesque).

Scarce.

11. Notropis heterodon (Cope).

Not rare. Lower jaw black at tip; lateral line nearly or quite complete.

12. Notropis megalops (Rafinesque).

Common.

13. Notropis whipplei (Girard).

Common. These specimens are rather slender and seem to represent the form called *Photogenis spilopterus* by Cope.

14. Notropis rubrifrons (Cope).

Scarce.

15. Hybopsis kentuckiensis (Rafinesque).

Common.

16. Lucius vermiculatus (Le Sueur).

Common among weeds.

17. Aphredoderus sayanus (Gilliams).

One specimen, very dark. Scales 51.

18. Ambloplites rupestris (Rafinesque).

Common.

19. Chænobryttus gulosus (Cuv. & Val.).

Common.

20. Lepomis pallidus (Mitchill).

Common.

21. Lepomis megalotis (Rafinesque).

Common.

22. Micropterus dolomieu (Lacépède).

Common.

23. Micropterus salmoides (Lacépède).

Scarce.

24. Etheostoma nigrum (Rafinesque).

Abundant.

25. Etheostoma aspro (Cope and Jordan).

Very abundant. Specimens of very large size, some of them more than 4 inches long, and all extremely plump, and very dark in color. These look quite unlike the ordinary *E. aspro*, but they differ in no structural character. Scales 63.

26. Etheostoma zonale (Cope).

Very abundant. Coloration usual; the ventrals speckled; the green bands extending around body below. Cheeks and breast scaly. Scales 50.

27. Etheostoma cœruleum (Storer).

Abundant.

28. Cottus bairdi Girard.

Scarce.

P.—UPPER WABASH RIVER.

The Wabash River has its rise in the streams and springs of western Ohio and northern Indiana. The main stream flows from Ohio westward across the northern central part of Indiana, then turns gradually to the southward, and forms nearly half of the boundary line between Indiana and Illinois. The Upper Wabash and most of its tributaries are clear streams, many of the latter having their source in lakes. Collections have been made by Mr. Evermann at the following points:

1. *Blue River*, Columbia City, Ind. (Collection of W. E. Clapham, November 5, 1888.) Blue River is a small tributary of Eel River, itself a branch of the Wabash. It has a gravelly bottom, with many large bowlders. Water plants are few. The water is moderately clear and cold. Collections were made at points from the Eel River railroad bridge, down the stream to the brewery. Species from this locality are marked B.

2. *Eel River* at Logansport. September 21; temperature 68°. The Eel River rises in Whitley County east of Columbia City, and flows southwestward, entering the Wabash at Logansport. It is a rather clear stream. In the neighborhood of Logansport its bottom is of limestone and very rough, being full of pot-holes and large stones. The stream was seined from the second dam to the mouth. Near its mouth are some gravelly stretches and a few patches of water plants. Species taken in Eel River are marked E.

3. *Lake Maxinkuckee.* September 19; temperature 68° to 70°, the latter in shallow water, the former at 8 feet depth. This is a clear lake, some 3 miles long by 2 broad, in Marshall County, Ind. Its outlet is a small stream which flows into Tippecanoe River. Collections were made in shallow water along the shore at Long Point. The bottom here is sand or fine gravel, in many places covered with algæ. The seine was drawn in the outlet of the lake, on muck bottom, among lily pads. The species obtained are marked M. The number of species found in the lake is here, as elsewhere, less than the number to be obtained from the tributary streams.

4. *Tippecanoe River*, Marshland, Ind. September 20; temperature 68°. The Tippecanoe River is a very clear, cold stream, having its rise in the deep lakes about Warsaw, Ind., flowing south-westward, and entering the Wabash above La Fayette. At Marshland, 5 miles south of Lake Maxinkuckee, the water is very clear, with gravelly bottom and many water plants. Collections were made at a point just above the Vandalia Railroad bridge.

This is one of the best streams in the State for the collection of darters. Species from Tippecanoe River are marked T.

5. *Deer Creek*, Camden, Ind. September 21. Deer Creek is a rather small, clear stream, flowing into the Wabash from the east, its mouth being at Delphi, Ind.

Collections were made at points from the head of the mill-race above Camden to the wagon bridge south of the town. The bottom is generally of coarse gravel, with swift places alternating with quiet stretches over sandy bottom. Specimens from Deer Creek are marked D.

1. **Lepisosteus osseus** (L). M.

Common in the lake.

2. **Ameiurus natalis** (Le Sueur). M., T., D.
Common.

3. **Noturus gyrinus** (Mitchill). M.
Scarce.

4. **Noturus miurus**, Jordan. T., D.
Common among weeds. Specimens from Tippecanoe River are very plump and dark in color.

5. **Ictiobus difformis** (Cope). E.

6. **Catostomus nigricans** (Le Sueur). T., E., D., B.
Common.

7. **Erimyzon sucetta** (Lacépède) (var. *oblongus*). T.
Common.

8. **Moxostoma duquesnei** (Le Sueur). E., D.
Common.

9. **Campostoma anomalum** (Rafinesque). E., D., B.
Common.

10. **Pimephales notatus** (Rafinesque). M., T., E., D.
Common.

11. **Ericymba buccata** Cope. D.
Rather rare, in sandy or gravelly streams only.

12. **Notropis heterodon** (Cope). M.
Scarce.

13. **Notropis microstomus** (Rafinesque). E.
Scarce.

14. **Notropis whipplei** (Girard). T., E., D.
Common.

15. **Notropis megalops** (Rafinesque). T., E., D., B.
Common.

16. **Notropis atherinoides** (Rafinesque). T., E.
Large specimens of the form called *Notropis arge.*

17. **Notropis rubrifrons** Cope. T., E., D.
Common in the smaller streams.

18. **Hybopsis watauga** Jordan & Evermann. T.
A few specimens similar to those from the Holston. Scales 46; 20 before dorsal.

19. **Hybopsis amblops** (Rafinesque) T., E.
Common.

20. **Hybopsis kentuckiensis** (Rafinesque) T., E., D., B.
Common.

21. **Semotilus atromaculatus** (Mitchill). D.
In small brooks.

22. **Umbra limi** (Kirtland). D., B.
Rather scarce.

23. **Fundulus diaphanus** (Le Sueur). M.
Abundant in the lake. These belong to var. *menona* Jordan & Copeland, distinguished from the eastern *diaphanus* by the more distinct dark cross-bands and by the presence of dark spots on the back.

24. **Zygonectes notatus** (Rafinesque). D.
Scarce.

25. **Zygonectes dispar** Agassiz. M.
Not rare in the lake.

26. **Lucius vermiculatus** (Le Sueur). M., T., B.
Common.

27. **Labidesthes sicculus** Cope. M., T., E., D.
Common.

28. **Aphredoderus sayanus** (Gilliams). B.
Scarce.

29. **Pomoxis sparoides** (Lacépède). M.
Common in the lake.

30. **Ambloplites rupestris** (Rafinesque). M., T., E., D., B.
Common.

31. **Lepomis pallidus** (Mitchill). M.
Common in the lake.

32. **Lepomis megalotis** (Rafinesque). M., T., E.
Common.

33. **Lepomis gibbosus** (Linnæus). M.
Common in the lake; not found in the Lower Wabash.

34. **Micropterus dolomieu** (Lacépède). M., T., E., D.
Common in swift waters.

35. **Micropterus salmoides** (Lacépède). M., B.
Common in quiet waters.

36. **Perca flavescens** (Mitchill). M.
Common in the lake; not found in the Lower Wabash.

37. **Etheostoma pellucidum** Baird. E.
Common in sandy clear rivers.

38. **Etheostoma nigrum** (Rafinesque). M., E., B., T., D.
Common.

39. **Etheostoma blennioides** (Rafinesque). T., E., D., B.
Common; very large specimens in Tippecanoe River.

40. **Etheostoma caprodes** Rafinesque. E.

41. **Etheostoma phoxocephalum** Nelson. E.

42. **Etheostoma aspro** (Cope & Jordan). E., D., B.
Rather common.

43. Etheostoma scierum (Swain). T.

Very abundant in Tippecanoe River; the largest specimens yet seen; the largest about 5 inches in length. Colors dark, and the body very plump, much as with *E. aspro* in Yellow River. Scales 68; cheeks and opercles scaly; breast usually so; base of caudal with 3 to 4 dark spots in a cross-series. In *E. aspro* there is usually a single spot at base of caudal, more distinct than in *E. scierum*.

44. Etheostoma evides (Jordan & Copeland). T., E.

Not rare. Scales 55.

45. Etheostoma camurum (Cope). T.

Several fine specimens. Colors in life: Sides light brown, with 12 to 15 very narrow greenish lines running from pectorals to caudal; three rather plain vertical bars of the same color, but much broader just back of the pectorals, faint traces of 5 or 6 others between them and the tail; about 50 to 60 small deep orange spots scattered irregularly over the sides; axils dusky; belly pale bluish green; throat and chin deeper blue; top of head and cheeks light brown, more or less mottled with darker. Spinous dorsal uniform light brown, or greenish; soft dorsal deeper brown with a series of reddish spots near the top; above these a pale line above which is a still darker line forming the border of the fin, and same as soft dorsal; pectorals pale brown, darkest on outer half; ventrals same, but outer half a little darker than pectorals; caudal light brown with some dark near the middle, a reddish brown bar near the tip; outside this a pale bar, the extreme tip of the fin being a pale green. Scales 53; snout bluntly decurved.

46. Etheostoma maculatum Kirtland. T., D.

One specimen of this rare species taken in Deer Creek, and four in Tippecanoe River. Scales 56; cheeks without the dark spots found in its nearest relative *E. rufolineatum*.

47. Etheostoma *Species nova*. T.

Four specimens of this handsome little fish taken in Tippecanoe River.

They apparently belong to an undescribed species, closely allied to *E. cœruleum*, but with the head more pointed, the lower jaw more prominent, the dark cross bands nearly vertical, and the scales thickly dusted with dark points. We wait until larger specimens are obtained before giving it a name.

48. Etheostoma cœruleum Storer. M., E., T., D., B.

Very common.

49. Etheostoma flabellare (Rafinesque). T., D., B.

In cold waters; rather scarce.

50. Cottus bairdi Girard. B.

Scarce.

Q.—THE LOWER WABASH RIVER.

Towards its junction with the Ohio the Wabash becomes a large river with moderate current, the water not very clear, and the bottom covered with gravel and sand in which grow many water plants. The tributary streams are mostly sluggish and yellow with clay and mud. The fish fauna of the Lower Wabash was found to be unexpectedly rich, its most striking feature being the abundance of several species

(*Noturus nocturnus*, *Etheostoma uranidea*, *E. ouachitæ*, *E. histrio*) supposed to be confined to the rivers of Arkansas, as well as of other species (*E. phoxocephalum*, *E. chlorosoma*, *E. jessiæ*, *E. shumardi*) more at home on the western side of the Mississippi.

A similar feature in distribution is the presence along the Lower Wabash (according to Prof. John M. Coulter) of numerous southwestern plants, nowhere else found so far north.

1. *Wabash River* at Vincennes. September 15; temperature 74°. Collections were made at a point 1½ miles north of Vincennes. Here the river is shallow on the Indiana side. No great depth is reached within a hundred yards of the shore. The bottom is of gravel and sand at this point, the gravel near shore being covered with *Spirogyra* and other algæ. The current is swift, although not breaking into ripples. Some muddy bayous tributary to the river were also seined. Species from the Wabash at Vincennes are marked V.

2. *Wabash River* at New Harmony. September 13; temperature 74°. Many years ago the New Harmony "community" dug a canal across the peninsula just below New Harmony. At the lower end of this "cut-off" was built a dam and a mill. The main current of the Wabash now flows through this channel. Collections were made at the old dam. At this point the bed of the stream is of sandstone. The current is broken up into narrow rapids and little falls, furnishing excellent localities for darters. Collections were also made on a shallow gravel bar near the mouth of Black River, near New Harmony. Species from the Wabash River at this point are marked W.

A number of species from the Wabash River at New Harmony were seen in the collection of Mr. James Sampson, of New Harmony. Such species are marked S.

3. *Black River* at New Harmony. September 12; temperature 76°. This is a small stream with muddy bottom and sluggish current. Collections were made from a point some 300 yards above the mouth down to the mouth of the stream. In one place the stream flows over gravel with considerable current. Species taken in Black River are marked B.

4. *Gresham's Creek*, New Harmony. September 12; temperature 77°. Collections were made at a point 1½ miles east of New Harmony. The stream is very small and shallow, the water a few inches deep, the bottom and shores sandy. Species obtained in Gresham's Creek are marked G.

5. *Patoka River* at Patoka, Gibson County. September 14; temperature 75°. The Patoka is a very sluggish and muddy stream of considerable size. It rises in the central part of southern Indiana, and flows westward, entering the Wabash near the mouth of White River, about half way between Vincennes and New Harmony. At the point examined at Patoka (just below the dam and one-fourth mile below the Evansville and Terre Haute Railroad bridge) the stream is shallow and swift for a hundred yards or more, and the bottom is covered with shingle from an outcropping ledge of coarse shale. Darters are abundant, the species being nearly the same as those found by Jordan & Gilbert in a similar stream; Poteau River, in Indian Territory. Species from Patoka River are marked P.

6. *Big Creek*, Lynn Township, Posey County, Ind. September 10; temperature 77°. Big Creek is a small, sluggish stream with warm and muddy water, and bottom and banks of mud. It flows westward through Posey County, entering the Wabash River below New Harmony. Collections were made at a point 6½ miles north of Mount

Vernon, Ind. In one locality an outcrop of sandstone gives a hard bottom for some distance. Elsewhere the stream is full of logs and snags. Species found in this creek are marked C.

7. *Wabash River* at Mackey's Ferry, Posey County. September 11; temperature 75°. At Mackey's Ferry, 7 miles west of Mount Vernon, and about 10 miles north of the mouth of the Wabash, considerable collections were made. The seine was used on a long, shallow, sandy bar on the Indiana side. Numerous catfishes, sunfishes, and cyprinodonts were taken in a neighboring pond or bayou. This overflows in spring and is then connected with the river. It is a long, narrow channel, very stagnant, filled with snags in most places, and having an extremely muddy bottom. Species from the pond or river at Mackey's Ferry are marked M.

1. **Petromyzon concolor** (Kirtland). S.
2. **Polyodon spathula** (Walbaum). S.
3. **Acipenser rubicundus** Le Sueur. S.
4. **Lepisosteus osseus** (Linnæus). S.
5. **Lepisosteus platystomus** (Rafinesque). V., W., M.
6. **Lepisosteus tristœchus** (Bloch & Schneider). S.
7. **Amia calva** Linnæus. M.
8. **Noturus gyrinus** (Mitchill). C.
9. **Noturus miurus** Jordan. V., P., W.
10. **Noturus flavus** Rafinesque. V., W.
11. **Leptops olivaris** (Rafinesque). P.
12. **Ameiurus melas** (Rafinesque). G.
13. **Ameiurus natalis** (Le Sueur). M., C.
14. **Ictalurus punctatus** (Rafinesque). V., P., W., B., M., C.
15. **Ictiobus cyprinella** (Cuv. & Val.). M.
16. **Ictiobus bubalus** (Rafinesque). V., W., M.
17. **Ictiobus difformis** (Cope). V., P., W., M., C.
18. **Catostomus nigricans** (Le Sueur). V.
19. **Erimyzon sucetta** (Lacépède). G. Var. *oblongus*.
20. **Minytrema melanops** (Rafinesque). W., G., M.
21. **Moxostoma duquesnei** (Le Sueur). V., P.
22. **Moxostoma aureolum** (Le Sueur). W.

Head $4\frac{3}{4}$ in length; outline of dorsal somewhat concave.

23. **Moxostoma anisurum** (Rafinesque). B. (*Ptychostomus velatus* and *collapsus* Cope. *Catostomus carpio* Val. *Moxostoma valenciennesi* Jordan.)

Not rare. Lips moderate, the lower strongly Λ-shaped; its surface rather finely plicate and also papillose; the papillæ coarser than in *M. papillosum*, to which this species is related; mouth not large, the snout projecting beyond it; dorsal high, of 15 rays, its free edge straight; eye large, $3\frac{3}{4}$ in head; head large, broad, and flat above; body deep, compressed.

24. **Campostoma anomalum** (Rafinesque). V., G.
25. **Hybognathus nuchalis** (Agassiz). W., M., C.
26. **Pimephales notatus** (Rafinesque). V., P., W., G., C.
27. **Cliola vigilax** (Baird & Girard). V., W., B., M., C.
28. **Notropis microstomus** (Rafinesque). W.

29. **Notropis heterodon** (Cope). V.

30. **Notropis megalops** (Rafinesque). V., P., W., B., M., C.

31. **Notropis whipplei** (Girard). V., P., W., B., G., C.

One very large specimen, besides many of the usual type.

32. **Notropis atherinoides** (Rafinesque). V., P., W.

These specimens are smaller, more compressed, with shorter snout and paler coloration than the ordinary *atherinoides* (*jaculus*, *argе*). The eye is similarly large, and no other difference is evident.

33. **Notropis dilectus** (Girard) var. W., C., G., M.

Compared with specimens of *Notropis dilectus* from Red River, Arkansas, these examples have the eye much smaller—about $3\frac{3}{4}$ instead of 3—in head. In all other respects they seem to agree. Compared with *N. rubrifrons* these specimens have smaller eye, shorter and blunter head ($4\frac{1}{2}$ in length), and the body more compressed. For the present we refer them to *N. dilectus*. No group of minnows is in more confusion than the one to which this species belongs.

34. **Ericymba buccata** Cope. G.

Found in clear waters with sandy bottom.

35. **Hybopsis hyostomus** Gilbert. V., W.

36. **Hybopsis dissimilis** (Kirtland). V., W.

37. **Hybopsis storerianus** (Kirtland). V., W., M., C.

38. **Semotilus atromaculatus** (Mitchill). G.

39. **Opsopœodus emiliæ** Hay. W., M., C.

40. **Notemigonus chrysoleucus** (Mitchill). W., G., M., C.

41. **Dorosoma cepedianum** (Le Sueur). P., W., M..

42. **Clupea chrysochloris** Rafinesque. M.

43. **Hiodon alosoides** (Rafinesque). W.

44. **Gambusia patruelis** (Baird & Girard). M., B., G.

45. **Zygonectes dispar** Agassiz. V., M.

46. **Zygonectes notatus** (Rafinesque). C., M., G., B., W., V., P.

47. **Lucius vermiculatus** (Le Sueur). M.

48. **Lucius lucius** (Linnæus). S.

This species was described from New Harmony by Le Sueur, as *Esox deprandus*.

49. **Labidesthes sicculus** Cope. M., P., W.

50. **Aphredoderus sayanus** (Gilliams). S., C.

Scales 48.

51. **Pomoxis annularis** Rafinesque. W., M.

52. **Pomoxis sparoides** (Lacépède). V., P., W.

53. **Chænobryttus gulosus** (Cuv. & Val.). V., W., M.

54. **Lepomis cyanellus** Rafinesque. V., G.

55. **Lepomis pallidus** (Mitchill). V., W., M.

56. **Lepomis megalotis** (Rafinesque). P., W., M.

57. **Lepomis garmani** Forbes. M.

Rather common in the pond at Mackey's Ferry.

58. **Lepomis humilis** (Girard). C.

59. **Lepomis notatus** (Agassiz). M.

60. Micropterus dolomieu (Lacépède). V., M.

In the river only.

61. Micropterus salmoides (Lacépède). P., M., V., W., B.

In ponds and bayous chiefly.

62. Etheostoma pellucidum Baird. W., M.

63. Etheostoma asprellus (Jordan). V., W.

Specimens of very large size, the largest 5½ inches long. Scales 98. Three broad oblique black shades across back, extending downwards and forwards to lateral line; these about as wide as the interspaces.

64. Etheostoma nigrum (Rafinesque). V., W., P., B., G., M., C.

Very common.

65. Etheostoma chlorosoma (Hay). W., C., M. (*Boleosoma camurum* Forbes.)

Scales 45; lateral line incomplete.

66. Etheostoma copelandi (Jordan). W., V.

Scarce. Scales 48.

67. Etheostoma histrio Jordan & Gilbert. P.

Seven specimens, some of them considerably larger than any of the original types. Blotch at base of caudal very distinct. Cheeks naked; opercles naked or with some large scales. Scales 53; dorsal spines 10. Premaxillaries protractile, in some specimens with a slight frenum at base, crossed by a crease. The species seems to be an ally of *E. simoterum*, and should be placed with the latter in the subgenus *Ulocentra*.

68. Etheostoma shumardi (Girard). V., W.

Many fine large specimens, 3 to 3½ inches in length; belly largely orange-yellow in life. Anal very high. Scales 52; scales of belly small, those of the middle line caducous; premaxillaries usually distinctly protractile, one specimen, however, with a small but unmistakable frenum at base of premaxillaries.

69. Etheostoma uranidea (Jordan & Gilbert). V., W.

Many specimens 3 to 3½ inches long, much larger than the original types; grayish above, yellow or orange below; an obscure lateral band of dark blotches; four black oblique bands extending downward and forward on back. Cheeks naked; opercles scaly. Scales 52; median line of belly with slightly enlarged scales, which are probably caducous. This handsome species is closely allied to *E. shumardi* and belongs to the group called *Imostoma*.

70. Etheostoma caprodes Rafinesque. M., V., W., P., B.

71. Etheostoma phoxocephalum Nelson. C., V., W., P.

Common.

72. Etheostoma aspro (Cope & Jordan). W., C.

Rather scarce.

73. Etheostoma ouachitæ (Jordan & Gilbert). P.

Five specimens, 2½ to 3 inches long, larger than the original types from Washita (Ouachita) River, Arkansas. Scales 52 to 56. The close resemblance of this species to the eastern *E. peltatum* has been already noticed.

74. Etheostoma scierum (Swain). V., P., W.

Common. Scales 68; ventral scales slightly enlarged but probably caducous; color very similar to that of *E. aspro*, but with usually three dark spots at base of caudal

instead of one; lateral shades broader. Gill-membranes considerably united; preopercle serrulate, at least in young specimens.

75. Etheostoma evides (Jordan & Copeland). W., V.

Common in the river. Scales 61.

76. Etheostoma cœruleum Storer. V.

Less common than farther north. Scales 46.

77. Etheostoma jessiæ (Jordan & Brayton). V., W., C.

This species seems here to approach very closely to *E. cœruleum*, there being very little difference in the specimens from Vincennes except that *cœruleum* has naked cheeks while in *jessiæ* the cheeks are scaly. Scales 50, 54, 55, 55 in four specimens. The species or group of species called *E. jessiæ* (*E. asprigene*, *E. swaini*) is much in need of farther study.

E. iowæ Jordan & Meek has a form more like that of *E. eos* (*fusiforme* var.), and color markings similar to those of the latter, including three spots at base of caudal; its lateral line is, however, nearly straight, as in *E. jessiæ*.

78. Etheostoma squamiceps Jordan. G., B.

In shallow, sandy streams. This species is allied rather to *E. whipplei* than to *E. flabellare*. Scales 55 to 60; opercles scaly; cheeks scaly or naked; three dark spots across base of caudal; no bright red or blue markings; body covered with dark specks.

79. Etheostoma fusiforme (Girard). W., C.

Rather scarce. These specimens represent the form or variety called *palustre*.

80. Aplodinotus grunniens (Rafinesque). P., W., M.

Common.

R.—LOWER OHIO RIVER.

Collections were made in two streams tributary to the Ohio in southwestern Indiana.

1. *Big Pigeon Creek* at Evansville, Ind. September 10. This is a sluggish, muddy stream, usually with muddy bottom. Collections were, however, made at a point where the bottom is of sandstone and shingle. The rocks are smooth and bare, there being no algæ or other vegetation in the stream. The following is the list:

1. Noturus nocturnus Jordan & Gilbert.

Head much less broad than in *N. gyrinus* and less blunt; no black streak along side of body; pectoral spine 2¼ in head, *its inner edge entire*. In the latter respect these two specimens differ from the Arkansas types of *N. nocturnus*.

2. Leptops olivaris (Rafinesque).

3. Ictalurus punctatus (Rafinesque).

4. Ictiobus bubalus (Rafinesque).

5. Ictiobus difformis (Cope).

6. Moxostoma duquesnei (Le Sueur).

7. Hybognathus nuchalis (Agassiz).

8. Notropis megalops (Rafinesque).

9. Notropis whipplei (Girard).

10. **Notropis dilectus** (Girard).
11. **Dorosoma cepedianum** (Le Sueur).
12. **Clupea chrysochloris** Rafinesque.
13. **Zygonectes notatus** (Rafinesque).
14. **Pomoxis annularis** Rafinesque.
15. **Micropterus salmoides** (Lacépède).
16. **Etheostoma flabellare** (Rafinesque).
17. **Aplodinotus grunniens** (Rafinesque).

2. *Cypress swamp*, Mount Vernon, Ind. September 11; temperature 74°. A small collection was made in a cypress swamp 5 miles east of Mount Vernon. It is a rather deep, stagnant slough, full of logs and brush, with much *Lemna* and *Chara*. The following species were taken:

1. **Opsopœodus emiliæ** Hay.
2. **Zygonectes notatus** (Rafinesque).
3. **Zygonectes dispar** (Agassiz).
4. **Lepomis pallidus** (Mitchill).
5. **Chænobryttus gulosus** (Cuv. & Val.).
6. **Pomoxis sparoides** (Lacépède).
7. **Etheostoma chlorosoma** (Hay).
8. **Etheostoma fusiforme** (Girard).

8.—WHITE RIVER.

The White River rises in various branches in the eastern and central part of the State of Indiana, running southwestward and entering the Wabash near Patoka. It is for the most part a clear stream, flowing with a gentle current over sand and fine gravel. Of the two large and nearly equal branches the west fork is the clearer, and its bottom is more sandy and freer from mud than that of the other. The extensive collections already made in the west fork by the writer and others at Indianapolis, Gosport, and Bloomington, have been elsewhere recorded.

Collections were made by Messrs. Evermann and Bollman at Spencer, Ind., and also in a tributary called Eel River at Cataract, in Owen County, north of Spencer.

At Spencer the bottom of the river is mostly muddy or sandy, with an occasional stretch of rocky ripples. Collections were made just above the wagon bridge. Here the water is shallow, with moderate current, the rocks covered with algæ, while near one shore are patches of *Ruellia* and other water plants.

The following species were taken:

1. *White River (West Fork)*, Spencer, Ind.

1. **Ictalurus punctatus** (Rafinesque).
2. **Noturus flavus** Rafinesque.
3. **Noturus miurus** Jordan.
4. **Catostomus nigricans** (Le Sueur).
5. **Moxostoma duquesnei** (Le Sueur).
6. **Moxostoma breviceps** (Cope).

This is the species called *Moxostoma crassilabre* by Jordan, Man. Vert., ed. 5. It is probably not *M. crassilabre* (Cope). It may be *M. conus* (Cope), and is probably Cope's *M. breviceps*, though the latter may really be *Placopharynx carinatus*. This species is

found in the great lakes in abundance, and it is not improbable that it is *Moxostoma lesueuri* (Richardson).

7. **Campostoma anomalum** (Rafinesque).
8. **Notropis rubrifrons** Cope.
9. **Notropis whipplei** (Girard).
10. **Notropis megalops** (Rafinesque).
11. **Notropis microstomus** (Rafinesque).
12. **Hybopsis kentuckiensis** (Rafinesque).
13. **Hybopsis storerianus** (Kirtland).
14. **Hybopsis dissimilis** (Kirtland).
15. **Ericymba buccata** Cope.
16. **Micropterus dolomieu** (Lacépède).
17. **Micropterus salmoides** (Lacépède).
18. **Etheostoma nigrum** (Rafinesque).
19. **Etheostoma blennioides** (Rafinesque).
20. **Etheostoma caprodes** Rafinesque.
21. **Etheostoma phoxocephalum** Nelson.
22. **Etheostoma scierum** (Swain).
23. **Etheostoma cœruleum** Storer.

2. *Eel River* at Cataract, Ind.

The Eel River (Owen County) is a rather clear but sluggish stream with greenish water full of clayey sediment after heavy rains. At Cataract there are two considerable water-falls. Collections were made at a point just below the upper falls. The bottom is of limestone, with intervals of mud in which are many water plants. Fishes are scarce in this locality, the following species being taken:

1. **Noturus flavus** Rafinesque.
2. **Ameiurus melas** (Rafinesque).
3. **Campostoma anomalum** (Rafinesque).
4. **Notropis whipplei** (Girard).
5. **Notropis megalops** (Rafinesque).
6. **Hybopsis kentuckiensis** (Rafinesque).
7. **Semotilus atromaculatus** (Mitchill).
8. **Lucius vermiculatus** (Le Sueur).
9. **Micropterus dolomieu** (Lacépède).
10. **Lepomis cyanellus** Rafinesque.
11. **Etheostoma flabellare** (Rafinesque).

All common species.

Wabash River, Terre Haute, Ind.—Collections were also made in the Wabash and its tributaries about Terre Haute, Ind. The following species are the only ones worthy of special note:

1. **Etheostoma phoxocephalum** Nelson.
2. **Etheostoma shumardi** (Girard).
3. **Etheostoma copelandi** (Jordan).
4. **Etheostoma fusiforme** (Girard).
5. **Umbra limi** (Kirtland).

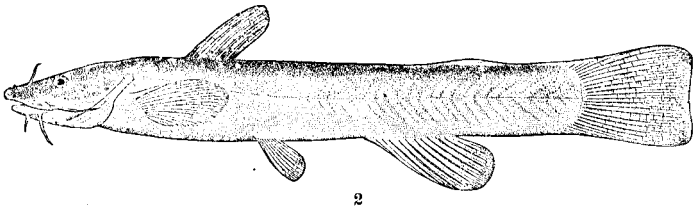
GENERAL CONCLUSIONS.

The results of the observations recorded in the present paper are fully in accord with the general conclusions as to the geographical distribution of fresh-water fishes advanced in a paper on the subject in Science Sketches (1888, pp. 83–133). It is evident that the question of distribution reduces itself to the question of barriers of various sorts. Each species extends its range in every direction and holds the ground thus taken if in the struggle for existence it is able to do so.

To quote from the work just mentioned: "The present distribution of fishes is the result of the long-continued action of forces still in operation. The species have entered our waters in many invasions from the Old World or from the sea. Each species has been subjected to the various influences implied in the term Natural Selection, and, under varying conditions, its representatives have undergone many modifications. Each of the six hundred species we now know (in rivers of the United States) may be conceived as making each year inroads on territory occupied by other species. If these colonies are able to hold their own in the struggle for possession they will multiply in the new conditions and the range of the species will become widened. If the surroundings are different, new species or varieties will be formed with time and these new forms may again invade the territory of the parent species. Again, colony after colony of species after species may be destroyed by other species or by uncongenial surroundings. The ultimate results of centuries on centuries of the restlessness of individuals are seen in the facts of geographical distribution. Only in the most general way can the history of any species be traced, but could we know it all, it would be as long and as eventful a story as the history of the colonization and settlement of North America by immigrants from Europe. But by the fishes, each river in America has been a hundred times discovered, its colonization a hundred times attempted. In these efforts there is no co-operation. Every individual is for himself, every struggle a struggle of life and death, for each fish is a cannibal, and to each species each member of every other species is an alien and a savage."

The fact of the analogy existing between the fauna of rivers and the land faunæ of islands is rendered very evident. As the fauna of the islands is limited by the barrier of the sea, so that of the rivers is limited by barriers of land, and analogous laws determine what species can obtain a hold in either case.

Additional confirmation has been given to the idea that the lowland swamp fishes of the United States are remains of an earlier and, in part, now extinct fauna. To such a fauna, it is generally admitted, belong the genera *Amia* and *Lepisosteus*. To this list I would add *Umbra*, *Lucius*, *Chologaster*, *Aphredoderus*, *Jordanella*, *Elassoma*, *Acantharchus*, *Pomoxis*, *Enneacanthus*, *Mesogonistius*, and doubtless *Percopsis*. The upland fishes seem to be mostly of more recent origin, the species of *Notropis* and *Etheostoma* probably latest of all.



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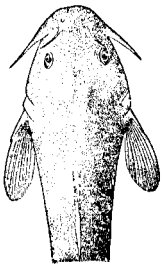

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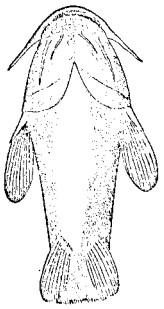

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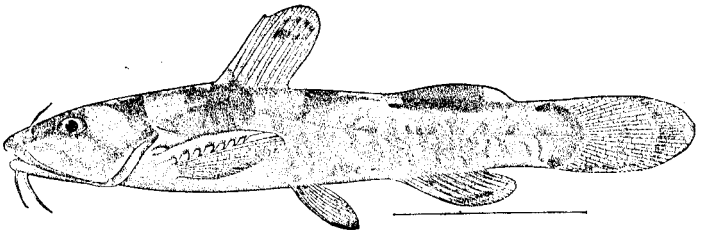

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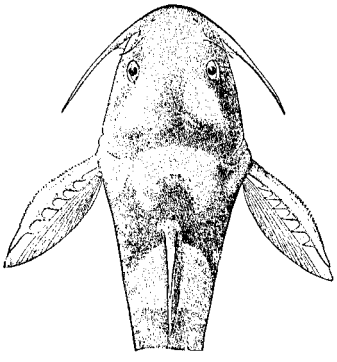

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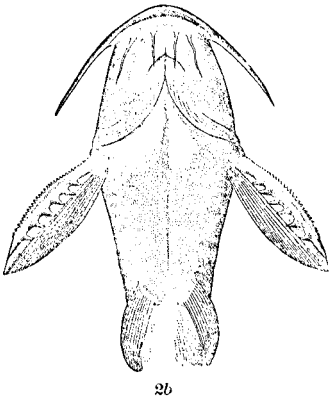
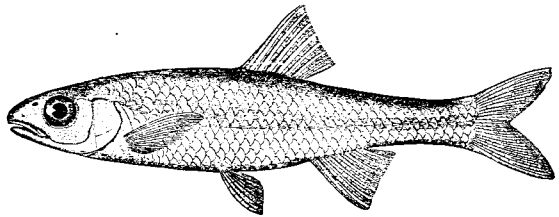


2b

FIGS. 1, 1*a*, 1*b*. *Noturus furiosus*, Jordan & Meek.
FIGS. 2, 2*a*, 2*b*. *Noturus gilberti*, Jordan & Evermann.



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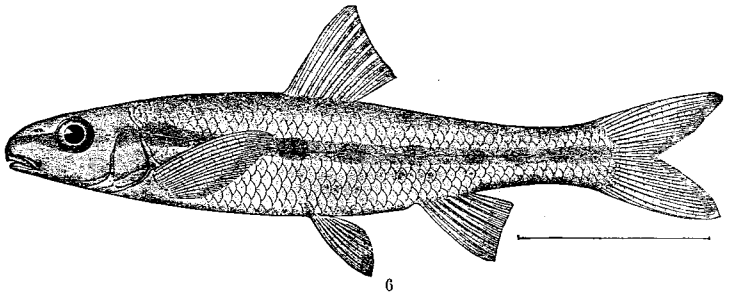

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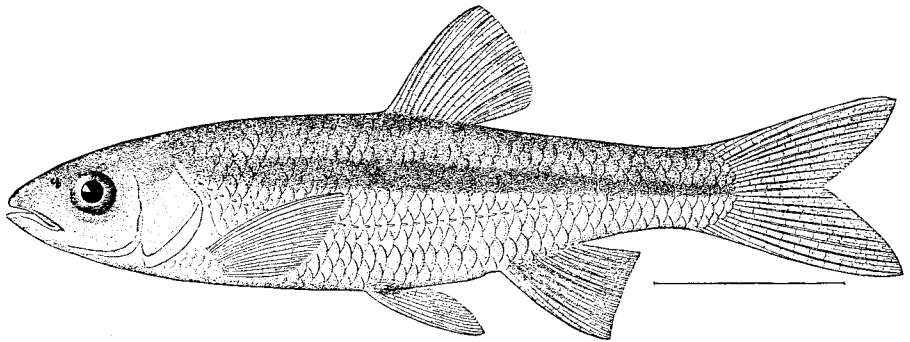

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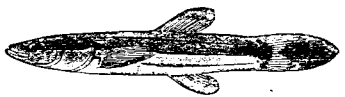

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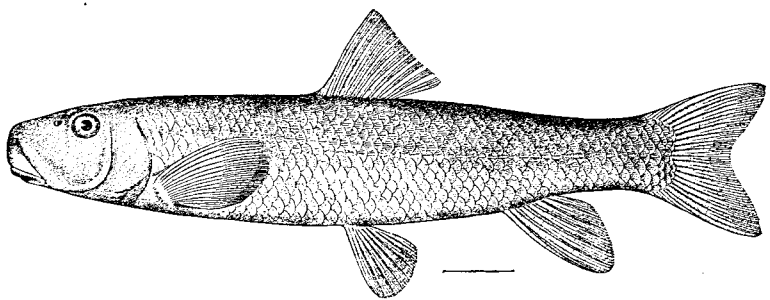

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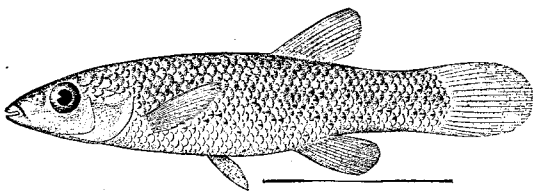
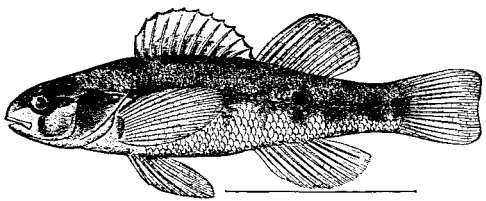


7

FIG. 3. *Moxostoma rupiscartes*, Jordan & Jenkins.
FIG. 4. *Notropis macdonaldi*, Jordan & Jenkins.
FIG. 5. *Notropis kanawha*, Jordan & Jenkins.

FIG. 6. *Hybopsis watauga*, Jordan & Evermann.
FIG. 7. *Fundulus rathbuni*, Jordan & Meek.
FIG. 8. *Chologaster avitus*, Jordan & Jenkins.



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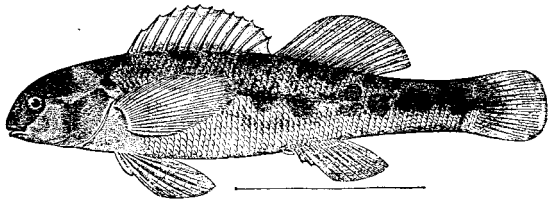

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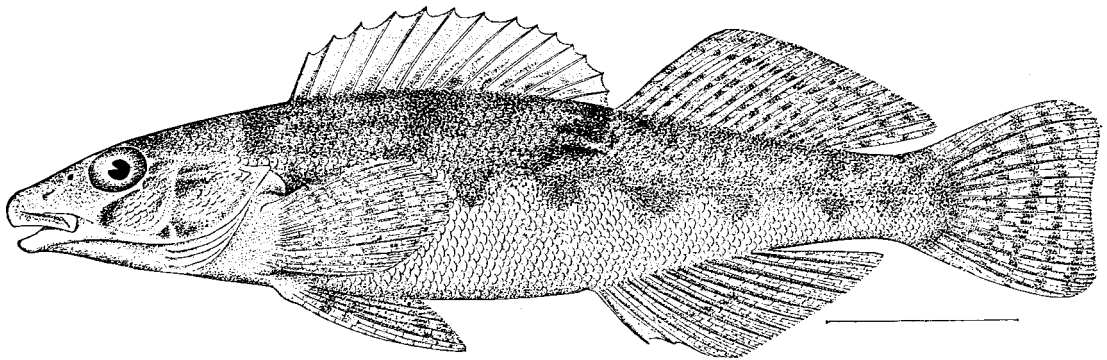

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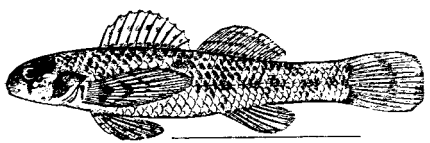

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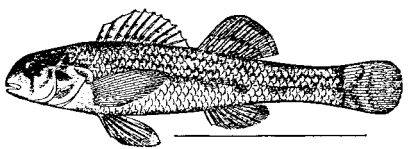

12

FIG. 9. *Etheostoma rex*, Jordan & Evermann.
FIG. 10. *Etheostoma roanoka*, Jordan & Jenkins.
FIG. 11. *Etheostoma podostemone*, Jordan & Jenkins.

FIG. 12. *Etheostoma verecundum*, Jordan & Evermann.
FIG. 13. *Etheostoma swannanoa*, Jordan & Evermann.

INDEX.