

UNIVERSITY OF MICHIGAN
MUSEUM OF ZOOLOGY

Miscellaneous Publications No. 15

**A Check-List of the Fishes of the Great Lakes
and Tributary Waters, with Nomenclatorial
Notes and Analytical Keys**

BY

CARL L. HUBBS

ANN ARBOR, MICHIGAN
PUBLISHED BY THE UNIVERSITY
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ALEXANDER G. RUTHVEN,
Director of the Museum of Zoology,
University of Michigan.

A CHECK-LIST OF THE FISHES OF THE GREAT LAKES AND
TRIBUTARY WATERS, WITH NOMENCLATORIAL
NOTES AND ANALYTICAL KEYS

BY CARL L. HUBBS

The last general list of the fishes of the Great Lakes and connecting waters was published more than twenty years ago.¹ Since that time 43 species and subspecies have been added to the known fish fauna of the region, while 29 others have been shown to be invalid as elements in the fauna of the basin. Furthermore, recent work has indicated the desirability, or necessity, as the case may be, of further nomenclatorial changes. Most of these cases are discussed in due order in the following list.

The blue pike of Lake Erie is treated as a new species, *Stizostedion glaucum*. A new subspecies, *Notropis heterodon richardsoni*, is described in collaboration with Mr. C. Willard Greene.

According to the present list, the fish fauna of the Great Lakes and tributary waters comprises 28 families, 96 genera and 154 species, or including also subspecies, a total of 166 forms. A few of these are perhaps erroneously accredited to the basin, and it may later be found impossible to recognize some of the subspecies here accepted. It is probable, also, that a few, but not many, additions to the list will be made in the future.

Obviously or apparently erroneous records are discussed under the heading of related species, with a statement of the error or doubt involved. Introduced species which have become even slightly established in our area are listed in proper sequence, even including those which have subsequently become extinct in the Great Lakes region.

Professor T. L. Hankinson and the writer are planning the preparation of a general treatise on the fishes of the Great Lakes and tributary waters. As we expect to be engaged in this work for several years, we have considered as desirable the publication of this check-list at the present time.

KEY TO THE FAMILIES²

a¹.—Mouth a sucking disc. Gill openings seven. Paired fins absent. (Class Marsipobranchii: lampreys, etc.)1. *Petromyzonidae*

¹ Evermann, Bull. U. S. Fish Comm., 21, 1901 (1902), pp. 95-96.

² Only the more obvious characters are employed in this key. Nevertheless, an effort has been made to maintain a natural system as far as possible. The key, however, can not be applied to any other region, as the characters are drawn primarily from the Great Lakes representatives of each group.

- a².—Mouth a gape bordered by upper and lower jaws. Gill-slits four, covered by opercular bones. Paired fins present. (Class Teleostomi, and subclass Actinopterygii: typical fishes)³
- b¹.—Caudal fin typically heterocercal. Body naked or partially plated. (Superorder Chondrostei: paddle-fish and sturgeons)
- c¹.—Maxillary obsolete. Skin of body naked. Snout paddle-like. (Order Selachostomi: paddle fish)2. *Polyodontidae*
- c².—Maxillary developed. Body partially plated. Snout conical. (Order Acipenseroides: sturgeons)3. *Acipenseridae*
- b².—Caudal fin abbreviate-heterocercal. Body scaled. (Superorder Holostei: gars and dog-fish)
- d¹.—Body covered with thick, rhombic ganoid scales. Dorsal fin short. Face produced into a beak. (Gars)4. *Lepisosteidae*
- d².—Body covered with cycloid scales. Dorsal fin elongate. No beak developed. (Dog-fish)5. *Amiidae*
- b³.—Caudal fin nearly or quite homocercal. (Superorder Teleostei: bony fishes)
- e¹.—Dorsal fin with no spinous (that is, unsegmented) rays, or with only one. Pelvic fin without spine. (Series Malacopterygii: soft-rayed fishes)
- f¹.—Branchiostegal rays various in number and arrangement, the uppermost a wide thin plate always exposed and margining the suboperculum and interoperculum.⁴ Pectoral fins inserted ventrally and horizontally (except in the eel).
- g¹.—Body not eel-shaped. Pelvic fins developed.
- h¹.—Caudal fin forked (except in some cat-fishes, which unlike the Haplomi have barbels and pectoral spines).
- i¹.—Chin without barbels. Pectoral fin without a spine. Body scaled.
- j¹.—Gill-slits extended far forward; the gill membranes free from the isthmus.
- k¹.—No adipose fin developed.
- l¹.—Lateral line present. Belly without strong spiny scutes. (Moon-eye)6. *Hiodontidae*
- l².—Lateral line absent. Belly with strong spiny scutes. (Herring-like fishes)7. *Clupeidae*
- k².—An adipose fin developed.
- m¹.—Scales larger, fewer than 100 in lateral line.
- n¹.—Base of dorsal fin much shorter than head.
- o¹.—Teeth strong. (Smelt)8. *Osmeridae*
- o².—Teeth very weak or absent. (White-fish, lake herring, etc.)9. *Coregonidae*
- n².—Base of dorsal fin much longer than head. (Grayling)10. *Thymallidae*
- m².—Scales very small, more than 100 in lateral line. (Salmon and trout)11. *Salmonidae*
- j².—Gill-slits not extended far forward below; the gill-membranes united to the isthmus.

³ The general classification is the same as that adopted by the present writer in 1919 (Science, 48, p. 570).

⁴ See Hubbs, Jour. Morph., 33, 1919 (1920), pp. 61-71.

Correction: The Esocidae have the caudal fin forked and should enter group h¹. They are distinguishable from other fishes placed there by the shape of the head.

- p¹.—Pharyngeal teeth numerous and comb-like. Mouth fitted for sucking, the lips more or less thick and plicate or papillose. (Suckers)12. *Catostomidae*
- p².—Pharyngeal teeth fewer than 8 on each side, and highly specialized. Mouth usually not fitted for sucking, the lips thin and never plicate or papillose. (Minnows, etc.)13. *Cyprinidae*
- i².—Chin with barbels. Pectoral fin with a strong spine. Body scaleless. (Cat-fishes)14. *Ameiuridae*
- h².—Caudal fin rounded.
 - q¹.—Lateral line wanting. Front of head not shaped like a duck's bill. (Mud-minnow)15. *Umbridae*
 - q².—Lateral line present. Front of head shaped like a duck's bill. (Pike)16. *Esocidae*
 - g².—Body eel-shaped. Pelvic fins wanting. (Eel)17. *Anguillidae*
- f².—Branchiostegal rays (as in the Acanthopterygii) 4 + x in number, folded up like a fan, so that the uppermost is hidden behind the opercular bones. Pectoral fins (as in higher groups) inserted laterally and vertically18. *Cyprinodontidae*
- e².—Dorsal fin with more than one spine (unsegmented ray); pelvic fin with a spine. (Series Acanthopterygii: spiny-rayed fishes)
 - r¹.—An adipose fin developed. Only two dorsal spines. (Trout-perch).....19. *Percopsidae*
 - r².—No adipose fin. More than two dorsal spines.
 - s¹.—Anus far in advance of anal fin, located near throat. (Pirate perch).....20. *Aphredoderidae*
 - s².—Anus located posteriorly, immediately before anal fin.
 - t¹.—No barbel at tip of lower jaw. Vertebral column ending in a large flat hypural plate.
 - u¹.—Dorsal spines connected by membrane. No bony plate behind pelvic fins.
 - v¹.—Body covered with ordinary scales. Pelvic fin with 5 soft (articulated) rays.
 - w¹.—Lateral line not extended across caudal fin.
 - x¹.—Pelvic fins thoracic, located close to the pectorals. Dorsal spines more than six.
 - y¹.—Dorsal fins two, entirely separated or slightly joined together.
 - z¹.—Anal spines three. (White bass and yellow bass).....21. *Serranidae*
 - z².—Anal spines one or two. (Perch, darters, etc.).....22. *Percidae*
 - y².—Dorsal fin single (deeply emarginate in Aplites). Anal spines three or more (except very rarely in Micropterus). (Sun-fishes, black bass, etc.).....23. *Centrarchidae*
 - x².—Pelvic fins (secondarily) abdominal, located far behind the pectorals. First dorsal separated from second and composed of four weak spines. (Silver-sides)24. *Atherinidae*
 - w².—Lateral line extended across the caudal fin. Anal spines two, the second very strong. (Sheepshead)25. *Sciaenidae*
 - v².—Body scaleless, or with a few prickles only. Pelvic fins with only 3 or 4 soft rays. (Sculpins)26. *Cottidae*

- u².—Dorsal spines isolated. A bony plate behind pelvic fins. (Sticklebacks)27. *Gasterosteidae*
 t².—A barbel at tip of lower jaw. Vertebral column isocercal, not ending in a large flat hypural. (Lawyer)28. *Gadidae*

Family 1. PETROMYZONIDAE

KEY TO THE GENERA⁵

- a¹.—Buccal funnel with series of teeth radiating in all directions from the mouth, and deflected backward toward the margin of the disc; supraoral narrow.
 b¹.—A single more or less deeply emarginate dorsal fin; dorsal fin not separated from the caudal by a sharp notch; caudal a broadly oval lobe. Innermost lateral disc teeth usually unicuspid (one to five on each side sometimes bicuspid); bases of teeth poorly developed. Myotomes between last gill-opening and anus fewer than 60 (48 to 57)1. *Ichthyomyzon*
 b².—Two distinct, more or less widely separated dorsal fins; posterior dorsal fin separated from the caudal by a sharp notch; caudal a rather angular lobe. Innermost lateral disc teeth always bicuspid. Myotomes between last gill-opening and anus more than 60 (about 70)2. *Petromyzon*
 a².—Teeth of the buccal funnel not in distinct radiating series, but in several groups: several enlarged lateral teeth, usually multicuspid, at the edge of the oral opening; a marginal series around edge of disc; few to many teeth on the anterior part of the disc; supraoral broad, the main cusps separated by a bridge. Fins about as in *Petromyzon*.
 c¹.—A posterior series of small teeth present, parallel to the marginal series and connecting the last pair of enlarged laterals3. *Entosphenus*⁶

Genus 1. ICHTHYOMYZON Girard

KEY TO THE SPECIES⁷

- a¹.—Buccal funnel when expanded much greater in diameter than the width of the body. Supraoral lamina greatly constricted, with one to four (usually two) sharp contiguous cusps; anterior lingual lamina with two transverse elements, each with sharp denticles; all disc teeth large and sharp. Oral fimbriae arranged in a double row, not appearing matted. Intestine well developed and functional in adults. Ammocoetes probably transforming at a size of less than 120 mm. (Subgenus *Ichthyomyzon* Girard)1. *I. concolor*
 a².—Buccal funnel constricted, when fully expanded not greater in diameter than the width of the body. Supraoral lamina with two small, blunt, well separated cusps;

⁵ Key adapted from that of Creaser and Hubbs (Occ. Pap. Mus. Zool., Univ. Mich., 120, 1922, pp. 3-7).

⁶ The genus *Lampetra* may ultimately be found to occur in Great Lakes tributaries. It is represented in the Ohio system by *Lampetra lamottenii* Le Sueur, which differs from *Entosphenus appendix* not only in the lack of the posterior series of teeth as described in the key, but also in the dentition, the more widely connected dorsal fins and the fewer myotomes. (See Creaser and Hubbs, *l. c.*, pp. 8, 14, and pl. 1.)

⁷ From Creaser and Hubbs (*l. c.*, p. 4).

anterior lingual lamina with a single transverse element with minute rounded denticles; all disc teeth weak and blunt, largely obsolescent. Oral fimbriae presenting a matted appearance. Intestine degenerate and non-functional in adults. Amocoetes probably usually attaining a size of 120 mm. or more before transforming. (Subgenus *Reighardina* Creaser and Hubbs)2. *I. unicolor*

1. *Ichthyomyzon concolor* Kirtland

Silver lamprey; river lamprey

2. *Ichthyomyzon unicolor* DeKay

Reighard lamprey

The nomenclature of this species, first accurately distinguished as *Ichthyomyzon fossor*,⁸ has already been discussed by us.⁹

Genus 2. PETROMYZON Linnaeus

3. *Petromyzon marinus* Linnaeus

Sea lamprey; lake lamprey

“The dwarfed race (*P. marinus dorsatus* Wilder) land-locked in the New York lakes, of which we have examined material, does not appear to us worthy of even subspecific recognition.”—Creaser and Hubbs, *l. c.*, p. 9. Gage's excellent figure of the dentition of this form has been erroneously used by Pratt¹⁰ to illustrate the degenerate *Ichthyomyzon unicolor*.

Genus 3. ENTOSPHEMUS Gill

4. *Entosphenus appendix* DeKay

American brook lamprey

This name, as Creaser and Hubbs (*l. c.*, p. 11) have pointed out, should replace that of *Lampetra wilderi* for the best known of the three species of non-parasitic lampreys of eastern North America.

Family 2. POLYODONTIDAE

Genus 4. POLYODON Lacépède

5. *Polyodon spathula* Walbaum

Paddle-fish; spoon-bill cat

An intelligent fish dealer at Monroe, Captain Parker, has recounted to the writer the taking in Lake Erie, off Monroe, Michigan, of a fish which,

⁸ Reighard and Cummins, *Oec. Pap. Mus. Zool., Univ. Mich.*, 31, 1916, pp. 1-12.

⁹ Creaser and Hubbs, *ibidem*, 120, 1922, pp. 4, 8.

¹⁰ A manual of land and fresh water vertebrate animals of the United States (exclusive of birds), Philadelphia, 1923, p. 25.

judging from his description, could have been none other than the paddlefish. This furnishes the fourth record of the species for the Great Lakes—St. Lawrence system, the second for Lake Erie, and the first for Michigan.

Family 3. ACIPENSERIDAE

Genus 5. ACIPENSER Linnaeus

6. *Acipenser fulvescens* Rafinesque

Lake sturgeon; rock sturgeon

As demonstrated elsewhere,¹¹ the sturgeon of the Great Lakes must be known by this name, the oldest for the species. The change has been accepted by Jordan¹² and others.

The relationship of this species with *Acipenser brevirostrum* of the Atlantic Coast is in need of closer definition.

Family 4. LEPISOSTEIDAE

Genus 6. LEPISOSTEUS Lacépède

KEY TO THE SPECIES¹³

- a¹.—Beak shorter and broader, its least width about $5\frac{1}{2}$ in its length; its length 3.6 to 6 in distance from eye to caudal. Length of caudal peduncle normally not greater than greatest depth of body. (Subgenus *Cylindrosteus* Rafinesque).....7. *L. platostomus*
- a².—Beak long and slender, its least width about 20 in its length; its length 3.4 in distance from eye to caudal. Length of caudal peduncle $1\frac{1}{3}$ to $1\frac{1}{2}$ (or even twice) greatest depth of body. (Subgenus *Lepisosteus* Lacépède).....8. *L. osseus*

7. *Lepisosteus platostomus* Rafinesque

Duck bill gar; short-nose gar

The type of *Lepisosteus oculatus* Winchell,¹⁴ a nominal species synonymous with *L. platostomus*, is still preserved in the Museum of Zoology. It came from Duck Lake, Michigan (where the species still occurs), not from the Huron River as incorrectly stated by Jordan and Evermann.¹⁵

A specimen collected by Baird at Cleveland, Ohio, is in the United States National Museum. In the Great Lakes region this gar is very rare.

¹¹ Hubbs, Copeia, 44, 1917, p. 48.

¹² Jordan, Copeia, 49, 1917, p. 86.

¹³ From Forbes and Richardson, Fishes of Illinois, 1908, p. 31.

¹⁴ Proc. Acad. Nat. Sci. Phila., 1864, p. 183.

¹⁵ Bull. U. S. Nat. Mus., 47, pt. 1, 1896, p. 111.

8. *Lepisosteus osseus* Linnaeus

Long-nose gar; bill-fish

Fowler's opinion¹⁶ that the long-nose gars should be referred to more than one species I have not been able to confirm. In fact, Mr. Fowler himself now recognizes but the single species.

Family 5. AMIIDAE

Genus 7. AMIA Linnaeus

Opinion 89 of The International Commission on Zoological Nomenclature reinstates *Amia* as the valid name for this genus.

9. *Amia calva* Linnaeus

Dogfish; bowfin

Family 6. HIODONTIDAE

Genus 8. HIODON Le Sueur

10. *Hiodon tergisus* Le Sueur

Moon-eye

Evermann,¹⁷ Shelford,¹⁸ and others, have listed the related gold-eye (*Amphiodon alosoides* Rafinesque)¹⁹ from the Great Lakes, but I know of no actual record, nor can I find any specimens from this region preserved in the chief museums of the country. Shelford's record is particularly misleading, since it gives a fallacious appearance of definiteness to a statement without any real basis. The species was probably listed from our basin on the supposition that it should occur here, since it inhabits waters both to the northward and the southward. Until a definite record is produced, *Amphiodon alosoides* must be dropped from the list of Great Lakes fishes.

Family 7. CLUPEIDAE

The genus *Dorosoma* has usually been regarded, by American ichthyologists, as the type of a distinct family, *Dorosomidae*. In a recent revision of the clupeoid fishes, however, Regan²⁰ disposes of the genus in the family *Clupeidae*, and I here follow his judgment.

¹⁶ Proc. Acad. Nat. Sci. Phila., 1910 (1911), pp. 604-606.

¹⁷ Bull. U. S. Fish Comm., 1901 (1902), p. 96.

¹⁸ Animal Communities in Temperate America, Chicago, 1913, p. 85.

¹⁹ See Jordan and Thompson, Proc. U. S. Nat. Mus., 38, 1910, pp. 353-357.

²⁰ Ann. Mag. Nat. Hist. (8), 19, 1917, p. 297.

KEY TO THE GENERA

- a¹.—Snout sharp. Lower jaw more or less projecting. Upper gill-rakers overlapping the lower. Stomach not gizzard-like. Last dorsal ray not prolonged.
- b¹.—Premaxillaries meeting at a large angle, so that the tip of the upper jaw does not appear notched, and does not receive the tip of the lower jaw. Cheeks longer than deep9. *Pomolobus*
- b².—Premaxillaries meeting at front at a very acute angle, so that the emarginate front of the upper jaw receives the slender tip of the lower. Fore part of cheeks very deep, deeper than long.....10. *Alosa*
- a².—Snout thick. Lower jaw included. Upper gill-rakers not overlapping the lower. Stomach gizzard-like. Last dorsal ray greatly produced.....11. *Dorosoma*

Genus 9. POMOLOBUS Rafinesque

KEY TO THE SPECIES²¹

- a¹.—Lower jaw strongly projecting. Gill-rakers few, 20 to 25 on lower part of anterior arch. Anterior teeth persistent. Caudal peduncle longer than deep. (Subgenus *Pomolobus* Rafinesque)11. *P. chrysochloris*
- a².—Lower jaw little projecting. Gill-rakers rather numerous, 40 to 50 on lower limb of anterior arch. Jaws toothless. Caudal peduncle not longer than deep. (Subgenus *Alausella* Gill)12. *P. pseudo-harengus*

11. *Pomolobus chrysochloris* Rafinesque

Skipjack, golden shad

This herring has been recorded from Lakes Erie and Michigan, which it is supposed to have attained by passing through canals. I have not seen the species in Great Lakes waters.

12. *Pomolobus pseudo-harengus* Wilson

Ale-wife, branch herring

In the Great Lakes region this species is confined to the Lake Ontario watershed, where it is abundant.

Genus 10. ALOSA Cuvier

13. *Alosa sapidissima* Wilson

Shad

We do not know whether any shad originally occurred in Lake Ontario, but the species has been planted there. Apparently the efforts to introduce the species met with only slight success,²² although examples have been taken as late as 1924.

²¹ Characters derived from Regan's recent critical revision (*l.c.*, p. 299).

²² See Evermann and Kendall, Rep. U. S. Comm. Fish., 1901 (1902), p. 213.

Genus 11. DOROSOMA Rafinesque

14. *Dorosoma cepedianum* Le Sueur

Gizzard shad, hickory shad, saw-belly

This species is common in the western end of Lake Erie, and occurs sporadically as far north as Saginaw Bay and Georgian Bay, two arms of Lake Huron.

Lacking adequate material from distant points, the division of this species into subspecies is not attempted here.

Family 8. OSMERIDAE

Regan, Kendall, Jordan and others have separated the Osmeridae and Coregonidae as families distinct from the Salmonidae and Argentinidae, basing the distinction on skeletal and visceral characters.

Genus 12. OSMERUS Linnaeus

15. *Osmerus mordax* Mitchill

Smelt

As Hankinson and Hubbs²³ have pointed out, the smelt has become established in Great Lakes waters. The specimens there recorded came from Crystal Lake, Michigan, where the species is particularly abundant. Others from Lake Michigan have been obtained, however, one from five miles south of Frankfort and another from Big Bay de Noc, an arm of Green Bay. The species has also become established in the Lake Superior watershed.

Family 9. COREGONIDAE

With his kind permission, some of the conclusions arrived at by Dr. Walter Koelz in his very thorough revision, soon to be published, of the coregonid fishes of the Great Lakes have been adopted here. Most of the species are divisible into local races, some of which, in my own opinion, it may eventually be found desirable to separate nomenclatorially.

KEY TO THE GENERA

a¹.—Two flaps between the nostrils. Mouth rather large, the upper jaw more than one-fourth length of head. Vestigial teeth developed on jaws, palate or tongue. Gill-rakers slender, the longest more than 8% as long as head; more than 24 on first arch. Parr markings never developed in young.

b¹.—Premaxillaries longer than high, the outer face directed downward and forward. Upper jaw typically more than 31% of head length; lower jaw contained not

²³ Copeia, 109, 1922, pp. 57-59. See also Creaser, Pap. Mich. Acad. Sci., Arts and Letters, 5, 1925, pp. 405-424, pl. 24-27.

- more than 2.3 times in head. Gill-rakers typically more than 30 (*johannae* excepted) 13. *Leucichthys*
- b².—Premaxillaries higher than long, the outer face directed downward and backward. Upper jaw typically less than 31% of head length; lower jaw contained not less than 2.4 times in head. Gill-rakers typically fewer than 30..... 14. *Coregonus*
- a².—A single flap between the nostrils. Mouth smaller, the upper jaw less than one-fourth length of head. No teeth. Gill-rakers thick, the longest less than 5% as long as head; not more than 20 on the first arch. Parr markings developed in young 15. *Prosopium*

Genus 13. LEUCICHTHYS Dybowsky

The relationships of the species of this genus are at once so intimate and so complex, and their variations both individual and racial so wide, that it is seemingly impossible to construct a serviceable analytical key of the genus. For a satisfactory means of identifying the species, therefore, one will have to refer to Dr. Koelz's forthcoming monograph on the group.

16. *Leucichthys artedi* Le Sueur

Lake herring; tullibee; cisco, etc.

Dr. Koelz regards the nominal forms *harengus*, *osmeriformis*, *sisco*, *huronius*, *ontariensis*, *bisselli*, *eriensis*, *supernus*, *manitoulinus* and *tullibee*²⁴ all as inseparable from *artedi*. An extensive investigation of the local races of the lake herring, tullibee and allied types will be required to determine their mutual relationships and the possibility, which now seems remote, of their alignment into subspecies.

17. *Leucichthys birgei* Wagner²⁵

Green Lake cisco

18. *Leucichthys nipigon* Koelz²⁶

Nipigon cisco

19. *Leucichthys reighardi* Koelz²⁷

Reighard cisco

20. *Leucichthys xenithicus* Jordan and Evermann

Lake Superior longjaw

Dr. Koelz unites with this species the *hoysi* of Jordan and Evermann, 1911 (not of Gill and of Hoy).

²⁴ The synonymy and some of the characters of the various forms to which these names have been assigned are given by Jordan and Evermann (Bull. U. S. Bur. Fish., 39, 1909 [1911], pp. 1-34, numerous figures).

²⁵ Wagner, Bull. Wisc. Nat. Hist. Soc., 9, 1911, pp. 73-77.

²⁶ Occ. Pap. Mus. Zool., Univ. Mich., No. 158, 1925, pp. 1-3.

²⁷ *Ibidem*, No. 146, 1924, p. 5.

21. *Leucichthys alpenae* Koelz²⁸

Alpena longjaw

22. *Leucichthys hoyi* Gill

Bloater

According to Dr. Koelz, this name should be applied to the little bloater of the Great Lakes, the types of the species representing that form.

23. *Leucichthys johannae* Wagner²⁹

Chub

24. *Leucichthys kiyi* Koelz³⁰

³⁰ *Ibidem*, No. 104, 1921, pp. 1-4.

Kiyi

25. *Leucichthys nigripinnis* Gill

Blackfin

26. *Leucichthys cyanopterus* Jordan and Evermann

Bluefin

Dr. Koelz regards this Lake Superior representative of the blackfin as synonymous with *L. nigripinnis*, but since it can ordinarily be quite readily distinguished from that form, it is provisionally retained here as a distinct species.

Genus 14. COREGONUS Linnaeus

27. *Coregonus clupeaformis* Mitchill

Whitefish

Dr. Koelz has not been able to confirm the separation of the nominal species *clupeaformis*, *albus*, *labradoricus* and *stanleyi*.

Genus 15. PROSOPIUM Milner

As indicated in the key, this genus is more distinct from *Leucichthys* and *Coregonus* than they are from one another.

28. *Prosopium quadrilaterale* Richardson

Pilot; Menominee whitefish

²⁸ *Ibidem*, No. 146, 1924, p. 1.

²⁹ *Argyrosomus johannae* Wagner, Science, 31, 1910, p. 957.

Family 10. THYMALLIDAE

Genus 16. THYMALLUS Cuvier

29. *Thymallus tricolor* Cope

Michigan grayling

This splendid fish is now extinct in the streams of the Lower Peninsula of Michigan, but still persists in the Upper Peninsula, at least in the Otter River.

Efforts to introduce the Montana grayling (*T. montanus*) into Michigan have, so far as known, met with no success.

Family 11. SALMONIDAE

KEY TO THE GENERA

- a¹.—Eggs all ripening simultaneously, the fishes spawning but once. Anal fin longer than high, with 13 or more developed rays.....17. *Oncorhynchus*
- a².—Eggs in part only ripening each year, the fishes normally spawning more than once. Anal fin higher than long, with 12 or fewer developed rays.
- b¹.—Vomer flat, its toothed surface plane; teeth on the shaft of the vomer in alternating rows or in one zigzag row, those on the shaft placed directly on the surface of the bone, not on a free crest (posterior vomerine teeth sometimes few and deciduous). Scales larger, in fewer than 190 rows. Species black-spotted; parr markings with a sharp ventral border.....18. *Salmo*
- b².—Vomer boat-shaped, the shaft strongly depressed, without teeth. Scales very small, in about 200 lateral rows. Species spotted with red or gray; parr markings diffuse ventrally.
- c¹.—Vomer with a raised crest, extending backward from the head of the bone, free from its shaft; this crest armed with strong teeth. Hyoid bone with a broad band of strong teeth. Ethmoid long and slender, with subparallel striae. Species spotted with gray, without bright colors.....19. *Cristivomer*
- c².—Vomer without a raised crest, the teeth not extending far behind the head. Hyoid bone with very weak teeth or none. Ethmoid short and fan-shaped, with radiating striae. Species red-spotted, the lower fins with bright edgings 20. *Salvelinus*

Genus 17. ONCORHYNCHUS Suckley

30. *Oncorhynchus tshawytscha* Walbaum^{30a}

King salmon; Chinook

^{30a}The silver salmon or coho, *Oncorhynchus kisutch* Walbaum, is at present being rather extensively propagated in Michigan, but we have not as yet found any evidence of the establishment of the species in our waters. This species differs from the king salmon (*O. tshawytscha*) in being a smaller and more silvery fish, with the dark spots less developed; in having fewer scales (120 to 140, rather than 135 to 155), fewer anal rays (12 to 15, instead of 14 to 17), fewer branchiostegals (12 to 15, not 13 to 18), and, especially, fewer pyloric caeca (52 to 81, rather than 90 to 214), also in having at

Efforts to introduce this Pacific salmon into the waters of the Great Lakes seem to have been almost wholly lacking in successful outcome. I have, however, seen an adult specimen taken at Killarney on Georgian Bay.³¹

Genus 18. SALMO Linnaeus

KEY TO THE SUBGENERA, SPECIES AND SUBSPECIES

- a¹.—Vomerine teeth little developed, those on the shaft of the bone few and deciduous. Sexual differences strong, the breeding males (as in *Oncorhynchus*) with the lower jaw hooked upward, the upper jaw emarginate or perforate to receive its tip. Size typically larger. (Subgenus *Salmo* Linnaeus: 31. *S. salar*)
- b¹.—The ordinary sea-run Atlantic salmon³².....31a. *S. salar salar*
 b².—“Smaller in size, rather more plump in form, and non-migratory”.....
31b. *S. salar sebago*
- a².—Vomerine teeth well developed, those on the shaft of the bone numerous and persistent, arranged in one zigzag row or two alternating rows. Sexual differences much less marked, but more or less approaching those of the salmon. (Subgenus *Trutta* Cuvier and Valenciennes)
- c¹.—Black spots larger and more diffuse, scarcely developed on caudal fin; red spots more or less strongly developed, often ocellated with bluish; adipose fin of young orange, without dark margin or spots. Pectoral fin larger and heavier 32. *S. fario*
- c².—Black spots smaller and sharper, well developed on caudal fin; red spots wholly undeveloped; adipose fin of young olive, with black margin or spots. Pectoral fins shorter. (33. *S. irideus*)
- d¹.—Scales usually in fewer than 135 rows. Colors usually duller and more silvery. Head usually shorter and more pointed.....33a. *S. irideus irideus*
- d².—Scales usually in more than 135 rows. Colors usually brighter and less silvery. Head usually larger and less conical.....33b. *S. irideus shasta*

31. *Salmo salar* Linnaeus

Two subspecies of not thoroughly determined status or validity inhabit (or have inhabited) Great Lakes waters.

31a. *Salmo salar salar* Linnaeus

Salmon; Atlantic salmon

Formerly, at least, this species migrated into Lake Ontario and tributary lakes and streams. I am not acquainted with its present status in these waters.

least 7 or 8, instead of few or no ridges completely continued around the exposed field of the scale, and in lacking that peculiar area of reticulated ridges at the edge of the exposed field which is characteristic of *tshawytscha*.

³¹ Specimen examined by the writer at the Provincial Museum, Toronto, Ontario.

³² I have made no real study of the Atlantic salmon.

31b. *Salmo salar sebago* Girard

Land-locked or Sebago salmon

The landlocked salmon has been repeatedly planted in the lakes of our region, and more or less authentic reports of the capture of adults are not infrequently heard. The only specimen actually received, however, is a breeding male caught at Naubinway, at the northern end of Lake Michigan.

32. *Salmo fario* Linnaeus

German brown trout

The European brook trout is now abundant in many waters in the Great Lakes region. Some are handled by the fish culturists as Loch Leven trout, but their actual source is not definitely known. Furthermore, the nomenclature of the European trout is far from settled. For these reasons all our brown trout are provisionally referred to *Salmo fario*.

33. *Salmo irideus* Gibbons

At least two subspecies of rainbow trout have been introduced into the Great Lakes region.

33a. *Salmo irideus irideus* Gibbons

Rainbow trout; steelhead trout

The "steelhead" has now become abundant in Lake Michigan, from which it ascends such streams as the Manistee to spawn. From this source most of the rainbow trout eggs propagated in Michigan are obtained. Observations indicate that this large-scaled form ("rainbow" or "steelhead" depending on conditions of water and of development) is rapidly replacing the Shasta trout in the streams.

33b. *Salmo irideus shasta* Jordan

Rainbow trout; Shasta trout

In our hatcheries this form and the last have been more or less indiscriminately crossed. In the streams the larger-scaled type (typical *S. irideus*) is replacing, has probably largely replaced, and has no doubt been crossed with, the original stock of this subspecies.

Genus 19. CRISTIVOMER Gill and Jordan

34. *Cristivomer namaycush* Walbaum

No thorough study has yet been made of the races of the lake trout. Pending such an investigation, I propose to follow custom in recognizing two subspecies, as listed below.

34a. *Cristivomer namaycush namaycush* Walbaum

Lake trout

34b. *Cristivomer namaycush siscowet* Agassiz

Siscowet

According to Dr. John N. Lowe, who is studying the life history of the lake trout, the excessively fat siscowet of Lake Superior in certain places, but not in others, completely intergrades with the ordinary *namaycush*.

Genus 20. SALVELINUS Richardson

35. *Salvelinus fontinalis* Mitchill

Two subspecies of the brook trout are now being propagated in Michigan. One is the native subspecies (here as usually identified with typical *S. fontinalis*), now largely intermixed with stock from New England, Pennsylvania, etc. The other is the Cascapedia trout, lately introduced, and already also intermixed with the native trout.

35a. *Salvelinus fontinalis fontinalis* Mitchill

Brook trout

35b. *Salvelinus fontinalis hudsonicus* Suckley

Cascapedia trout

The sea-run race of brook trout of the Gulf of Saint Lawrence is currently regarded as identical with *Salvelinus fontinalis*, but material recently introduced into Michigan from the Cascapedia River, Quebec, appears to be racially distinct from the typical subspecies, for the distinctive features of the two persist in offspring reared in Michigan hatcheries under approximately identical conditions, even in the second generation.

The name *hudsonicus* appears applicable to this subspecies. The older name of Storer (*Salmo immaculatus*) is not available, there being a prior *Salmo immaculatus*.

Salvelinus fontinalis hudsonicus differs from typical *fontinalis* in certain average characters. The body is slenderer and thicker, therefore more terete. The lesser egg yield claimed for the Cascapedia trout by the hatchery superintendents may be due in part to this difference in the shape of the body. The colors are duller and more silvery, especially during the breeding season. The bright red spots of healthy examples of *fontinalis* are replaced by much smaller and fainter spots of a yellow to orange color. The red color on the lower fins is also less intense, on the average. The whitish to pale yellowish blotches of the sides average more distinct. Under some conditions it grows faster; under others, slower than the native trout.

This subspecies, especially as mixed with typical *fontinalis*, has been planted rather extensively in the North Branch of the Au Sable River, Michigan.

Family 12. CATOSTOMIDAE

KEY TO THE GENERA

- a¹.—Dorsal fin elongate, as in the carp covering nearly half the length of the back, containing 25 to 40 developed rays. Eye in front part of head.—Air-bladder with two chambers.
- b¹.—Body deep, as in the carp, and the head large and not abruptly slenderer than body. Scales larger, in 40 or fewer rows. Lips smooth or plicate. Posterior fontanelle well developed.³³
- c¹.—No anterior fontanelle, the frontals being closely joined with the ethmoid. Cheek somewhat shallow and foreshortened; distance from eye to lower posterior angle of preopercle about $\frac{3}{4}$ of that to upper corner of gill-cleft. Subopercle broadest at its middle, subsemicircular.
- d¹.—Mouth large and very oblique; upper lip about on level with lower margin of orbit; upper jaw as long as snout. Lips thin, but faintly striate.....21. *Macrostomatobus*
- d².—Mouth smaller, little oblique; level of upper lip far below lower margin of orbit; upper jaw distinctly shorter than snout. Lips more or less coarsely striate22. *Ictiobus*
- c².—Anterior fontanelle well developed, separating anterior edges of frontals and notching ethmoid. Cheek relatively deep and long; eye about equidistant between upper corner of gill-cleft and posteroventral angle of preopercle. Subopercle broadest below its middle, subtriangular.....23. *Carpiodes*
- a².—Dorsal fin short, much less than half as long as back, containing fewer than 20 developed rays. Eye near middle of head, or farther back.
- e¹.—Air-bladder with two chambers. Scales rather numerous, in more than 50 rows (except in three species, distinguishable from all members of group e² by the obsolescent lateral line or the posterior location of the eye).
- f¹.—Lateral line well developed (except in young). Scales in 46 or more rows. Body less compressed; greatest depth less than one-fifth the standard length.
- g¹.—Head convex above; the orbital rim not elevated. Eye near middle of head. Scales in more than 60 rows, reduced in size anteriorly. Body blotched, or plain in coloration.....24. *Catostomus*
- g².—Head concave above; the orbital rims broadly elevated. Eye far behind middle of head. Scales in fewer than 48 rows, scarcely reduced in size anteriorly. Body crossed by oblique bars.....25. *Hypentelium*
- f².—Lateral line more or less obsolete, even in adult. Scales in 46 or fewer rows. Body more compressed; greatest depth more than one-fifth the standard length.
- h¹.—Lateral line wanting at all ages. Body more oblong in form. Vertebrae about 34. Mouth subinferior, somewhat oblique. Color pattern consisting of two lengthwise streaks or of several vertical bars, or of combinations of streaks and bars; the young striped.....26. *Erimyzon*

³³ The genus *Cycleptus*, with alternative characters, and containing the single species *C. elongatus*, has not as yet been found in the Great Lakes waters.

- h².—Lateral line somewhat developed in adults. Body less oblong in form. Vertebrae about 37. Mouth inferior, horizontal. Color pattern consisting (except in the obscurely mottled young) of one black spot on each scale27. *Minytrema*
- e².—Air-bladder with three chambers. Scales in fewer than 50 rows.—Lateral line well developed. Eye located near middle of head.
- i¹.—Premaxillaries protractile. Lower lip with the two sides widely conjoined.
- j¹.—Pharyngeal teeth sharply compressed, very numerous, comb-like. Mouth wholly inferior. Lips thinner.....28. *Moxostoma*
- j².—Pharyngeal teeth much enlarged and reduced in number, subcylindrical. Mouth somewhat oblique. Lips very thick.....29. *Placopharynx*
- i².—Premaxillaries non-protractile. Lower lip in two separated lobes.—Otherwise like *Moxostoma*30. *Lagochila*

Genus 21. MACROSTOMATOBUS Fowler

Fowler,³⁴ in proposing *Macrostomatobus* as a subgeneric name to replace *Sclerognathus* as used by recent authors, stated that this action was necessary because Jordan and Gilbert first indicated the type of *Sclerognathus*, in 1877, as *Catostomus cyprinus* Le Sueur (= *Carpiodes cyprinus*), and thus made *Sclerognathus* a synonym of *Carpiodes*. But in so doing he overlooked the fact that Günther had already (1868) restricted the name *Sclerognathus* to the species *cyprinella*. Nevertheless Fowler's name should apparently be retained, for Agassiz in 1854 definitely stated that *Sclerognathus* was based on Le Sueur's *cyprinus*.

36. *Macrostomatobus cyprinella* Cuvier and Valenciennes

Big-mouth or red-mouth buffalo

Mr. E. L. Wickliff has notified me of the capture of a specimen of this species in Lake Erie, near the east shore of Put-in Bay, Ohio. He states that it undoubtedly was one of the buffalo plant made five years ago by the federal government.

Genus 22. ICTIOBUS Rafinesque

Fowler has claimed³⁵ that *Ambloclon* should replace *Ictiobus* Rafinesque (or *Ichthyobus* as corrected; or *Ictiorus* as originally both misspelled and misprinted), both having the same type species, *bubalus*. Rafinesque in 1819 based the name *Ambloclon bubalus* on a composite of the genera now known as *Ictiobus* (*Catostomidae*) and *Aplodinotus* (*Sciaenidae*), deriving the generic name from the pharyngeals of the sciaenid and the specific name from the vernacular name of the sucker. The next year (1820) he recognized his original *Ambloclon bubalus* as a complex, and transferred the

³⁴ Proc. Acad. Nat. Sci. Phila., 65, 1913, p. 45.

³⁵ Proc. Acad. Nat. Sci. Phila., 65, 1913, p. 45.

generic name to the sciaenid but retained the specific name for the catostomid, for which he then erected the new genus *Ictiorus* (a misprint, corrected in the index to *Ictiobus*), for the latter. This action has been accepted as valid by recent authors, until challenged by Fowler. A solution of the matter depends in part on an unsettled problem in nomenclature,—namely the question of whether a genus rests on the actual species on which the diagnosis was based, or on the original species to which the *name* of the type species was first applied, in the case of misidentified material. For this reason I follow general custom, awaiting a decision on the case. By strict application of the rules, the name *Amblodon* should replace either *Aplodinotus* or *Ictiobus*. The International Commission should decide this case.

37. *Ictiobus urus* Agassiz

Mongrel buffalo

Buffalo-fish occur in several localities in the Great Lakes basin, and are especially common in the lagoons about the southern end of Lake Michigan. It is quite probable that they have been introduced. About Chicago, at least, this species is the common form.

It is not certain that this nominal species can be separated from *I. bubalus*, but I am not now in a position to afford this problem a critical study. Furthermore, it is quite possible that the name *bubalus* was not based on the present species, rather than on the one (*Bubalichthys altus* Nelson) which now bears that name.

Genus 23. CARPIODES Rafinesque

KEY TO THE SPECIES

- a¹.—Snout short and very blunt, 3.9 to 4.5 in head; distance from anterior nostril to tip of snout less than length of orbit; tip of lower lip scarcely in advance of nostrils. Scales 35 to 37, thinner and less closely imbricated. Dorsal rays 22 to 2738. *C. difformis*
- a².—Snout longer and subconic, 2.9 to 3.5 in head; distance from anterior nostril to tip of snout greater than length of orbit; tip of lower lip well in advance of nostrils. Scales 37 to 41, thicker and more closely imbricated. Dorsal rays 27 to 3039. *C. cyprinus*

38. *Carpionodes difformis* Cope

There are only two undenied records of this species from Great Lakes waters. Cope described an example as *Carpionodes selene*,³⁶ and attributed it,

³⁶ Cope, Proc. Am. Philos. Soc., 11, 1870, p. 480; Fowler, Proc. Acad. Nat. Sci. Phila., 1913, p. 47; Occ. Pap. Mus. Zool., Univ. Mich., No. 60, 1918, p. 8, pl. 2. Specimen re-examined by the writer.

doubtfully, to Root River, Michigan. There seems to be no such stream in this state, but there is a stream of that name in Wisconsin; the type was probably obtained there. The second record was given by Forbes and Richardson, in their distributional map (No. 13) for the species.

39. *Carpiodes cyprinus* Le Sueur

Quillback; white carp

The species of this genus have been so extensively confused in the literature that practically all opinions and records need to be confirmed by a re-examination of the material involved. Frequently two species in one lot have been recorded under one name, and the same species recorded under two names. The great individual and age variations exhibited by these fishes have blinded authors to the real diagnostic features.

I have studied a large amount of material identified as *cyprinus*, *velifer* and *thompsoni*, and find no characters by which these nominal species may be separated. Therefore all are united under the oldest available name, *C. cyprinus* Le Sueur.

The number of scales in the lateral line decreases southward from an average of about 40 in the Great Lakes to one of about 36 along the Gulf of Mexico. The gradation is apparently quite regular, and the individual variation at any one locality is rather wide. For these reasons it is not desirable, at least at present, to attempt a division of the species into subspecies. The supposed difference in the roughness of the opercular ridges, held to separate out the Atlantic slope species, I fail to appreciate.

Genus 24. CATOSTOMUS Le Sueur

KEY TO THE SPECIES

- a¹.—Scales of moderate size, fewer than 80 in lateral line. Lips rather constricted; the median fissure of lower lip scarcely apparent when mouth is in normal position. Posterior fontanelle more than one-fourth as wide as long (becoming narrow in large adults)40. *C. commersonnii*
- a².—Scales fine, more than 95 in lateral line. Lips flatly expanded; the median fissure of lower lip clearly visible with mouth at repose. Posterior fontanelle narrower, sometimes sublinear41. *C. catostomus*

40. *Catostomus commersonnii* Lacépède

Sucker; common sucker; white sucker

Lacépède originally spelled the specific name as here given. Jordan has lately reconsidered the tenability of the name *commersonnii*, and writes me that it seems applicable to this form.

41. *Catostomus catostomus* Forster

Sturgeon sucker; long-nose sucker;
red or red-side sucker

Genus 25. HYPENTELIUM Rafinesque

The current recognition of Hypentelium as a genus distinct from Catostomus appears fully warranted.

42. *Hypentelium nigricans* Le Sueur

Black sucker; stone roller; hog sucker

Genus 26. ERIMYZON Jordan

43. *Erimyzon sucetta oblongus* Mitchill

Chub sucker

We do not possess the material needed to determine the relationship of *oblongus* with *sucetta*, and therefore I maintain them, for the present, as only subspecifically distinct.

Genus 27. MINYTREMA Jordan

44. *Minytrema melanops* Rafinesque

Spotted sucker; black sucker

Genus 28. MOXOSTOMA Rafinesque

KEY TO THE SPECIES

- a¹.—Halves of lower lip meeting at a rather sharp angle. Mouth rather large. Head more squarish in cross-section and in lateral view, and longer; its length 3.5 to 4.5 in standard length. Lower fins dull red to olive. Free margin of dorsal fin straight or nearly so.
- b¹.—Plicae of lips coarser and more regular, not broken up into papillae. Developed dorsal rays 12 to 1445. *M. aureolum*
- b².—Plicae of lips finer and broken up into papillae. Developed dorsal rays 14 to 17, usually 15 or 1646. *M. anisurum*
- a².—The papillo-plicate lower lip with a straight posterior margin (forming an obtuse angle when the mouth is shut very tightly). Mouth small. Head bluntly subconical, and short, its length 4.5 to 5.5 in standard length. Lower fins a brighter red. Dorsal fin with the free margin concave or sigmoid,—its developed rays 12 to 1447. *M. lesueurii*

45. *Moxostoma aureolum* Le Sueur

Mullet; red-horse

46. *Moxostoma anisurum* Rafinesque

Mullet; white-nose red-horse

47. *Moxostoma lesueurii* Richardson

Red-horse

Material recently examined from Lakes Nipigon and Abitibi, Canada, sent me for examination by Mr. J. R. Dymond, obviously represents *Catostomus lesueurii* Richardson, 1823 (= *Cyprinus sueurii* Richardson, 1836). This proves to be merely a large, deep-bodied race of the species currently called *M. breviceps* Cope. The variation does not appear definite enough to warrant the nomenclatorial separation of the forms, and I therefore refer *breviceps* to the synonymy of *lesueurii*.

Genus 29. PLACOPHARYNX Cope

48. *Placopharynx carinatus* Cope

Big-mouth red-horse

Fowler has held that *Catostomus duquesnii* Le Sueur is a *Moxostoma*, not a *Placopharynx*, and for this reason has returned to Cope's specific name *carinatus* for the *Placopharynx*. This view appears to be correct, and is here adopted. This sucker occurs in Lake Erie and the Detroit River.

Genus 30. LAGOCHILA Jordan and Brayton

49. *Lagochila lacera* Jordan and Brayton

Hare-lip sucker

Kirsch³⁷ has given us our only records of this species from the Great Lakes region. Subsequent authors have overlooked these records.

Family 13. CYPRINIDAE

KEY TO THE GENERA

a¹.—Dorsal fin elongate; dorsal and anal fin each with a strong serrated spine. Teeth molar or submolar.) (Subfamily Cyprininae)

b¹.—Upper jaw with two barbels on each side. Teeth 3,1,1-1,1,3.....31. *Cyprinus*

b².—Upper jaw without barbels. Teeth 4-432. *Carassius*

a².—Dorsal fin short; no spines in fins. Teeth not molar.

c¹.—Intestine never spirally coiled about the air-bladder. Front margin of lower jaw without hard transverse ridge inside the usual margin.

d¹.—Dorsal fin with first ray slender and bony and closely attached to the second.

Dorsal fin with anterior black spot wanting, or located either at extreme base or above middle of fin. (Subfamily Leuciscinae)

³⁷ Bull. U. S. Fish Comm., 1894 (1895), p. 328.

- e¹.—Intestine short, with a single main loop; less than twice as long as body. Peritoneum typically pale (dusky to blackish in *Notropis anogenus* and *Pfrille neogaesus*).
- f¹.—Abdomen behind pelvic fins rounded over and fully scaled.
- g¹.—Maxillary with a barbel (often absent in *Margariscus*; occasionally obsolescent in other genera).
- h¹.—Barbel terminal. Teeth in the main row always 4-4.
- i¹.—Premaxillaries protractile. Dorsal fin inserted little or not at all behind middle of total length (exclusive of caudal fin). Scales with radii restricted to apical (exposed) field.
- j¹.—Upper jaw strictly terminal. Mouth oblique, rising to the horizontal of eye anteriorly. Scales more than 55 in lateral line. Two teeth in the lesser row on one or both sides.....33. *Couesius*
- j².—Upper jaw more or less inferior. Mouth low, entirely below level of eye. Scales larger, fewer than 45 in lateral line. Not more than one tooth in lesser row on either side.
- k¹.—Upper jaw almost terminal. Snout rather conical. Preorbital much wider than eye. Nuptial tubercles very strong. Large fishes with the aspect of *Semotilus*34. *Nocomis*
- k².—Upper jaw decidedly inferior, lying below the projecting snout. Preorbital not wider than eye. No nuptial tubercles. Aspect of *Gobio*.
- l¹.—Teeth 4-4. Preorbital almost as wide as eye. Upper jaw not nearly reaching eye. Center of eye a little behind middle of length of head.....35. *Erimystax*³⁸
- l².—Teeth 4,1-1,4 (the tooth of the lesser row of either or both sides sometimes absent). Preorbital much narrower than eye. Upper jaw reaching eye. Center of eye a little in advance of middle of length of head.....36. *Erinemus*
- i².—Premaxillaries non-protractile, bound to the forehead by a broad frenum. Dorsal fin inserted well behind middle of total length (caudal fin excluded). Scales small, more than 55 in the lateral line, with radii on all fields.—Nuptial tubercles very small.....37. *Rhinichthys*
- h².—Barbel on lower edge of maxillary well in advance of its tip. Teeth in the main row usually 5-4.
- m¹.—Barbel usually well developed. Gape very wide, the upper jaw extending to or beyond front of eye. Nuptial tubercles developed. No specialized dark scales (the margins of some scales may be especially darkened in *Semotilus*).
- n¹.—Origin of dorsal over pelvic base, between thirteenth and fourteenth vertebrae. Scales large, little silvery. No black spot on dorsal fin. Nuptial tubercles small, densely covering the entire snout38. *Leucosomus*
- n².—Origin of dorsal just behind pelvic fin, between fourteenth and fifteenth vertebrae. Scales usually smaller, scarcely silvery. A

³⁸ The groups *Erimystax* and *Erinemus* can not be distinguished by the character of the grinding surface on the teeth, for this, contrary to current descriptions, is similarly developed in each.

- black spot on dorsal fin. Nuptial tubercles greatly enlarged, confined to upper rim of orbit and front of snout, and greatly reduced in number (frequently but three developed).....
-39. *Semotilus*
- m².—Barbel usually obsolescent. Gape moderate, the upper jaw not extending to front of eye. Nuptial tubercles minute or undeveloped. Sides mottled by specialized dark scales.—Origin of dorsal well behind pelvic base. Scales of moderate to small size. No black spot on dorsal fin
-40. *Margariscus*
- g².—Maxillary with no trace of a barbel.
- o¹.—Teeth in the main row typically 5-4 (sometimes 5-5, 4-5 or 4-4).
- p¹.—Mouth large; only moderately oblique. Teeth two-rowed, not serrate.
- q¹.—Head broad and gape moderate. Lateral line incomplete. Scales minute, more than 80, each with radii on all fields. No specialized dark scales. No nuptial tubercles.....
-41. *Pfritte*
- q².—Head narrow and gape very wide. Lateral line complete. Scales fewer than 80, with radii only on exposed fields. Sides mottled with specialized dark scales. Nuptial tubercles small but numerous, developed on head and often also on nape.....
-42. *Clinostomus*
- p².—Mouth extremely small, nearly vertical. Teeth one-rowed, serrate.—Nuptial tubercles developed
-43. *Opsopoeodus*
- o².—Teeth in the main row almost invariably 4-4.
- r¹.—Chin normal, well covered with flesh. Dentary bones divergent.
- s¹.—Lower lip rather thin, not forming a thick fleshy lobe on each side.
- t¹.—Mandible, interopercle and suborbital not cavernous.....
-44. *Notropis*
- t².—Mandible, interopercle and suborbital with conspicuous, externally visible, cavernous chambers
-45. *Ericymba*
- s².—Lower lip greatly thickened, so as* to form a conspicuous fleshy lobe on each side
-46. *Phenacobius*
- r².—Chin an almost fleshless, concave, bony lobe, abruptly marked off from the fleshy throat and conspicuous lip lobes.....
-47. *Exoglossum*
- f².—Abdomen behind pelvic fins with a fleshy keel over which the scales do not pass. Body sharply compressed. Lateral line much decurved. Anal fin falcate
-48. *Notemigonus*
- e².—Intestine elongate, with more than one main loop and more than twice as long as the body. Peritoneum black.
- u¹.—Scales large, fewer than 50 in the lateral line, and with the radii confined to the exposed field. Lateral line complete. Teeth 4-4. Mouth low. Snout fleshy, overhanging the premaxillaries
-49. *Hybognathus*
- u².—Scales smaller, more than 65 in the lateral line, and with radii on all four fields. Lateral line incomplete. Teeth 5-5 or 5-4. Mouth median. Premaxillaries strictly terminal
-50. *Chrosomus*
- d².—Dorsal fin with the first ray enlarged, covered by thick skin and separated from the second ray by a well defined membrane (these characters accentuated in breeding males). Dorsal fin with a definite black spot at front, above base but below middle of fin (the spot sometimes diffuse in *Pimephales*). Nuptial tubercles few but much enlarged, confined to the muzzle. Teeth 4-4 (rarely 5-4). (Subfamily *Pimephalinae*)

- v¹.—Alimentary canal more or less elongate, almost always longer than head and body. Peritoneum blackish. Teeth weakly or not hooked; lips rather thin.³⁹
- w¹.—Mouth inferior and horizontal. Tip of upper jaw swollen in nuptial males to form a barbel-like projection. Nuptial tubercles confined to three rows on snout. Body slender, with depressed back. Lateral line complete. A definite caudal spot51. *Hyborhynchus*
- w².—Mouth terminal and oblique. Upper jaw never forming a barbel-like projection. Nuptial tubercles often developed on chin as well as snout. Body compressed, with more or less elevated back. Lateral line rudimentary (in Great Lakes form). No definite caudal spot52. *Pimephales*
- c².—Intestine spirally wound about the air-bladder.⁴⁰ Front margin of lower jaw with a hard transverse ridge inside the usual margin.—Dorsal fin with first ray slender. No barbels. Teeth 4-4 (one tooth of inner series rarely developed). Peritoneum black. (Subfamily Campostominae)53. *Campostoma*

Genus 31. CYPRINUS Linnaeus

50. *Cyprinus carpio* Linnaeus

Carp

We do not recognize the various types of carp as subspecies, regarding them rather as domestic races.

Genus 32. CARASSIUS Nilsson

51. *Carassius auratus* Linnaeus

Goldfish

Like the carp, the goldfish has become established in some of the marginal waters of the Great Lakes. It is particularly abundant in the western end of Lake Erie, where it hybridizes with the carp.

I have been unable to find *Carassius carassius* in the lagoons at Chicago, although that species is stated by Meek and Hildebrand⁴¹ to thrive there, in company with the abundant goldfish. In my opinion, only the latter form occurs in a wild state in America. Furthermore, the repeated reference by Shelford and his associates of the goldfish used in their experimental studies to *Carassius carassius* seems unwarranted.

³⁹ *Ceratichthys (vigilax)*, which may occur in the Great Lakes drainage, has contrasting characters: alimentary canal shorter than head and body; peritoneum pale; teeth well hooked; lips thick; mouth terminal and oblique; lateral line complete; as in *Hyborhynchus*; nuptial tubercles confined to two rows on snout.

⁴⁰ This character is subject to a considerable amount of abnormal variation (see Kraatz: Ohio Jour. Sci., 24, 1924, pp. 265-298).

⁴¹ Publ. Field Mus., Zool., 7, 1910, p. 283.

Genus 33. COUESIUS Jordan⁴²52. *Couesius plumbeus* Agassiz

Lake chub

On comparison I am wholly unable to distinguish *C. dissimilis* from this species.

As indicated under the head of that form, *Margariscus margarita nachtstriebi* has been confused with *Couesius plumbeus* within our area.

Genus 34. NOCOMIS Girard

With Cockerell,⁴³ Jordan⁴⁴ and others, I recognize *Nocomis* as a distinct genus.

The genus (or subgenus) *Nocomis* is currently regarded as containing but one species, *kentuckiensis*. I find, however, that this supposed species is a complex of three forms.

KEY TO THE SPECIES

a¹.—Teeth 4, 1-1, 4 (the inner tooth sometimes absent on one side, rarely lacking on both sides); the pharyngeal bone broader at its base. Nuptial males without interorbital swelling or nuchal crest; the tubercles antrorse, extending from between the nostrils to the occiput, rarely still farther back. Preorbital less than half the postorbital length of the head (the opercular membrane included). Caudal fin in the young bright red, with a conspicuous round black spot at its base; a vermilion spot behind eye, especially conspicuous in breeding males. Smaller.
.....52. *N. biguttatus*

a².—Teeth always 4-4; the pharyngeal bone narrower, without a shelf on which an inner tooth might occur. Nuptial males with a very conspicuous interorbital swelling and a fleshy nuchal crest; the tubercles broad and erect, developed chiefly between the eyes and the nostrils, and often on the front of the snout as well, but never behind the eyes. Preorbital more than half the postorbital length of the head. Caudal fin in the young olive or amber, with a much smaller and less rounded spot at its base; no red spot behind eye. Larger.....54. *N. micropogon*

⁴² Fowler (Occ. Pap. Mus. Zool., Univ. Mich., No. 60, 1918, p. 36) describes a specimen of *Platygobio gracilis* which he found in a bottle containing also Cope's series of *Notropis cornutus* from Bruce, Macomb County, in southeastern Michigan. In view of the extreme dissimilarity of these two species, it seems strange that Cope would not have separated them; possibly the two species have inadvertently been brought together in one specimen jar. In any case, the record requires confirmation, for no other specimen of *Platygobio* has been recorded from the Great Lakes area, nor from any immediately adjacent region.

⁴³ Cockerell and Allison, Proc. Biol. Soc. Wash., 22, 1909, p. 161.

⁴⁴ Jordan, Copeia, No. 130, 1924, p. 52.

53. *Nocomis biguttatus* Kirtland

River chub; horny head

Plate I, Fig. 1; Plate II, Fig. 3

In order to determine what names we may apply to the three species into which I am dividing the old "*Hybopsis*" *kentuckiensis*, it is necessary to reconsider all of the supposed synonyms of that nominal species.

Luxilus kentuckiensis Rafinesque has successively been identified with different species of *Notropis* and with the present group. The fact that Rafinesque referred the species to the typical subgenus *Luxilus*, defined only as having the "mouth rather large, with small flat lips, jaws equal, scales large" argues against the application of his name to the species here under discussion. The very brief specific description given by Rafinesque, however, seems to apply better to a species of *Nocomis* than to any form of *Notropis*. But even if we assume that *kentuckiensis* was based on a species of *Nocomis*, we can not tell which species he had, for specimens lately received from Kentucky show that the fins may be quite as red there in *micropogon* as they are in *biguttatus*. The latter species we have not seen from Kentucky, but it doubtless occurs in that state along the Ohio River, to which region the type-locality of *kentuckiensis* has been restricted. I propose, therefore, to regard the name *kentuckiensis* as unidentifiable.

Catostomus melanotus Rafinesque, also described in 1820, has been listed in the synonymy of *kentuckiensis*. This nominal species, seen but once by the erratic naturalist, was quite as likely a sucker as a minnow; even if assumed to be a cyprinid, its specific identification seems impossible.

The description and figure of *Semotilus biguttatus* Kirtland, 1840, are based on nuptial males, and are so accurate as to leave no doubt as to which species Kirtland had.

The next name to receive consideration is that of *Nocomis nebrascensis* Girard. The character of the dentition and of coloration, as described by Girard, indicate clearly that he had the same species as that earlier called *biguttatus* by Kirtland.

Nocomis bellicus Girard, also described in 1856, is of less certain application. The type, from the Black Warrior River, Alabama, apparently belongs to the same species as the North Carolina example described on the same page as *Ceratichthys leptocephalus*. The short head and the lack of the inner row of teeth (which Girard wrongly presumed had been lost in the specimen), as described for *bellicus*, indicates that Girard had an example of *leptocephalus*, rather than one of the species here named *biguttatus* or *micropogon*.

The name *Nocomis leptocephalus*, just discussed, may be used for a third species of *Nocomis* (Plate I, Fig. 2; Plate II, Fig. 2), which occurs along

the Atlantic Coast from the Roanoke drainage of southern Virginia southward. This species agrees with *micropogon* in dentition and in the shape of the individual nuptial tubercles. The occipital swelling of the breeding males is even better developed than in *micropogon*, but the nuchal crest is apparently not formed. The arrangement of the tubercles is more or less intermediate; they are best developed between the eyes, do not occur before the nostrils, but often extend back toward or to the occiput; the individual tubercles are larger than in *biguttatus*, and not nearly so numerous. The head is shorter than in either of the other species, and blunter anteriorly; the preorbital is of intermediate width. In the degree of development of the caudal spot, *leptocephalus* is intermediate between *biguttatus* and *micropogon*.

Ceraticthys cyclotis Cope, 1864, may have been based on both *biguttatus* and *micropogon*, but even if so, Fowler's redescription of the species in 1918 amounts to a restriction of the name to *biguttatus*.

Ceraticthys micropogon Cope, 1864. Cope's and Fowler's descriptions of the type of *micropogon* indicate which species was represented. Furthermore, but this one species of *Nocomis* occurs in the Atlantic drainage of Pennsylvania, from which region *micropogon* was described.

Ceraticthys stigmaticus Cope, 1864, is an obvious synonym of *biguttatus*.

54. *Nocomis micropogon* Cope

River chub; crested chub

Plate I, Fig. 3; Plate II, Fig. 1

Ceraticthys micropogon Cope, Proc. Acad. Nat. Sci. Phila., 1864, p. 277; Trans. Am. Phil. Soc., 13, 1866 (1868), p. 366, pl. 12, fig. 2; Fowler, Proc. Acad. Nat. Sci. Phila., 60, 1908 (1909), p. 550, pl. 27.

This species, now confounded with *biguttatus*, occurs with that form throughout southern Michigan. Here and in Indiana it seems to find its western limit of distribution; it ranges eastward to the St. Lawrence River and the Susquehanna, and southward to the James River system in Virginia and to Tennessee. *Nocomis biguttatus*, on the other hand, ranges far to the westward, and occurs in the Atlantic drainage only through the Great Lakes area. Even where they occur in the same vicinity, they show certain differences in habitat preferences. *Nocomis micropogon* is commoner in the lower courses of streams, *biguttatus* more abundant in the tributaries. The young of *micropogon* live chiefly on the gravel riffles; those of *biguttatus* typically in dense patches of vegetation.

Genus 35. ERIMYSTAX Jordan

I follow Jordan in his generic revision of the complex formerly united into one genus and called "Hybopsis."⁴⁵ The genus *Erimystax* contains two species, *dissimilis* and *watauga*, of which the first only occurs within the limits covered by this paper.

55. *Erimystax dissimilis* Kirtland

Spotted chub

This species ranges northward as far as the Thames River in southern Ontario, at which locality Mr. D. E. S. Brown has recently collected the species.

Genus 36. ERINEMUS Jordan

Two very different species of this genus, another member of the old "Hybopsis" complex, occur in the Great Lakes watershed.

KEY TO THE SPECIES

- a¹.—Size large, 4 to 10 inches when adult. Dorsal fin inserted distinctly in advance of pelvics, decidedly nearer snout than caudal base. Color silvery, without a dark lateral stripe. Mouth larger, the upper jaw 3.2 to 3.7 in head.....
 56. *E. storerianus*
- a².—Size small, 2 to 3 inches when adult. Dorsal fin inserted over origin of pelvic, usually a little nearer caudal base than tip of snout. Color less silvery, with a dark lateral stripe. Mouth smaller, the upper jaw 3.6 to 4.6 in head
 57. *E. hyalinus*

56. *Erinemus storerianus* Kirtland

Storer chub

57. *Erinemus hyalinus* Cope

Big-eye chub

This is the species usually but apparently wrongly called *Hybopsis amblops*.⁴⁶

Genus 37. RHINICHTHYS Agassiz

KEY TO THE SPECIES

- a¹.—Snout scarcely projecting beyond the somewhat oblique mouth. Eyes lateral
 58. *R. atronasmus lunatus*
- a².—Snout projecting far beyond the horizontal mouth. Eyes superolateral
 59. *R. cataractae*

⁴⁵ Jordan, Copeia, No. 130, p. 51-52.

⁴⁶ See Jordan, Copeia, No. 130, 1924, p. 51-52.

58. *Rhinichthys atronasmus lunatus* Cope

Black-nose dace

While awaiting a critical revision of the subspecies of *Rhinichthys atronasmus*, I retain this name for the Great Lakes form of the species. It is characterized chiefly by the very small eye.

59. *Rhinichthys cataractae* Cuvier and Valenciennes

Long-nose dace

I have compared series of specimens of *Rhinichthys cataractae* from various parts of its extensive range, and find that the characters supposed to set off a western subspecies, *R. c. dulcis*, do not hold.

Genus 38. LEUCOSOMUS Heckel

Jordan has recently proposed the recognition of *Leucosomus* as a genus distinct from *Semotilus*.⁴⁷

60. *Leucosomus corporalis* Mitchill

Fall fish; silver chub

Genus 39. SEMOTILUS Rafinesque

61. *Semotilus atromaculatus atromaculatus* Mitchill

Creek chub; horned dace

Genus 40. MARGARISCUS Cockerell

The dace of eastern North America currently referred to *Leuciscus* (or *Richardsonius*) *margarita*, *nachtriebi*, *rubrilateralis* and *carletoni* comprise a small, compact group, apparently most nearly related to *Semotilus*, but generically distinguishable. The name *Margariscus*, proposed by Cockerell⁴⁸ as a subgenus, may be used for this group, despite the fact that the characters on which it was based are not of trenchant significance: *margarita* was definitely designated the type-species. Cockerell referred the very different species *neogaeus* to the same group, and placed the intimately related *carletoni* in another subgenus.⁴⁹ Jordan has recently proposed elevating *Margariscus* to generic rank.⁵⁰

⁴⁷ Copeia, No. 132, 1924, p. 72.

⁴⁸ Proc. Biol. Soc. Wash., 22, 1909, p. 217.

⁴⁹ The characters used by Cockerell (*l.c.*, p. 160) to separate these and related species are quite valueless, as Snyder has already pointed out. The absolute size of

⁵⁰ Copeia, No. 132, 1924, p. 70.

The genus *Margariscus* may now be defined as follows:

Dorsal and anal fins short, each usually of 8 principal rays; the dorsal inserted well behind middle of body length, overlying the interspace between pelvic fin and anus. Body slender, but everywhere broadly rounded in cross-section. Fins all small. Belly not keeled; breast completely scaled. Scales rather small, more than 50 but fewer than 80 in lateral series; in individual outline more or less shield-shaped; the focus far basal; apical radii alone developed, strong, divergent, of moderate number; ridges coarse except on narrowed basal field, angulated between basal and lateral fields and somewhat drawn out longitudinally on the wide exposed field so as to form on the midline a more or less distinct angle, but one more rounded than in *Semotilus*. Lateral line only slightly and gently decurved anteriorly, more or less interrupted, the pores developed late in life. Pharyngeal teeth usually 5, 1 or 2-1 or 2, 4, hooked, rather slender, with a short cutting edge excavated by the grinding trough throughout its length. First gill slit markedly constricted; gill-rakers rudimentary, variable, only 2 to 5 on lower limb of first arch. Snout becoming blunt with age. Mouth small, somewhat curved, terminal; lower jaw included. Barbel highly variable as to presence or absence, but never elongate, being rather triangular and flaplike in form, as in *Semotilus*, and as in that genus located well in advance of end of maxillary; barbel very rarely doubled on one side. Sides mottled or speckled with dark. Belly reddened in breeding males. Nuptial tubercles developed very weakly in spring males, often not evident at all.

I have compared material representative of the nominal species *margarita*, *nachtriebi*, *rubrilateralis* and *carletoni*, and find all to agree in every way, including the character of the barbel, with the preceding diagnosis of the genus *Margariscus*.

62. *Margariscus margarita nachtriebi* Cox

Northern dace

Leuciscus nachtriebi U. O. Cox, Rept. U. S. Comm. Fish., 1894 (1896), p. 605; A preliminary report on the fishes of Minnesota, 1897, p. 30; Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 3, 1898, p. 2798.

Coesius plumbeus P. Cox, Trans. Roy. Soc. Canada, 5, 1899, p. 148; Hankinson, Mich. Geol. Biol. Surv., Publ. 20, Biol. Ser. 4, 1915, p. 3 (not *Gobio plumbeus* Agassiz).

the scale was used to separate *carletoni* from other species, some of which (as all descriptions show) have smaller, others larger scales. No account seems to have been taken of the fact that the teleost scale grows in size and that the growth of fishes is indeterminate. Similarly, differences in number of ridges is here mainly an index of age or of individual variation. Finally, distinctions in peritoneal pigmentation as described seem to be due to the degree of contraction of the chromatophores, or to the method of preservation. No other characters were used by that author.

Couesius plumbeus rubrilateralis P. Cox, Bull. Nat. Hist. Ass. Miramichi, No. 2, 1901, p. 42.

Leuciscus rubrilateralis Cox, Can. Field Nat., 35, 1921, p. 66, fig.

Leuciscus neogaeus Meek and Clark, Publ. Field Mus., Zool., 3, 1902, p. 135 (not *Phoxinus neogaeus*; material re-examined).

Leuciscus carletoni Kendall, Bull. U. S. Fish Comm., 1902 (1903), p. 357, fig. 1; Hankinson, Occ. Pap. Mus. Zool., Univ. Mich., No. 37, 1917, p. 1.

A comparative study has been made of specimens of *Margariscus* from New Brunswick (sent by Cox as representative of his *rubrilateralis*); Maine (including paratypes of *carletoni*); southern and northern Ontario; various localities in Michigan and Wisconsin; Minnesota (paratypes of *nachtriebi*), and North Dakota (a fine series). No characters have been discovered, in this study, by which one might distinguish among this material more than the single form. All of the nominal species are therefore here referred to the synonymy of the first described, namely *nachtriebi*.

This form differs from typical *margarita* chiefly in the smaller size of the scales. The difference is bridged over completely, as Kendall indeed indicated in his description of *carletoni*, in the region about the southern shore of Lake Ontario, an area joining together the ranges of the typical subspecies of either side, *margarita* ranging to the southward, *nachtriebi* to the northwest and northeast.

Genus 41. PFRILLE Jordan

Pfrille Jordan, Copeia, No. 132, 1924, p. 71.

Type, *Phoxinus neogaeus* Cope, 1866.

The little dace of eastern North America variously known as *Phoxinus*, *Leuciscus* or *Richardsonius neogaeus*, is not closely related to the type of any of the genera to which it has been referred; nor can it apparently be placed satisfactorily in any of the other genera of this general type.

Dorsal and anal fins short, each usually of 8 principal rays; the dorsal inserted a little behind middle of body length, its base largely overlying the interval between the bases of pelvic and anal fins. Head little compressed, the body heavy forward. Breast and belly rounded, unkeeled, completely scaled. Scales minute (more than 80 in lateral line), roundish in individual outline, the focus submedian; radii developed on all fields of scale; ridges coarse, almost concentric, nowhere angulated, but somewhat interrupted basally. Lateral line developed only on front part of trunk, curved downward anteriorly. Pharyngeal teeth, 5 (rarely 4), 1 or 2-1 or 2, 4,⁵¹ hooked, much compressed, with long, slightly uneven cutting edge

⁵¹ In seven specimens from Maine, Ontario and Michigan: 5,2-1,4; 5,1-2,4; 5,2-2,4; 4,2-2,4; 5,2-1,4; 5,1-1,4; 5,2-1,4; the left side in all cases enumerated first.

excavated by a narrow grinding trough. Gill-slits narrow; gill-rakers rudimentary, variable in size and number, only 3 to 6 on lower limb of first arch. Snout sharper than in *Margariscus* but blunter than in *Clinostomus*; mouth terminal, oblique, of moderate size; jaws equal; no trace of barbels. Sides with a median stripe but no dark mottlings; lower regions red in spring males. Nuptial tubercles apparently never developed; paired fins enlarged in male, and thickened in breeding season.

63. *Pfrille neogaeus* Cope

Fine-scaled dace

One published record⁵² of this species, from Hawkstone, Ontario, was based on specimens of *Margariscus margarita nachtriebi*. The material in question has been re-examined by Prof. Hankinson and the writer.

Genus 42. CLINOSTOMUS Girard

As a result of the disruption of the unrelated complex of species formerly grouped together as the "genus" *Leuciscus*, several forms of eastern North America require revived or new generic names. One of these, "*Leuciscus*" *elongatus*, may be referred to *Clinostomus* Girard,⁵³ of which it is the type species. This genus may be defined as follows:

Dorsal and anal fins short, the dorsal usually of 8, the anal of 9 principal rays; the dorsal inserted a little behind middle of body length, its base overlying the interval between the bases of the pelvic and anal fins. Body elongate, not thoroughly compressed. Belly and breast broadly rounded, covered with scales of reduced size. Scales on sides rather small, about 70 in course of lateral line. The scale in individual outline intermediate between that of *Margariscus* and that of *Pfrille*; the focus basal, but less excentric than in *Margariscus*; radii apical only; the ridges coarse, moderately angulated between the basal and lateral fields, rounded across midline of exposed field. Lateral line completely developed, gently decurved anteriorly. Pharyngeal teeth usually in two rows, 5 (rarely 4), 2 (rarely 1),—1 or 2 (rarely 0 or 3), 4 (rarely 5),⁵⁴ hooked, with the cutting edge slightly uneven and with a lanceolate grinding concavity near the hook. Gill-slits narrow; gill-rakers rudimentary but variable in size, only 4 to 6 on lower limb of first arch, fewer than on following arches. Snout sharp; mouth terminal and oblique; the lower jaw strongly projecting, a

⁵² *Leuciscus neogaeus* Meek and Clark (Publ. Field Mus., Zool., 3, 1907, p. 135).

⁵³ See also: Jordan, Copeia, No. 132, 1924, p. 70.

⁵⁴ The teeth of the left side enumerated first. In eleven specimens the dentition was found to be as follows: 5,2-0,4; 5,2-1,4; 5,2-2,4; 4,2-2,5; 5,2-2,4; 5,2-3,4; 5,1-1,4; 5,2-1,4; 4,1-2,4; 5,2-2,4; 5,2-2,4.

slight hook at its tip fitting into a shallow emargination at front of premaxillaries; gape nearly straight, extremely wide, the upper jaw more than two-fifths, the mandible about one-half the length of the head. Barbels absent. Sides often mottled with dark; lateral band crimson, and belly more or less reddened, in spring males. Nuptial tubercles minute and granular, on the anterodorsal part of the body, one located on each scale; the tubercles on the head of two sizes: extremely minute ones covering the entire surface of the head, interspersed dorsally with granules of larger size and whiter color; the latter resembling in size and spacing those of the body; none on the fins; paired fins enlarged in the male, and thickened in the breeding season.

"*Leuciscus*" *vandoussulus* is closely related to *Clinostomus elongatus*, and appears to represent it to the southward. It may be referred to the same genus, as it conforms with the diagnosis of *Clinostomus* given above in most respects. It differs from *C. elongatus*, however, in several characters: body somewhat deeper and more strongly compressed; scales of moderate size, about 50 in the lateral line; jaws about equal, or the lower only slightly projecting; lower sides bright red in spring males.

64. *Clinostomus elongatus* Kirtland

Red-side dace

Genus 43. OPSOPOEODUS Hay

65. *Opsopoeodus emiliae* Hay

Pug-nose minnow

Specimens of this species have been taken in a marsh near the mouth of the River Raisin. These are the first to be recorded for the state of Michigan.

Genus 44. NOTROPIS Rafinesque

While it is obvious that the genus *Notropis*, as at present constituted, is a heterogeneous assemblage of more or less unrelated species, a division of the complex into smaller genera should await a thorough revisory study of all the known species. The present subdivision of the genus into subgenera appeals to the writer as wholly unsatisfactory.

KEY TO THE SPECIES AND SUBSPECIES

a¹.—Teeth of inner row usually 0 or 1 (but often 2 in *heterodon*, *blennius* and *hudsonius*). Anal base short, the principal rays usually 7 or 8 (often 9 in *whippelii*, rarely 9 in other species).

- b¹.—Eye large, more than one-fourth length of head in adults. Muzzle bluntly rounded; the head not closely approaching a triangle in outline. Scales with exposed field not noticeably deeper than long. Anal rays 7 or 8, rarely 9. Dorsal fin without a black blotch on posterior rays; this fin subtriangular in outline, the last ray less than half as high as the longest.
- c¹.—Teeth of inner row lacking (except often in *heterodon*).
- d¹.—Lateral band blackish (sometimes very indistinct in life), continued forward through eye and around muzzle. Lateral line incomplete (in Great Lakes forms, except in *anogenus*).
- e¹.—Lateral band in surrounding muzzle confined to chin and premaxillaries. Mouth more oblique, making an angle of more than 60 degrees with the vertical. Jaws about equal anteriorly (the lower more or less included in *N. heterodon richardsoni*).
- f¹.—Mouth rather large, moderately oblique; upper jaw extending beyond anterior nostril almost to below eye. Teeth of inner row frequently developed. Lateral line incomplete. Peritoneum silvery. (66. *N. heterodon*)
- g¹.—Anal rays typically 8 (7 to 9). Eye large, much longer than snout, little less than one-third length of head. Jaws equal, or nearly so; the mouth large and markedly oblique; the snout sharp66a. *N. heterodon heterodon*
- g².—Anal rays 7 (rarely 8). Eye smaller, about as long as snout, much less than one-third length of head. Lower jaw more or less included, and the snout blunter.....66b. *N. heterodon richardsoni*
- f².—Mouth extremely small, almost vertical; upper jaw extending only to below anterior nostril. Teeth of inner row lacking. Lateral line nearly or quite complete. Peritoneum blackish.—Anal rays usually 7 (sometimes 8)67. *N. anogenus*
- e².—Lateral band in surrounding muzzle encroaching on the snout above the premaxillaries, encroaching little or not at all on chin. Mouth less oblique, making an angle of less than 60 degrees with the vertical. Lower jaw included.
- b¹.—Size smaller. Body deeper; the back considerably elevated. Fins larger (length of first dorsal when depressed about 1.2 in distance from occiput to dorsal). Dorsal fin inserted farther forward, usually nearer tip of snout than base of caudal, and over or before pelvic insertion. Scales before dorsal rather regularly arranged, 11 to 14, usually 12 or 13 in number. Snout blunter, much shorter than eye. Premaxillaries strictly terminal. Mouth moderately oblique. Lateral band encroaching only narrowly onto snout above premaxillaries; the band on the body more deeply and uniformly pigmented, the crescentic marks on lateral line scales indistinct. Life colors brighter.....68. *N. bifrenatus*
- b².—Size larger. Body slenderer, the back scarcely elevated. Fins smaller (length of depressed dorsal about 1.5 in distance from occiput to dorsal). Dorsal fin inserted farther backward, usually nearer base of caudal than tip of snout, and distinctly behind the pelvic insertion. Scales before dorsal rather irregularly arranged, 13 to 22 in number. Snout sharper, fully as long as eye. Premaxillaries not quite terminal, being more or less overhung by the snout. Mouth nearly horizontal.

- Lateral band widely encroaching onto snout above premaxillaries; the band on the body less deeply and uniformly pigmented, the crescentic marks on the lateral line scales usually sharply evident. Life colors duller69. *N. heterolepis*
- d².—Lateral band dusky or obsolete, not definitely continued forward through eye and around muzzle. Lateral line complete.—Teeth always 4-4. (70. *N. deliciosus*)
- i¹.—Body rather robust, the back considerably elevated; depth 3.6 to 4.4 in standard length. Fins larger; length of depressed dorsal more than two-thirds its distance from occiput; pectorals often reaching to or nearly to pelvis, usually about half-way to anal. Scales larger, usually 32 to 3570a. *N. deliciosus deliciosus*
- i².—Body more elongate, the depth 4.3 to 5.5 in length. Fins all shorter: length of depressed dorsal seldom as much as two-thirds its distance from occiput; pectorals never reaching pelvis, nor half-way to anal. Scales smaller, 35 to 3870b. *N. deliciosus stramineus*
- c².—Teeth typically developed in inner row.
- j¹.—Maximum size less than three inches. Teeth in lesser row never 2, often lacking on one and sometimes on both sides.—Anal rays usually 8, as in *hudsonius*, but the mouth larger, the jaws about as long as in *blennius*.
- k¹.—Eye very large, contained less than 3.3 times in head; decidedly longer than snout. Head wide and flat above. Mouth terminal, oblique, rising to level of pupil; lower jaw but slightly the shorter; lips thinner. Scales before dorsal fewer than 1671. *N. boops*
- k².—Eye of moderate size, contained more than 3.3 times in head; decidedly shorter than snout. Head narrower and more rounded above. Mouth subinferior and nearly horizontal, not rising to lower level of orbit; lower jaw included; lips thick. Scales before dorsal more than 1672. *N. gilberti*
- j².—Size larger (especially in *hudsonius*), the maximum length more than 3 inches. Teeth in lesser row often 2, rarely lacking on either side.—Eye a little shorter than snout (sometimes a little longer in *hudsonius*).
- l¹.—No caudal spot developed. Anal rays usually 7 (sometimes 6 or 8). Mouth larger, the upper jaw 2.8 to 3.4 in head. Nuptial tubercles apparently not developed73. *N. blennius*
- l².—A definite black or blackish caudal spot developed. Anal rays usually 8. Mouth smaller, the upper jaw 3.7 to 4.5 in head. Nuptial tubercles developed, though fine. (74. *N. hudsonius*)
- m¹.—Caudal spot smaller and less regular. One tooth of inner row often lacking on one or both sides.....74a. *N. hudsonius hudsonius*
- m².—Caudal spot larger and more regular. Full complement of teeth (4,2-2,4) usually developed⁵⁵.....74b. *N. hudsonius selene*
- b².—Eye small, less than one-fourth length of head in adult. Muzzle conical; the head subtriangular in outline. Scales with exposed field notably deeper than long. Anal rays 8 or 9. Dorsal fin with a black blotch on posterior rays (except in young); this fin subquadrate in outline, the last ray in adults much more than half as high as the longest75. *N. whipplii whipplii*

⁵⁵ Individual teeth are often missing due to some prior accident, especially in larger fishes. For this reason care must be exercised in counting all tooth sockets as well as teeth.

a².—Teeth of inner row usually 2. Anal basis longer, the principal rays 9 to 12 (rarely 8 in *N. cornutus*).

n¹.—Body slender, the depth less than one-fourth the standard length. Exposed portions of scales not notably deeper than long. Length of depressed dorsal fin less than two-thirds distance from dorsal to occiput. Nuptial tubercles minute. Breeding males with little or no red.

o¹.—Eye extremely large, decidedly more than one-third length of head and much longer than snout. Anal rays 9. Origin of dorsal almost directly over pelvic insertion76. *N. ariommus*

o².—Eye of moderate size, less than one-third length of head, and in adult not decidedly longer than snout. Anal rays 10 to 12 (rarely 9 or 13). Origin of dorsal distinctly behind pelvic insertion.

p¹.—Snout short and blunt, less than two-thirds postorbital length of head; distance from tip of snout to posterior margin of eye much less than depth of head (from occiput to isthmus), and about equal to interspace between eye and base of pectoral fin. Body rather sharply compressed. Position of dorsal and size of eye intermediate between that of *photogenis* and that of *rubrifrons*77. *N. atherinoides*

p².—Snout produced and sharp, more than two-thirds postorbital length of head; distance from tip of snout to posterior margin of eye almost equal to or greater than depth of head, and decidedly greater than interval between eye and pectoral. Body thicker and heavier.

q¹.—Origin of dorsal approximately over end of pelvic base, about midway between nostril or front margin of orbit and base of caudal, always nearer middle of eye than caudal base. Eye larger, about as long as snout, contained 3.0 to 3.8 times in head. Vertebral streak more intense. Size larger, often more than four inches78. *N. photogenis*

q².—Origin of dorsal well behind end of pelvic base, about midway between posterior margin of orbit and base of caudal, varying considerably in either direction, but always nearer caudal base than middle of eye. Eye smaller, decidedly shorter than snout, and about one-fourth length of head (orbit contained 3.7 to 5.0 times in head). Vertebral streak duller. Size smaller, less than four inches, seldom more than three79. *N. rubrifrons*⁵⁶

n².—Body deep, the depth in adults typically more than one-fourth the standard length. Exposed portions of scales notably deeper than long. Length of depressed dorsal more than two-thirds distance from dorsal to occiput. Nuptial tubercles larger. Breeding males with much red.

r¹.—Anal rays 8 to 10, usually 9. Origin of dorsal usually a little in advance of, never much behind, pelvic insertion; nearer tip of snout than base of caudal. Dorsal fin without anterobasal spot. Breeding males with top of head not blue, sides with large dusky blotches and fins tipped with rosy. Size larger, to 8 inches. Lateral line gently decurved (80. *N. cornutus*).

s¹.—Scales before dorsal typically fewer than 22. Body averaging deeper and head heavier80a. *N. cornutus chrysocephalus*

s².—Scales before dorsal usually more than 26. Body and head averaging more slender80b. *N. cornutus frontalis*

⁵⁶ The characters used in this key to separate *Notropis atherinoides*, *N. photogenis* and *N. rubrifrons* from one another hold well only for the Great Lakes area and upper Ohio basin.

r².—Anal rays 10 to 12, usually 11. Origin of dorsal well behind pelvic insertion, and nearer base of caudal than tip of snout. Dorsal fin with a black antero-basal spot. Breeding males with top of head whitish blue, the sides without dark mottlings and fins bright red. Size smaller, to 3 inches. Lateral line greatly decurved81. *N. umbratilis cyanocephalus*

66. *Notropis heterodon* Cope

Black-nose shiner

Evermann and Clark's record of *N. bifrenatus* from Indiana in their Maxinkuckee report was apparently based on this species, for I am unable to identify their material otherwise.

66a. *Notropis heterodon heterodon* Cope

Plate III; Fig. 1

The typical subspecies of *heterodon* ranges from northern Wisconsin through Michigan and southern Ontario to western New York.

66b. *Notropis heterodon richardsoni* Hubbs and Greene, new subspecies

Plate III; Fig. 2

Type, a male 44 mm. long to caudal fin, taken by C. Willard Greene and Harmon S. Jones in Fox River, opposite Lock 25, Columbia County, Wisconsin, on August 26, 1925; Cat. No. 66536, Museum of Zoology, University of Michigan. The numerous paratypes are from the same and several other localities in the Fox River system, tributary to Green Bay, Wisconsin.

We have some evidence of the intergradation of this subspecies with typical *heterodon*, but we are not yet prepared to delimit its range nor to define in any detail its geographic or taxonomic relationships with *N. h. heterodon*. This we hope to be able to do on a later occasion. Forbes and Richardson indicate the occurrence of two distinct kinds of *heterodon*, in addition to the typical race, in Illinois. Their figure (fig. 30, p. 135) looks like the Wisconsin race here named, and may have been based on an example of *N. h. richardsoni*.

A diagnosis of *Notropis heterodon richardsoni* is offered in the key to the species and subspecies of *Notropis*. We add a brief description of the type specimen.

Body rather heavy, particularly robust below front of dorsal; depth, 4.1; shape subelliptical, the dorsal and ventral contours being about equally curved. Head, 3.5. Tip of rather blunt snout a little below main axis of body; lower jaw slightly included, the tip of premaxillaries being terminal. Mouth less oblique than in typical *heterodon*, but more slanting than in *heterolepis*; not very large, the upper jaw not quite extending to below

front of orbit, its length contained 4.3 times in head (to end of opercular membrane). Eye but little longer than snout, 3.6 in head. Teeth, 4, 1-2, 4.

Dorsal, 8; anal, 7. Dorsal origin over pelvic insertion, each about midway between tip of snout and base of caudal; length of depressed dorsal contained 1.15 times in distance from origin of dorsal to occiput. Pectoral fin extending half way to origin of anal; pelvic beyond anus nearly to anal origin.

Scales 5-34-3½ (4 to pelvic base); 15 before dorsal.

Color dark (like other fishes taken at same locality); upper parts dusky olive, cross-hatched to below lateral line. Lateral band broad and black, of nearly even intensity throughout; continued to end of median caudal rays and around tip of both jaws, but not encroaching on snout above premaxillaries. Mid-dorsal streak dusky, becoming narrow and indistinct toward caudal base. Anus and anal base surrounded by punctulations, continued thence backward to caudal.

(*Richardsoni*,—named for Robert Earl Richardson, co-author with Stephen Alfred Forbes of the *Fishes of Illinois*, by far the most valuable general account of the fishes of any American state.)

67. *Notropis anogenus* Forbes

Pug-nose shiner

Ward's record⁵⁷ of *N. anogenus* from Put-in-Bay, Ohio, seems unreliable, for the figure he gives scarcely suggests this species. We now have several records of this species from the Great Lakes basin.

68. *Notropis bifrenatus* Cope

Bridled shiner

As detailed in the account of *N. heterolepis*, this species occurs in the Lake Ontario drainage. The types of *Notropis cayuga* were specimens of this form; therefore, *cayuga* is a synonym of *bifrenatus*. The species usually called *cayuga* must consequently be known by another name, apparently *heterolepis*.

Evermann and Clark's Indiana record⁵⁸ of *bifrenatus* was apparently based on examples of *N. heterodon*, some of which have been re-examined.

Reed and Wright⁵⁹ have recorded another and somewhat similar Atlantic Coast species, namely *Notropis procne* Cope, from the Cayuga Lake region, on the basis, we have been told, of specimens so identified by Evermann.

⁵⁷ Jour. Paras., 6, 1919, p. 50.

⁵⁸ Lake Maxinkuckee, 1920, p. 143.

⁵⁹ Proc. Am. Phil. Soc., 48, 1909, p. 395.

Mr. Hankinson, who has also studied the fishes of Cayuga basin, has told me that he has long doubted this record. In response to a request for specimens, Professor Wright has sent us four examples collected in Fall Creek, a tributary of Cayuga Lake, labelled as *N. procne* and apparently the only specimens so identified in the Cornell collections. These on examination prove to be *Notropis heterolepis*. There appear to be no specimens of *N. procne* from the Great Lakes basin in the U. S. National Museum, nor in the reserve collection of the U. S. Bureau of Fisheries, and we have none in the Museum of Zoology. *Notropis procne* should not be included in the list of Great Lakes fishes, unless actual specimens are brought to light.

69. *Notropis heterolepis* Eigenmann and Eigenmann

Black-nose shiner

Notropis cayuga Meek, Ann. N. Y. Acad. Sci., 4, 1887-1889, p. 305 (aberrant specimens, not the types); Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 1, 1896, p. 260 (in part); Forbes and Richardson, Nat. Hist. Surv. Ill., 3, 1908 (ed. 1) and 1920 (ed. 2), p. 133, pl. opp. p. 128, lowest fig. (and of many authors; not the true *cayuga*, which is synonymous with *bifrenatus*).

Notropis heterolepis Eigenmann and Eigenmann, Amer. Nat., 1893, p. 152; Eigenmann, Bull. U. S. Fish Comm., 1894, p. 109.

Notropis albeolus Eigenmann and Eigenmann, Amer. Nat., 1893, p. 152 (not *Notropis megalops albeolus* Jordan).

Notropis jordani Eigenmann and Eigenmann, Amer. Nat., 1893, p. 592; Eigenmann, Bull. U. S. Fish Comm., 1894, p. 109; Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 1, 1896, p. 259 (substitute for *Notropis albeolus*, preoccupied).

Notropis muskoka Meek, Publ. Field Mus., Zool., 1, 1899, p. 308; Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 4, 1900, p. 3141.

In his original description of *Notropis cayuga*, Meek noted that two seemingly distinct types occur in Cayuga Lake. On the advice of Gilbert, however, he regarded the two as not separable specifically, and consequently referred both to *cayuga*. In topotypic material⁶⁰ from Cayuga Lake are the same two types. One of these two types represents the true *cayuga*, which on comparison can not be distinguished from *Notropis bifrenatus* of the Atlantic Coast drainage. The other type represents the form usually, but as here indicated improperly, called *cayuga*; it appears to be a valid species, and may be known as *Notropis heterolepis* Eigenmann and Eigenmann.

Notropis heterolepis differs from *Notropis bifrenatus* in many ways. It attains a decidedly larger size, and has a more slender body and less elevated back. The fins are smaller (the length of the first dorsal when depressed being contained about 1.5 instead of about 1.2 times in the distance

⁶⁰ I wish to thank Professor T. L. Hankinson for this material, and for his suggestion that the true *cayuga* might not be distinguishable from *bifrenatus*.

between the dorsal and the occiput). The dorsal fin is inserted farther backward, usually nearer base of caudal than tip of snout, rather than the reverse, and distinctly behind, instead of over or before the pelvic insertion. The scales before the dorsal fin are usually less regularly arranged and somewhat increased in number (13 to 22, instead of 11 to 14, usually 12 or 13). The head is a little longer, owing to the fact that the snout is much less blunt, and fully as long rather than much shorter than the eye; the mouth is definitely subinferior, usually slightly overhung by the snout, whereas in *bifrenatus* the mouth is always strictly terminal. The mouth is less oblique and lower in position, so that the lateral band passes with but slightly diminished width straight around the snout, above the tip of the premaxillaries, while in *bifrenatus* the band is either much diminished in width, or (more rarely) encroaches on the chin, as it always does in *heterodon*. The lateral band on the body is less deeply and uniformly pigmented, and the crescentic marks on the lateral line scales much more distinct. As described, the life colors are also distinct.

Notropis heterolepis occurs with *bifrenatus* in the southern tributaries of Lake Ontario, and with *kendalli*,⁶¹ the representative of *bifrenatus*, in Maine, but so far as now apparent does not intergrade with either. From this region the present species ranges westward through the Great Lakes region, remaining fairly consistent in its characters, and occurring also in the southern part of the Hudson Bay drainage and the northern part of the Mississippi basin. In Indiana and Illinois it occurs with the southwestern form, *Notropis atrocaudalis*,⁶² with which it may eventually prove to intergrade.

70. *Notropis deliciosus* Girard

Shore minnow; straw-colored minnow

As Fowler has already indicated,⁶³ after the examination of the type material, the original *blennioides* is not the species currently so named. The

⁶¹ *Notropis kendalli* Evermann and Cockerell (Proc. Biol. Soc. Wash., 22, 1909, pp. 186, 191) was supposed by these authors to represent the *Notropis muskoka* of Kendall from Maine, but the type they selected (examined) on the contrary represents Kendall's *bifrenatus*. It may provisionally stand as a distinct species, as it differs from the true *bifrenatus* in the reduced size of the fins, the more backward insertion of the dorsal fin, smaller eye, increased number of predorsal scales, etc., in which respects it resembles *heterolepis*. It differs from that species and resembles *bifrenatus* in the structure of the mouth and in coloration and general appearance. The material is limited, however, and *kendalli* may merely represent intergrades between *heterolepis* and *bifrenatus*.

⁶² This form differs from *heterolepis* and resembles *bifrenatus* in most of the technical characters which separate those forms, but it has a nearly complete lateral line, and resembles *heterolepis* in the size attained.

⁶³ Proc. Acad. Nat. Sci. Phila., 62, 1910, pp. 274-276, fig. 4, 6, 10.

latter should therefore be known as *Notropis deliciosus*. In our judgment Agassiz's *Hybopsis gracilis* can not be certainly identified with this species.⁶⁴

The true *blennioides* differs from *deliciosus* in having the pharyngeal teeth in two rows, in the smaller eye, broader and flatter head, coloration, etc. I also have re-examined the type material, with Mr. Fowler's and Mr. Bean's kind permission, and regard the true *blennioides* as the species currently known as *N. jejunus* Forbes. The latter should therefore be called *Notropis blennioides* Girard.

Notropis deliciosus is divisible into two subspecies, which may be separated by the characters given in the key, and which intergrade in parts of Indiana, Illinois, Michigan and Wisconsin. Both types are represented in the Great Lakes region.

70a. *Notropis deliciosus deliciosus* Girard

Although *deliciosus* and *stramineus* intergrade in Indiana, typical or nearly typical *deliciosus* also occurs locally, as at Turkey Lake in the Great Lakes drainage. This subspecies also inhabits at least one stream in southern Ontario, namely Big Creek, in Elgin County. Both forms apparently occur in the Detroit River, since the types of both *stramineus* and of *volucellus* (the latter an obvious synonym of *N. deliciosus deliciosus*) were taken there.

Numerous specimens of this subspecies from various parts of its wide range have been studied.

70b. *Notropis deliciosus stramineus* Cope

With the exception of the Upper Peninsula of Michigan, where the two forms intergrade, and of a few lakes and streams in Indiana and southern Ontario, this subspecies replaces typical *deliciosus* in the Great Lakes drainage. Its characters (indicated in the key) are quite consistent throughout this region.

71. *Notropis boops* Gilbert

Big-eye shiner

I have re-identified Kirsch's⁶⁵ material of this species from the Maumee basin. No other specimens have been obtained in the Great Lakes drainage area.

This species has been confounded with *Notropis shumardi* Girard and *N. illecebrosus* Girard, species from the southwest. The first of these nominal species apparently is not definitely identifiable, unless possibly with the second. *N. illecebrosus* is a very different species, as Fowler has shown.⁶⁶

⁶⁴ See: Jordan, Copeia, No. 130, p. 51.

⁶⁵ Bull. U. S. Fish Comm., 14, 1894 (1895), p. 329.

⁶⁶ Proc. Acad. Nat. Sci. Phila., 1910, p. 276, pl. 16, fig. 11.

An additional cotype of *illecebrosus*, preserved in the Museum of Zoology, agrees with Fowler's figure.

72. *Notropis gilberti* Jordan and Meek

Gilbert minnow

Entirely typical specimens of this species have been obtained from eleven localities in Michigan: Houghton Lake; Bear, Wolf, Townline and Bigelow creeks of the Muskegon system; Mill Creek, tributary of Grand River, near Comstock Park; Rabbit River, Allegan County, and the Sturgeon River and its West Branch, and Otter Lake and Otter River, Baraga and Houghton counties.

73. *Notropis blennioides* Girard

As explained in the account of *Notropis deliciosus* given above, the types of this species apparently represent the form currently known as *N. jejunus* Forbes. The name *blennioides* therefore replaces that of *jejunus* for the present species, while the shiner usually called *blennioides* should be known as *deliciosus*.

The only published record of the occurrence of this species in the Great Lakes basin is that shown by Forbes and Richardson on chart 42, of the "Maps showing distribution of Illinois fishes to accompany a report on the fishes of Illinois."

74. *Notropis hudsonius* Clinton

Spot-tail minnow; spawn eater

Two poorly defined subspecies of this minnow occur in the Great Lakes region.

74a. *Notropis hudsonius hudsonius* Clinton

A form identified very doubtfully with the typical subspecies inhabits the entire Great Lakes drainage area with the exception of the Lake Superior basin. Toward the north local variations are found which approach *selene*.

74b. *Notropis hudsonius selene* Jordan

Specimens from various portions of the Lake Superior watershed agree in having the caudal spot usually larger and more regular and the dentition more complete than in the race to the southward. These differences are slight, however, and the other supposedly diagnostic features of *selene* are not valid. It may eventually prove undesirable to maintain *selene* as a distinct subspecies.

Notropis scopiferus Eigenmann and Eigenmann (given later by Eigenmann and by Jordan and Evermann as *N. scopifer*), from the Hudson Bay

drainage, currently recorded as a valid species allied to *N. leuciodus* of the distant Tennessee basin, is fully identical with *Notropis hudsonius selene*. I have examined the types of this species, as well as series from the Red River drainage in North Dakota, and a specimen from the Mississippi River at Cass Lake, Minnesota.

75. *Notropis whipplii whipplii* Girard

Steel-colored minnow; silver-fin

The type of *Hybopsis fretensis* Cope, still recognized as a doubtfully valid species of *Notropis*, appears on renewed examination to be a specimen of this minnow.

76. *Notropis ariommus* Cope

Pop-eye shiner

This is another species known from the Great Lakes region only from Kirsch's Maumee basin record.⁶⁷ I have not been able to locate his material of this species, and therefore maintain the record solely on his authority.

77. *Notropis atherinoides* Rafinesque

Lake shiner

The lake shiner exhibits extensive local variation in several portions of its range. Although we have large series of specimens, our material is yet insufficient to attempt a division of the species into subspecies.

78. *Notropis photogenis* Cope

Silver shiner

Notropis arge, rare in our drainage although common in southern Ohio, is currently compared or confused with *atherinoides*, whereas in reality it is identical with *N. photogenis*, a fully distinct species more similar to *rubrifrons*. These conclusions are based on the study of a large amount of material in the National Museum and our Museum of Zoology.

79. *Notropis rubrifrons* Cope

Rosy-face shiner

80. *Notropis cornutus* Mitchill

Common shiner

We are making an extensive study of variation within this species. Although the results of this study are not yet ready for the press, it is already

⁶⁷ Bull. U. S. Fish Comm., 14, 1894 (1895), p. 329.

evident that the species should be divided into three subspecies, of which *N. cornutus cornutus*, from the Atlantic Coast drainage, is in general intermediate between the other two, which are compared in the preceding key.

80a. *Notropis cornutus chrysocephalus* Rafinesque

Throughout most of the Mississippi basin east of the Great Plains *Notropis cornutus* is quite constant in its characters, being represented here by the subspecies *N. c. chrysocephalus*. Toward the Rocky Mountains and toward the north, however, this form intergrades, in a highly irregular fashion, with *N. c. frontalis*. Races nearly typical of *chrysocephalus* occupy a considerable portion of the Great Lakes drainage, particularly in south-central Michigan.

The nominal species *plumbeolus* and *gibbus* of Cope were based on such Michigan specimens. Jordan and Evermann apply Agassiz's name *frontalis* to the Great Lakes population of *chrysocephalus*, but in my opinion *Leuciscus frontalis* and *gracilis* of Agassiz must both have been based on specimens of the northern subspecies, named *cyaneus* by Cope and by Jordan and Evermann.

80b. *Notropis cornutus frontalis* Agassiz

Throughout the Lake Superior region, and thence westward to the slope of the Rocky Mountains, *Notropis cornutus* is represented by this subspecies, which differs widely from *N. c. chrysocephalus*, but intergrades with it (in a highly irregular fashion) over a wide area.

I hope later to describe in detail the remarkable variation of this species, and the complex interrelationships of its subspecies.

An examination of the type of *Notropis universitatis* Evermann and Cockerell, 1909, shows that this nominal species is a synonym of *Notropis cornutus frontalis*. It has 9 anal rays and 30 scales before the dorsal.

81. *Notropis umbratilis cyanocephalus* Copeland

Red-fin shiner

I have studied a large number of specimens of *Notropis umbratilis* from the Great Lakes region and the Mississippi Valley, but can not align these into the present classification. I can detect no considerable differences between lots from southeastern Wisconsin (topotypic of *cyanocephalus*), Illinois (representing *atripes*) and Indiana (including the original types of *lythrurus*). The nominal subspecies *atripes* and *lythrurus* are therefore referred to the synonymy of *cyanocephalus*, the first to be described. The relationships of *cyanocephalus* to the several forms occurring to the southward remain to be determined.

Genus 45. ERICYMBA Cope

82. *Ericymba buccata* Cope

Silver-mouth minnow

We have taken this species in several localities in southwestern Michigan, including the River Raisin, just above Monroe.

Genus 46. PHENACOBIOUS Cope

83. *Phenacobius mirabilis* Girard

Sucker-mouth minnow

Mr. E. L. Wickliff has taken this species recently at several localities in the Maumee drainage of Ohio, and kindly has given me permission to record this interesting discovery.

Genus 47. EXOGLOSSUM Rafinesque

This genus in my opinion should not be made the type of a distinct subfamily, for the structure of the lower jaw is not fundamentally different from that of the other Leuciscinae.

84. *Exoglossum maxillingua* Le Sueur

Cut-lips

Lake Ontario drainage.

Genus 48. NOTEMIGONUS Rafinesque

The separation of this genus from the Old World *Abramis* is required.

85. *Notemigonus crysoleucas crysoleucas* Mitchill

Golden shiner; roach

The golden shiners of the Great Lakes are referable to the typical subspecies as currently defined.⁶⁸ It is not improbable, however, that the species on further study will require further division.

Genus 49. HYBOGNATHUS Agassiz

86. *Hybognathus nuchalis nuchalis* Agassiz

Silvery minnow

Genus 50. CHROSOMUS Rafinesque

This genus was probably derived from some genus like Pfrille, with which it has very much in common, including the finer structure of the scale.

I can not admit it as the type of a distinct subfamily.

⁶⁸ See: Hubbs, Trans. Illinois Acad. Sci., 1918 (1921), pp. 147-151; also Schultz, Pap. Mich. Acad. Sci., Arts and Letters (paper in press).

87. *Chrosomus erythrogaster* Rafinesque

Red-belly dace

I have studied series of specimens of *Chrosomus* from various localities, and fail to find grounds for the distinction of a western species or subspecies (*dakotensis*).

Genus 51. HYBORHYNCHUS Agassiz⁶⁹

We have already proposed⁷⁰ recognizing *Hyborhynchus* as a distinct genus; Jordan has made the same suggestion;⁷¹ I give here, in the key, the characters on which the validity of the genus may rest. In my opinion, *Hyborhynchus* is quite as distinct from *Pimephales*, with which it has long been united, as from *Ceratichthys* (= *Cliola*), which has arbitrarily been classified in another subfamily. These three genera form a closely related group, to which the subfamily name *Pimephalinae* may be applied.

88. *Hyborhynchus notatus* Rafinesque

Blunt-nose minnow

Genus 52. PIMEPHALES Rafinesque

89. *Pimephales promelas promelas* Rafinesque

Black-head minnow; fat-head minnow

Genus 53. CAMPOSTOMA Agassiz

90. *Campostoma anomalum* Rafinesque

Stone-roller minnow

The types of *Campostoma brevis* Haseman,⁷² a nominal species rather recently described from Indiana, on re-examination appear to be only selected variants of *C. anomalum*.⁷³

Family 14. AMEIURIDAE

Regan, in his revision of the Siluroidea,⁷⁴ has proposed recognizing the North American fresh-water genera as composing a distinct family.

⁶⁹ *Ceratichthys vigilax* Baird and Girard has been recorded by Fowler from Michigan, but the record was probably based on specimens of *Hyborhynchus notatus*. The material has been re-examined.

⁷⁰ Hubbs and White, *Copeia*, No. 123, 1923, p. 104.

⁷¹ Jordan, *Copeia*, No. 132, 1924, p. 72.

⁷² Haseman, *Proc. Indiana Acad. Sci.*, 1905 (1906), p. 161.

⁷³ See: Kraatz, *Ohio Jour. Sci.*, 24, 1924, pp. 282-283.

⁷⁴ Regan, *Ann. Mag. Nat. Hist.* (8), 8, 1911, pp. 553-557, 3 fig.

Jordan⁷⁵ and others have accepted this proposal, and I here follow their judgment (after all, the determination of the rank to be assigned a group is primarily a matter of opinion).

KEY TO THE GENERA.

- a¹.—Adipose fin with its posterior margin free, not adnate to back nor connected with caudal fin.
- b¹.—Premaxillary band of teeth without backward lateral extensions. Anal rays 17 to 35 (rudiments included). Adipose dorsal of moderate size. Lower jaw weakly or not at all projecting. Head less flattened.
- c¹.—Supraoccipital and predorsal processes joined together to form a firm bony bridge between head and dorsal fin. Caudal fin deeply and sharply forked (the shortest ray much less than half length of longest). Head narrow. Body black-spotted (in the single Great Lakes species).....54. *Ictalurus*
- c².—Supraoccipital and predorsal processes not or scarcely meeting, not forming a firm continuous bridge. Caudal less deeply and less sharply forked, or truncate or rounded (the shortest ray more than half length of longest). Head broader. Body without definite black spots (in Great Lakes species).
- d¹.—Caudal fin forked. Supraoccipital processes better developed than in *Ameiurus*. Species of large size, approaching *Ictalurus*. Coloration slaty to silvery55. *Villarius*
- d².—Caudal fin emarginate to rounded. Supraoccipital processes short. Species of relatively small size. Color more brownish or yellowish.....56. *Ameiurus*
- b².—Premaxillary band of teeth with backward lateral extensions. Anal rays 12 to 15. Adipose dorsal unusually large. Lower jaw strongly projecting. Head greatly flattened anteriorly57. *Leptops*
- a².—Adipose fin with the posterior margin adnate to the back, and separated from the fleshy upper margin of the caudal fin by not more than an incomplete notch.
- e¹.—Premaxillary band of teeth with backward lateral extensions, as in *Leptops*. Skin thick, tough, villose, opaque. Size moderate58. *Noturus*
- e².—Premaxillary band of teeth without backward extensions. Skin thinner, more delicate, smoother and less opaque. Size small59. *Schilbeodes*

Genus 54. ICTALURUS Rafinesque

91. *Ictalurus punctatus* Rafinesque

Catfish; channel cat

Genus 55. VILLARIUS Rutter

Villarius Rutter, Proc. Calif. Acad. Sci. (2), 6, 1896 (June 29), p. 256.

Haustor Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 1, 1896 (October 3), p. 136.

The group of species currently referred to the subgenus *Haustor*, of the genus *Ameiurus*, should in our opinion be regarded as a genus. The name *Villarius*, based on a species of the same group, has precedence over that of

⁷⁵ Jordan, The classification of fishes, 1923, p. 147.

Haustor. Villarius appears to be quite as closely related to Ictalurus as to Ameiurus.

The species of Villarius are catfishes of large size. Probably as a result of overfishing, many are becoming rare, if not facing extinction. As a consequence of their large size and their rarity, very few specimens (except of *V. catus*) are preserved in any museum, and the systematic status of not one of the species can be regarded as well established. The species of Villarius have even been confused with those of Ictalurus. For instance, *Amiurus ponderosus* Bean, known only from the type, is a species of Villarius, not of Ictalurus (as claimed by Evermann).⁷⁶

92. *Villarius lacustris* Walbaum

Northern catfish; mathemeg

The proper specific name for the Great Lakes representative of "Haustor" is still an open problem. I merely follow custom in using the name *lacustris*.

Genus 56. AMEIURUS Rafinesque

KEY TO THE SPECIES

- a¹.—Anal rays 17 to 24 (including rudiments), seldom more than 23. Caudal fin always evidently emarginate. Mental barbels gray to black.
- b¹.—Anal rays 17 to 21, usually 18 to 20. Pectoral spines shorter; at all ages entire or only slightly roughened behind. Outer two-thirds of inter-radial membranes of anal fin uniformly pigmented, always darker than the rays, the fin never mottled or barred or uniformly pigmented on both membranes and rays as in *nebulosus*93. *A. melas*
- b².—Anal rays 21 to 24, usually 22 or 23. Pectoral spine longer; in the young with long sharp barbs on posterior edge, their length being more than half diameter of spine (the teeth increasing in number and decreasing in relative size with age). Black pigment on anal fin typically densest on the membranes near their margin, or in spots forming an obscure longitudinal bar near base of fin, or in faint mottlings on both rays and membranes (in pale and unmottled specimens, membranes and rays about equally pigmented).....94. *A. nebulosus*
- a².—Anal rays 24 to 27 (rudiments all counted), usually 25 or 26. Caudal fin rounded posteriorly. Mental barbels whitish. Body waxy yellow to greenish, sometimes blackish above95. *A. natalis*

93. *Ameiurus melas* Rafinesque

Black bullhead

⁷⁶ Bull. U. S. Nat. Mus., 47, pt. 3, 1898, p. 2789; Rept. U. S. Fish Comm., 1898 (1899), p. 305.

94. *Ameiurus nebulosus* Le Sueur

Brown bullhead; speckled bullhead

Occasionally individuals of this species, usually large adults, but never the young, have the lower jaw projecting; the same condition holds in *A. melas*. Such specimens represent only the extremes of age and individual variation, although they have been referred to a distinct species "*vulgaris*." I refer *Pimelodus vulgaris* Thompson, *P. dekayi* Girard and *P. ailurus* Girard all to the synonymy of *A. nebulosus*.

A. n. marmoratus is merely a color phase—an individual variation at most.

95. *Ameiurus natalis* Le Sueur

Yellow bullhead

Genus 57. LEPTOPS Rafinesque

96. *Leptops olivaris* Rafinesque

Mud cat; yellow cat

The mud cat is known from the Great Lakes only through McCormick's record. The specimens identified as this species were either not preserved, or have since been lost. Probably only stragglers of the species have entered Lake Erie through canals.

Genus 58. NOTURUS Rafinesque

97. *Noturus flavus* Rafinesque

Yellow stone-cat

Genus 59. SCHILBEODES Bleeker

KEY TO THE SPECIES

- a¹.—Pectoral spine barbless. Adipose fin separated from caudal by at most a shallow non-acute notch. Axial streak conspicuous98. *S. gyrinus*
 a².—Pectoral spine with barbs on posterior edge. Adipose fin separated from caudal by a deeper more acute notch. Axial streak not conspicuous.
 b¹.—Pectoral spine short, about one-third as long as head; the barbs weaker, not half diameter of spine. Notch between adipose and caudal usually rather shallow. Posterior part of body pale, and uniform in coloration.....99. *S. exilis*
 b².—Pectoral spine more than half as long as head; the barbs very strong, nearly equalling diameter of spine. Notch between adipose and caudal deep and acute. Posterior part of body strikingly marked with dark bars and mottlings.....100. *S. miurus*

98. *Schilbeodes gyrinus* Mitchell

Tadpole cat

99. *Schilbeodes exilis* Nelson

Slender stone-cat

Only one specimen of this form has been recorded from Great Lakes tributaries, from the Tiffin River at Manitou Beach, Michigan.⁷⁷ This specimen has apparently been lost, and a recent search at the recorded locality has failed to yield another, although the other siluroids obtained there by Kirsch were secured. Some doubt is therefore attached to the record.

100. *Schilbeodes miurus* Jordan

Brindled stone-cat

Family 15. UMBRIDAE

Genus 60: UMBRA Krämer

101. *Umbra limi* Kirtland

Mud minnow

The inter-relationship of *U. limi* and *U. pygmaea* needs better definition.

Family 16. ESOCIDAE

Genus 61. ESOX Linnaeus

KEY TO THE SPECIES

- a¹.—Checks entirely scaly. Branchiostegals 11 to 16.
 b¹.—Opercles also entirely scaly. Dorsal rays 11 to 14. Body markings dark; fins without black spots. Size smaller. (Subgenus *Kenoza* Jordan and Evermann)
 c¹.—Branchiostegal rays 11 to 13. Scales in lateral line about 105. Middle of eye nearer tip of lower jaw than margin of opercle. Dark markings mostly transverse. Size smaller, to 13 inches.....102. *E. vermiculatus*
 c².—Branchiostegal rays 14 to 16. Scales in lateral line about 125. Middle of eye about midway between tip of lower jaw and margin of opercle. Dark markings mostly longitudinal. Size larger, to two feet.....103. *E. niger*
 b².—Opercles with lower half bare of scales. Dorsal rays about 14 to 16. Body markings whitish; fins with black spots. Size larger, to four feet. (Subgenus *Esox* Linnaeus)104. *E. lucius*
 a².—Checks as well as opercles with lower half scaleless. Branchiostegal rays usually 17 to 19.—Dorsal rays about 17. Body markings dark; fins with black spots. Size still larger than in *lucius*. (Subgenus *Mascalongus* Jordan)105. *E. masquinongy masquinongy*

102. *Esox vermiculatus* Le Sueur

Mud pickerel; little pickerel

It has seemed not improbable for some time that the Great Lakes representative of *americanus* and *vermiculatus* might prove distinct from either.

⁷⁷ Kirsch, Bull. U. S. Fish Comm., 1894 (1895), p. 327.

Mr. A. C. Weed of the Field Museum, who is making a special study of the species of *Esox*, now regards all these forms as subspecies of *americanus*, but I await the publication of his data before changing the nomenclature of the present form.

103. *Esox niger* Le Sueur

Eastern pickerel; jack pike

Jordan⁷⁸ has lately discussed the nomenclature of this species, showing that the name *reticulatus*, ordinarily used, is preoccupied. We provisionally adopt for this species the name *niger*, rather than *tridecemlineatus* (see discussion by Weed, Copeia, No. 144, 1925, p. 51).

104. *Esox lucius* Linnaeus

Pike; pickerel; grass pike; great northern pike

105. *Esox masquinongy masquinongy* Mitchill

Muskallunge (various spellings)

The status of the several species or subspecies of muskallunge is still uncertain. The Great Lakes form is very variable, and possibly a composite of more than one race.

Family 17. ANGUILLIDAE

Genus 62. ANGUILLA Shaw

106. *Anguilla rostrata* Le Sueur

Eel

This name, it is now held,⁷⁹ has priority for the American eel.

The eel was introduced many years ago into the Great Lakes waters. It became very abundant and attained a large size, but, unable to spawn, it became extinct in this region perhaps ten or fifteen years ago.

Family 18. CYPRINODONTIDAE

The Cyprinodontes have lately been divided up into smaller and more natural family groups.⁸⁰

⁸⁰ See Hubbs, Misc. Publ. Mus. Zool., Univ. Mich., No. 13, 1924, p. 4.

Genus 63. FUNDULUS Lacépède

KEY TO THE SPECIES

a¹.—Dorsal fin originating distinctly in advance of anal. Body with cross bands in both sexes.....107. *F. diaphanus menona*

⁷⁸ Proc. Acad. Nat. Sci. Phila., 1917, p. 278; Copeia, No. 61, 1918, p. 81.

⁷⁹ Jordan, Copeia, No. 49, 1917, p. 86.

- a².—Dorsal fin originating distinctly behind front of anal. Body with cross bands in male only.
- b¹.—Body rather deep and compressed; depth 3.5 to 4.3. Males with vertical bars; females with about ten horizontal streaks. A black blotch below eye108. *F. dispar*
- b².—Body slender and scarcely compressed anteriorly; depth 4.4 to 5.3. A purplish black lateral band, with irregular edges in the male. No black blotch below eye109. *F. notatus*

107. *Fundulus diaphanus menona* Jordan and Copeland

Menona killifish

108. *Fundulus dispar* Agassiz

Black-cheek topminnow

109. *Fundulus notatus* Rafinesque

Black-banded topminnow

Family 19. PERCOPSIDAE

Genus 64. PERCOPSIS Agassiz

110. *Percopsis omisco-maycus* Walbaum

Trout-perch

As Kendall has shown,⁸¹ the name *omisco maycus* of Walbaum replaces that of *guttatus* for the trout-perch. As the name was originally given as two words, the hyphenated form is adopted.

Family 20. APHREDODERIDAE

Genus 65. APHREDODERUS Le Sueur

111. *Aphredoderus sayanus* Gilliams

Pirate perch

Family 21. SERRANIDAE

KEY TO THE GENERA

- a¹.—Dorsal fins separated; anal rays III, 11 to 13; the spines graduated, the first about half length of second, and second distinctly shorter than third. Lower jaw projecting. Base of tongue with teeth66. *Lepibema*
- a².—Dorsal fins slightly conjoined at base; anal rays III, 10; the spines not graduated, the first scarcely one-third as long as second, the second and third subequal. Jaws almost equal. Base of tongue toothless67. *Morone*

⁸¹ Kendall, Proc. Biol. Soc. Wash., 24, 1911, p. 45-51.

Genus 66. *LEPIBEMA* Rafinesque

The trenchant characters of *Lepibema* seem fully sufficient to warrant its generic separation from *Roccus*.

112. *Lepibema chrysops* Rafinesque

White bass

Genus 67. *MORONE* Mitchill113. *Morone interrupta* Gill

Yellow bass

Forbes and Richardson (1908, map 101) indicate the occurrence of this species in the Chicago River.

Family 22. PERCIDAE

KEY TO THE GENERA

- a¹.—No distinct anal papilla. Pseudobranchiae well developed. Branchiostegals 7 (rarely 8). Top of skull ridged; supra-occipital crest strong and high. Preopercle strongly serrate. Maxillary with the upper border free behind. Mouth large, extending at least as far as middle of eye. Fishes of medium to large size.
- b¹.—No canine teeth. Body deeper and more compressed. Pelvic fins close together. Body with definite dark bands. (Subfamily Percinae).....68. *Perca*
- b².—Canine teeth strong. Body slender, subterete. Pelvic fins widely separated (interspace equalling width of base of fin). Body without definite dark bands. (Subfamily Luciopercinae)69. *Stizostedion*
- a².—Anal papilla large. Pseudobranchiae rudimentary or absent. Branchiostegals 6. Top of skull nearly or quite smooth; supraoccipital crest weak or absent. Preopercle entire, or almost so. Maxillary with upper border concealed by preorbital. Mouth small, extending little if at all behind middle of eye. Fishes of small size, not exceeding six inches in length. (Subfamily Etheostominae)
- c¹.—Midline of belly with a single median series of scales, which are more or less enlarged, thickened, spinous, caducous and separated from adjacent scales by a groove on either side, or without scales (the scaleless strip crossed by a bridge of normal scales before the anus in *Imostoma*). Pelvic fins separated by an interspace at least $\frac{3}{4}$ as wide as base of fin. Anal fin usually almost as large as second dorsal, or even larger. Body in most species more elongate and less compressed. Vertebrae 37 to 44.
- d¹.—Flesh opaque. Anal spines two in number. Squamation more nearly complete. Body less extremely elongate (depth 5.0 to 7.0).
- e¹.—Premaxillaries non-protractile, bound to snout by a frenum.—Air-bladder rather large (but thin-walled).
- f¹.—Snout not extended so far forward as the premaxillaries. Mouth more or less oblique. Anal spines stiff. Skull distinctly less depressed, and

- narrower between the eyes⁸² (interorbital width 5.5 to 8.0). Scales of moderate size (fewer than 80). Color pattern consisting essentially of broad bars or horizontally elongated blotches. Dorsal fins scarcely to widely separated. Vertebrae 39 to 42.....70. *Hadropterus*
- f².—Snout extended forward as a small conical projection beyond the premaxillaries. Mouth horizontal. Anal spines flexible. Skull more depressed than in any other darter, and broader between the eyes (interorbital width 4.0 to 5.0 in head). Scales small (78 to 103). Color pattern consisting essentially of narrow zebra-like markings. Dorsal fins scarcely or not at all separated. Vertebrae 44.....71. *Percina*
- e².—Premaxillaries protractile (rarely with a frenum in either genus).—Characters of skull, scales and color pattern as given above for *Hadropterus*; dorsal fins well separated.
- g¹.—Midline of belly with a single series of more or less enlarged, thickened, spinous, caducous scales set off by a groove on either side (as in the preceding genera). Air-bladder rudimentary. Snout decurved and slightly projecting beyond the premaxillaries; mouth horizontal. Anal spines flexible.—Vertebrae 3872. *Cottogaster*
- g².—Midline of belly a scaleless strip, crossed before the anus by a bridge of normal scales. Air-bladder fairly well developed. Snout pointed, but not extended so far forward as the premaxillaries; mouth oblique. Anal spines stiff73. *Imostoma*
- d².—Flesh pellucid. Anal spine single. Scales on trunk confined to sides of body. Body very elongate (depth 7.8 to 9.0).—Premaxillaries protractile (rarely with a frenum)74. *Ammocrypta*
- c².—Belly (between pelvic and anal fins) covered with normal scales. Pelvic fins separated by an interspace less than $\frac{1}{4}$ as wide as base of fin (except in *Boleosoma*). Anal fin obviously smaller than second dorsal (elevated in the male of *Microperca*). Body usually deeper and more compressed. Vertebrae 30 to 42.
- h¹.—Premaxillaries free from the preorbital at side, and projecting forward as far as, or (usually) farther than, the more or less pointed snout; and non-protractile, bound to snout with a frenum (except in *Boleosoma*). Vertebrae 30 to 39. Color not largely green.
- i¹.—Lateral line more or less developed, running much nearer middle of sides than dorsal contour.⁸³ Vertebrae 33 to 39; scales 40 to 80; dorsal spines always more than 6 (usually more than 8). Lower fins shorter, especially in males; the pelvics rounded, not nearly reaching anus in either sex. Size larger.
- j¹.—Premaxillaries protractile, without frenum. One flexible anal spine. Pelvic fins separated by an interspace about as wide as base of fin.....75. *Boleosoma*

⁸² This character has been utilized by Jordan and Evermann and by Forbes and Richardson in the primary analysis of the Etheostominae, but its insufficiency and unreliability is indicated by the fact that several of the genera placed in one of the alternative groups by the first authors were transferred to the other by Forbes and Richardson, and further by the fact that even the latter separation does not hold valid in all cases.

⁸³ The lateral line runs very high in *Copelandellus fusiformis*, which may possibly occur in Great Lakes waters (see our account of *Poecilichthys exilis*).

- j².—Premaxillaries non-protractile, bound down to the snout by a frenum. Two stiff anal spines (very rarely but one). Pelvic fins inserted close together.
- k¹.—Dorsal spines without knobs. Lower jaw scarcely or not at all projecting (usually included). Head partially scaled and males brilliantly colored (in Great Lakes species).....76. *Poecilichthys*
- k².—Dorsal spines of males ending in fleshy knobs, especially in breeding season. Lower jaw definitely projecting. Head entirely scaleless; males plainly colored77. *Catnotus*
- i².—Lateral line wholly wanting. Vertebrae only 30; scales 33 to 37; dorsal spines usually 6 (rarely 7 or 8). Lower fins higher, especially produced in males; the pelvics pointed, reaching the anus. Minute fishes, not exceeding 1½ inches.—Other characters as here given for *Poecilichthys*.....78. *Microperca*
- h².—Premaxillaries bound to the preorbital at sides, overhung by the gibbous snout; without the anterior frenum. Vertebrae 42. Color largely green, especially in breeding males79. *Etheostoma*

Genus 68. PERCA Linnaeus

114. *Perca flavescens* Mitchill

Perch; yellow perch; ring perch

The perch exhibits a confusing array of variations in size, proportions and colors, which have never been systematically studied.

Genus 69. STIZOSTEDION Rafinesque

KEY TO THE SPECIES

- a¹.—Pyloric caeca 5 to 8, the 4 longest much shorter than the stomach. Rays of soft dorsal 17 to 19. Cheeks as a rule closely scaled. End of spinous dorsal without a black blotch; blotch at base of pectoral more distinct; dorsals with rows of definite spots. (Subgenus *Cynoperca* Gill and Jordan).....115. *S. canadense griseum*
- a².—Pyloric caeca 3, each as long as stomach. Rays of soft dorsal 19 to 22 (usually more than 20). Cheeks as a rule sparsely scaled. End of spinous dorsal with a large black blotch; blotch at base of pectoral less distinct; dorsals with only obscure reticulations. (Subgenus *Stizostedion* Rafinesque)
- b¹.—Body with brassy yellow mottlings, but never bluish; lower fins clear yellowish. Eyes smaller and set farther apart, the bony interorbital width being contained 1.1 to 1.4 times in the length of the orbit in the very young to half-grown, and being nearly as wide or even wider than eye in adults; vertical diameter of eye less than half (in adults two-fifths) depth of head at same point. Size larger, to 20 or 40 pounds, usually immature at less than one pound; slackening of growth occurring at much greater age. Flesh firmer.....116. *S. vitreum*
- b².—Body grayish blue, without brassy yellow mottlings; lower fins bluish white. Eyes larger and close-set, the bony interorbital contained 1.4 to 2.0 times in length of orbit (except in about one per cent. of the population); vertical diameter of eye more than half depth of head at same point. Size smaller, seldom 18 inches long, averaging well under one pound in weight. Slackening of growth

occurring at an age of about five years. Flesh softer, decomposing more rapidly117. *S. glaucum*

115. *Stizostedion canadense griseum* DeKay

Sauger; sand pike; gray pike

We are not sure of the distinctness of this nominal subspecies, and are ignorant of its exact relationships, either genetic or geographic, with the St. Lawrence sauger (typical *canadense*). It is not even certain that the names *griseum* and *canadense* were not based on the same subspecies, since DeKay in naming *Lucioperca grisea* did not especially describe the features by which the subspecies are supposed to be distinguished, nor did he assign to the form any definite locality. He merely remarked that *grisea* "is found with the preceding" (*americana* = *vitreum*), the range of which in New York he gives as "the Great Lakes, and most of the streams and inland lakes in the western parts of the state." In order to help retain the name *griseum* on the form with which it is now associated, we designate the definite type locality as the eastern end of Lake Erie.

116. *Stizostedion vitreum* Mitchill

Wall-eye; yellow pike; pike-perch; pickerel

Plate IV, Fig. 1

117. *Stizostedion glaucum*, new species

Blue pike

Plate IV, Fig. 2

Holotype, a specimen 239 mm. long to caudal fin, collected in Lake Erie, at a depth of 40 feet off Ashtabula, Ohio; Cat. No. 55674, Museum of Zoology, University of Michigan. We have many adult paratypes from Lake Erie, off Erie, Pennsylvania; off Sandusky, Ohio, and near Merlin, Ontario, and a young one from Squaw Bay, Put-in Bay, Ohio.

The blue pike of Lake Erie differs from the yellow pike, *Stizostedion vitreum* (of which we have fair series from various parts of the Great Lakes basin, including Lake Erie), in the blue color, the smaller size, the slower rate of growth, the larger and more closely set eyes, and in the less firm flesh; all as outlined in the preceding key. Other characters have been assigned to the blue pike, but I consider them as either not valid or not trenchant.

The name *salmonium* has been applied to the blue pike, but it is clear from the original account that Rafinesque's *Perca salmonia* was based on *S. vitreum*; furthermore *glaucum* is not known to occur in the Ohio River, where Rafinesque's fish was caught.

The structural features of these two forms have recently been discussed by Kendall,⁸⁴ and their rate of growth studied by Adamstone.⁸⁵

S. glaucum and *S. vitreum* apparently do not intergrade, for *glaucum* remains typical in its characters from the east end of Lake Erie to near the islands. It becomes rare about the islands, according to the dealers, and only stragglers occur to the westward, in the very shallow upper end of Lake Erie, where *vitreum*, in contrast, is common. Along the western shore of the lake, off Toledo and Monroe, and up the Detroit River, *vitreum* alone seems to occur. The yellow pike, while commoner west of the islands, occurs also to the eastward, living there with the blue species. The blue pike is said to spawn in deeper water than the yellow, and later in the spring, but I have not verified these statements. We do not know whether the blue pike of Lake Ontario is identical with that of Lake Erie.

(*Glaucum*: grayish blue.)

Genus 70. HADROPTERUS Agassiz

KEY TO THE SPECIES

- a¹.—Gill-membranes not united, meeting at a sharp angle; on midline scarcely farther from tip of snout than is back of eye. Spinous dorsal without orange stripe.
- b¹.—Sides with about seven distinct, broad, transverse dusky bars extending to below lateral line. Breeding males with bright colors and tuberculate fins. Cheeks naked. (Subgenus *Ericosma*)118. *H. evides*
- b².—Sides with an axial row of elongated and more or less connected black blotches, and with irregular mottlings above these. Breeding males without bright colors or tuberculate fins. Cheeks more or less completely scaled. (Subgenus *Alvordius*)119. *H. maculatus*
- a².—Gill-membranes united into a broad curve, distinctly more distant from tip of snout than is back of eye. Spinous dorsal with an orange stripe.—An axial series of blotches, fainter than in *maculatus*. Head slenderer. (Subgenus ?).....120. *H. phoxocephalus*

118. *Hadropterus evides* Jordan and Copeland

Barred darter

This species is known in the Great Lakes only from specimens (some of which are at hand) from the St. Joseph and from its confluence with the St. Mary's, in Indiana.

119. *Hadropterus maculatus* Girard

Black-side darter

Hadropterus maculatus and *Hadropterus aspro* of authors.

We have searched for specimens which might be taken to represent *Alvordius maculatus* Girard, and although we have material from near the

⁸⁴ Trans. Am. Fish. Soc., 50, 1920 (1921), pp. 257-267.

⁸⁵ Univ. Toronto Studies (Biol.), 20, 1922, pp. 77-86, figs. 1-5.

type locality (Fort Gratiot, Michigan) and large series from adjacent regions, this search has not been successful. The considerable variation that does exist in the squamation of the head in this region is obviously individual and not racial.

Consequently I am forced to conclude that *Alwordius maculatus* Girard is conspecific with *A. aspro* Cope and Jordan. As Girard's name is the older, the species should be known as *Hadropterus maculatus*. The probable identity of these nominal species was suggested by Jordan⁸⁶ only a year after Cope and he had described *aspro*.

While working with large series of *Percina caprodes* from Tippecanoe Lake, Indiana, Moenkhaus in 1896 found one specimen which he regarded as a hybrid between this species and *Hadropterus aspro* (= *maculatus*). Later he found two more darters of this type among 500 or 600, still later three in "a peck of darters" from Tippecanoe Lake. He decided finally that these specimens represented a distinct species, which he described as *Hadropterus evermanni*.⁸⁷ In the intensive survey of Illinois fishes, Forbes and Richardson obtained but a single darter of this type, which they likewise referred to *H. evermanni*. So far as we know, the supposed species has not been found by other workers.

These facts strongly suggest the hybrid nature of such material. This suggestion is confirmed by an examination of our own material of this type. We have three young of the year taken with a considerable number of young of each supposed parent species in the Huron River, in Livingston County, Michigan, another in a tributary of this stream, and in addition a fine adult from the Thames River, Ontario, and a number of adults, taken with the parent species in the Au Sable River, Michigan. Our specimens do not show such constancy of characters as would be expected if they represented a distinct species, but are variously and completely intermediate between *Percina caprodes zebra* and *Hadropterus maculatus*.

120. *Hadropterus phoxocephalus* Nelson

Slender-head darter

The status of this species as a Great Lakes fish is uncertain, since it is known for this region only from the record of McCormick.⁸⁸ This author had one specimen from near Lorain, Ohio, which he identified without question as of this species. I have not been able to locate this fish in the Oberlin Museum, and regard the record as somewhat doubtful.

⁸⁶ Bull. U. S. Geol. Surv. Terr., 4, 1878, p. 798.

⁸⁷ Bull. U. S. Fish. Comm., 1902 (1904), p. 397.

⁸⁸ Lab. Bull. Oberlin Coll., No. 2, 1892, p. 30.

Genus 71. PERCINA Haldeman

121. *Percina caprodes* Rafinesque

Log perch

This species is represented in Great Lakes waters by two subspecies, which intergrade perfectly in the Lake Erie region and eastward. The zone of intergradation apparently includes Lake Champlain, for of two specimens examined from that lake, one is like typical *caprodes*, the other like *zebra*. This fact adds a measure of complexity to the nomenclature of these subspecies, since *Pileoma semifasciatum* DeKay, from Lake Champlain, is an older name than that of *P. zebra* Agassiz. In order to avoid confusion of names, it will be best to regard the Lake Champlain race as a complex, and to continue the association of the name *semifasciatum* with typical *caprodes* rather than with subspecies *zebra*.

As explained above, *Percina caprodes* hybridizes with *Hadropterus maculatus*. In addition we have hybrids between the *Percina* and *Cottogaster*.

121a. *Percina caprodes caprodes* Rafinesque

In the Lake Michigan drainage of southern Wisconsin the species is represented by fairly typical *caprodes*.

121b. *Percina caprodes zebra* Agassiz

This subspecies occupies most of the Great Lakes area, intergrading southward with typical *caprodes*. Its chief distinctive feature is the scaleless nape.

Genus 72. COTTOGASTER Putnam

122. *Cottogaster copelandi* Jordan

Copeland darter

This species is common in the lower course of the Au Sable River, Michigan, and occurs in the Devil River, still farther north. In some specimens from the Au Sable the premaxillaries are bound back by a frenum.

C. putnami appears to be inseparable from *C. copelandi*.

Genus 73. IMOSTOMA Jordan

At present this group is regarded as a subgenus under *Cottogaster*, but its distinctive features are too trenchant to permit of retaining it as such, so long as we maintain our present conception of genera among the darters. *Imostoma* is contrasted with *Cottogaster* and other genera in the key.

123. *Imostoma shumardi* Girard

River darter

Specimens of this species have been seen in the water system of Chicago, which had been taken up in the "cribs" offshore in Lake Michigan.

*Imostoma cheneyi*⁸⁹ is known only from the type specimens taken in the St. Lawrence drainage below Lake Ontario.

Genus 74. AMMOCRYPTA Jordan⁹⁰124. *Ammocrypta pellucida* Baird

Sand darter

In some specimens from the Thames River, Ontario, the premaxillaries are non-protractile, being bound down to the forehead by a frenum.

Genus 75. BOLEOSOMA DeKay

KEY TO THE SPECIES AND SUBSPECIES

- a¹.—Lateral line more nearly, often quite, complete. Scales 45 to 52. Cheeks and breast usually largely devoid of scales. Snout longer. Pyloric caeca 6. (Subgenus *Boleosoma* DeKay).....125. *B. nigrum*
 b¹.—Soft dorsal rays 10 to 13. Size usually smaller.....125a. *B. nigrum nigrum*
 b².—Soft dorsal rays 13 to 15. Size usually larger.....125b. *B. nigrum olmstedii*
 a².—Lateral line absent on posterior half of body. Scales 52 to 60. Cheeks and breast closely scaled. Snout more snubby. Pyloric caeca 3. (Subgenus *Vallantia* Jordan)126. *B. camurum*

125. *Boleosoma nigrum* Rafinesque

Two subspecies of this darter enter Great Lakes waters. It is evident that they intergrade, but the details of the situation have not yet been worked out.

125a. *Boleosoma nigrum nigrum* Rafinesque

Johnny darter

The typical *nigrum* ranges over the drainage areas of the Great Lakes, excepting that of Lake Ontario, where the following subspecies lives.

⁸⁹ *Cottogaster cheneyi* Evermann and Kendall, Bull. U. S. Fish Comm., 1897 (1898), p. 129, pl. 8, fig. 8; Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 3, 1898, p. 2851; Bean, Bull. N. Y. St. Mus., 60, 1903, p. 510.

⁹⁰ The single record of the somewhat similar *Crystallaria asprella* from the Great Lakes region, as also the same author's record of *Cottogaster shumardi* from the same region (Fowler, Proc. Acad. Nat. Sci. Phila., 1906, p. 524) was based on a specimen of *Hadropterus maculatus* (see: Fowler, Occ. Pap. Mus. Zool., Univ. Mich., No. 60, 1918, p. 48).

125b. *Boleosoma nigrum olmstedii* Storer

Tesselated darter

126. *Boleosoma camurum* Forbes

Snub-nose darter

The only indication of the occurrence of this species in the Lakes drainage is the Illinois record of Forbes and Richardson (p. 299).

Genus 76. POECILICHTHYS Agassiz

This is the group ordinarily called Etheostoma. That generic name, however, by a decision of the International Commission on Zoological Nomenclature, goes with *blennioides*, thus replacing Diplesion. For the present group, therefore, the name Poecilichthys is to be resurrected.

Jordan has proposed⁹¹ that the various subgenera of Jordan and Evermann be recognized as valid genera. *Catonotus* (for *flabellaris*) is here separated out, as it seems to be the most distinct of the subgroups, but I do not attempt a further division. While it is obvious that several structural types are represented, and that most or all of these will eventually stand as distinct genera, the group is too poorly known at present to justify its partition.

KEY TO THE SPECIES

- a¹.—Lateral line complete (a few tubes rarely lacking). Snout abruptly decurved.
 b¹.—Gill-membranes not united, meeting well forward at an acute angle. Pelvic fins inserted very close to one another. Soft dorsal rays about 13. Depth, about 4.5. Scales 50 to 58. Body not barred; males with red spots.....127. *P. camurus*
 b².—Gill-membranes broadly connected across isthmus. Pelvic fins separated by an interspace half width of base of fin. Soft dorsal rays 10 to 12. Depth 4.7 to 6.0. Scales 48 to 53. Body barred; no red spots.....128. *P. zonalis*
 a².—Lateral line incomplete. Snout only moderately decurved.—Gill-membranes not united. Pelvic fins inserted close together.
 c¹.—Soft dorsal rays 12 to 14. Body deep (4.7 to 5.0). Scales 44 to 51. Cheeks scaleless. Bars extending across sides; the red bars of male blood-red.....129. *P. coeruleus coeruleus*
 c².—Soft dorsal rays 12 or 13. Body rather deep (4.8 to 5.4). Scales 49 to 57. Cheeks scaled. Bars confined to middle of sides; the red bars or interspaces of males rusty red.....130. *P. jessiae*
 c³.—Soft dorsal rays 9 to 11. Body slender (5.4 to 6.8). Scales 55 to 60. Cheeks more or less completely scaled. Bars confined to middle of sides; the red bars or interspaces rusty red.....131. *P. exilis*

⁹¹ Copeia, No. 29, 1916, pp. 25–26.

127. *Poecilichthys camurus* Cope⁹²

Blue-breast darter

This handsome darter is known from the area under treatment only from Osburn's record for the Huron River at Milan, Ohio.⁹³

128. *Poecilichthys zonalis* Cope

Banded darter

P. zonalis is recorded from the Great Lakes drainage only by Osburn⁹⁴ (Huron River at Milan, Ohio), and by Shelford⁹⁵ (Thorn Creek, Illinois). Mr. C. Willard Greene has taken the species, however, in several localities in the system of Fox River, tributary to Green Bay, Wisconsin.

129. *Poecilichthys coeruleus coeruleus* Storer

Rainbow darter

P. c. spectabilis is the southwestern representative of this form. Some young or female individuals within our territory show a marked approach toward that type, but nevertheless, in my opinion, are to be referred to typical *coeruleus*. Some authors, as Kirsch, have divided their material into both subspecies.

130. *Poecilichthys jessiae* Jordan and Brayton

Mud darter

This species is known from Great Lakes waters only from the head of Tiffin River, the outlet of Devil's Lake, Michigan, from which locality it was recorded by Kirsch.⁹⁶ We have seined at the same locality, but did not obtain this species, although we did find *P. exilis*, also taken there by Kirsch.

131. *Poecilichthys exilis* Girard

Iowa darter

Boleichthys exilis Girard, Proc. Acad. Nat. Sci. Phila., 1859, p. 103; Jordan, Man. Vert., Ed. 1, 1876, p. —; Nelson, Bull. Ill. Mus. Nat. Hist., 1, 1876, p. 34; Hoy, Geol. Wise., Surv. 1873-1879, 1, 1883, p. 428; Jordan and Evermann, Bull. U. S. Nat.

⁹² Hay has stated that Jordan secured a related species (*P. maculatus*) in the Maumee and St. Joseph rivers (Ann. Rept. Dept. Geol., Indiana, 1894, p. 278), but I find no such record made in the reference given, nor in any of Jordan's other works which have been consulted.

⁹³ Univ. Bull., Ohio St. Univ., (5) No. 20, 1901, p. 99.

⁹⁴ Osburn, *l. c.*, 1901, p. 98.

⁹⁵ Shelford, Animal Communities in Temperate America, Chicago, 1913, p. 120.

⁹⁶ Bull. U. S. Fish Comm., 14, 1894 (1895), p. 331.

Mus., 47, pt. 1, 1896, p. 1103; Michael, Bull. Mich. Fish. Comm., no. 8, 1906, p. 35 (name misspelled *exiles*); Surber, App. to Bien. Rep. St. Game and Fish Comm. Minn., 1920, p. 80; Conger, Key to Mich. Vert., 1920, p. 32.

Boleosoma exile Vaillant, Nouv. Arch. Mus. Hist. Nat. Paris, 9, 1873, p. 95.

Poecilichthys exilis Jordan and Gilbert, Bull. U. S. Nat. Mus., 16, 1883, p. 521; Jordan, Proc. U. S. Nat. Mus., 7, 1884, p. 479.

Etheostoma exile Jordan, Rept. U. S. Comm. Fish., 1885, p. 869; Boulenger, Cat. Fishes Brit. Mus., Ed. 2, 1895, p. 76.

Etheostoma fusiforme exile Jordan, Bull. U. S. Fish Comm., 1888 (1889), p. 118.

Etheostoma exilis Bollman, Bull. U. S. Fish Comm., 1888 (1890), p. 224.

Boleichthys warreni Girard, Proc. Acad. Nat. Sci. Phila., 1859, p. 103; Jordan, in Nelson, Bull. Ill. Mus. Nat. Hist., 1, 1876, p. 35.

Boleosoma warreni Vaillant, Nouv. Arch. Mus. Hist. Nat. Paris, 9, 1873, p. 95.

Poecilichthys warreni Jordan and Gilbert, Bull. U. S. Nat. Mus., 16, 1883, p. 521.

Boleichthys eos Jordan, in Nelson, Bull. Ill. Mus. Nat. Hist., 1, 1876, p. 34; Jordan and Copeland, in Jordan, Proc. Acad. Nat. Sci. Phila., 1877, p. 46; Jordan, Bull. Ill. Mus. Nat. Hist., 2, 1878, p. 42; Man. Vert., Ed. 2, 1878, p. 228; Hoy, Geol. Wiss., Surv. 1873-1879, 1, 1883, p. 428; Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 1, 1896, p. 1102 (in footnote key).

Poecilichthys eos Jordan and Gilbert, Bull. U. S. Nat. Mus., 7, 1884, p. 209; Gilbert, Proc. U. S. Nat. Mus., 7, 1884, p. 209; Jordan, *ibidem*, 1884, p. 478.

Etheostoma fusiforme eos Jordan, Rept. U. S. Comm. Fish., 1885, p. 869; Bull. U. S. Fish Comm., 1888 (1889), p. 118; Bollman, *ibidem*, 1888 (1890), p. 224.

Etheostoma eos Forbes, Rept. Ill. St. Fish Comm., 1884, p. 64; Evermann and Jenkins, Proc. U. S. Nat. Mus., 11, 1888, p. 52; Eigenmann and Beeson, Proc. Ind. Acad. Sci., 1893 (1894), p. 105; Kirsch, Bull. U. S. Fish Comm., 1894 (1895), p. 331; Eigenmann, Proc. Ind. Acad. Sci., 1895 (1896), p. 257; Blatchley and Ashley, Ann. Rept. Ind. Dept. Geol. Nat. Res., 25, 1900 (1901), pp. 99, 142, 147 and 288; Jordan, Man. Vert., Ed. 9, 1904, p. 134.

Boleichthys fusiformis eos Bean, Bull. N. Y. St. Mus., 60, 1903, p. 521.

Poecilichthys borealis Jordan, Proc. U. S. Nat. Mus., 7, 1884, p. 477.

Etheostoma boreale Boulenger, Cat. Fishes Brit. Mus., Ed. 2, 1, 1895, p. 78; Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 1, 1896, p. 1082; Meek, Publ. Field Mus., (Zool.) 1, 1899, p. 310; *ibidem*, 3, 1902, p. 119; Meek and Clark, *ibidem*, 1902, pp. 132 and 138; Evermann, Bull. U. S. Fish Comm., 21, 1901 (1902), p. 96; Evermann and Kendall, *ibidem*, 1902, p. 240; Bean, Bull. N. Y. St. Mus., 60, 1903, p. 744; Jordan, Man. Vert., Ed. 9, 1904, p. 132; Evermann and Goldsborough, Proc. Biol. Soc. Wash., 20, 1907, p. 109; Cockerell, Bull. U. S. Bur. Fish., 32, 1912 (1913), p. 156.

Etheostoma iowae Jordan and Meek, Proc. U. S. Nat. Mus., 8, 1885, p. 10; Jordan, Man. Vert., Ed. 5, 1888, p. 133; Meek, Bull. U. S. Fish Comm., 10, 1890 (1892), pp. 226 and 236; Eigenmann and Eigenmann, Am. Nat., 1892, p. 962; Eigenmann, Bull. U. S. Fish Comm., 14, 1894, p. 117; Boulenger, Cat. Fishes Brit. Mus., Ed. 2, 1, 1895, p. 72 (name altered to *ioae*); Woolman, Rept. U. S. Comm. Fish., 1893 (1896), pp. 358, 360 and 373; Evermann and Cox, *ibidem*, 1894 (1896), p. 421; Cox, *ibidem*, 1894 (1896), pp. 610 and 613; Eigenmann, Proc. Ind. Acad. Sci., 1895 (1896), p. 257; Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 1, 1896, p. 1083; pt. 4, 1900, p. 3270, pl. 174, fig. 460; Blatchley and Ashley, Ann. Rept. Ind. Dept. Geol. Nat. Res., 25, 1900 (1901), pp. 177, 191 and 197; Ramsey, *ibidem*, p. 211; Blatchley, *ibidem*, p. 257; Large, Rept. Ill. St. Fish Comm., 1900-1902 (1903), p. 28; Juday, Univ. Colo. Studies, 2, 1903, p. 113; Jordan, Man. Vert., Ed. 9, 1904, p. 133; Juday, Bull. U. S.

Fish Comm., 1904 (1905), p. 227; Evermann and Goldsborough, Proc. Biol. Soc. Wash., 20, 1907, p. 109; Hankinson, Rept. Biol. Surv. Mich., in Rept. Geol. Surv., 1907 (1908), pp. 178-181, 184, 188, 189, 191, 192, 199, 216, 239; Cockerell, Univ. Colo. Studies, 5, 1908, p. 178, fig. 8; Forbes and Richardson, Fishes of Illinois, Ed. 1, 1908, p. 306, col. pl.; Evermann and Clark, Proc. Biol. Soc. Wash., 23, 1910, p. 87; Hankinson, Trans. Am. Fish. Soc., 1910, p. 205; Meek and Hildebrand, Publ. Field Mus., (Zool.) 7, 1910, p. 328; Leathers, Publ. Mich. Geol. & Biol. Surv., 4, 1911, pp. 247, 254 (see also Ruthven, *l. c.*, pp. 25, 27); Cockerell, Bull. U. S. Bur. Fish., 32, 1912 (1913), p. 156; Ellis, Univ. Colo. Studies, 11, 1914, p. 108; Reighard, Bull. U. S. Bur. Fish., 33, 1913 (1915), pp. 239 and 247; Hankinson, Publ. Mich. Geol. & Biol. Surv., 20, 1915, pp. 27, 32; Adams and Hankinson, Trans. Am. Fish. Soc., 1916, p. 168; Colbert, Publ. Mich. Geol. and Biol. Surv., 20, 1916, p. 32; Jaffa, Copeia, No. 47, 1917, p. 71; Baker, Tech. Publ. N. Y. St. Coll. For., No. 9, 1918, p. 221; Surber, App. to Bien. Rep. St. Game & Fish Comm. Minn., 1920, p. 78; Forbes and Richardson, Fishes of Illinois, Ed. 2, 1920, p. 306, col. pl.; Evermann and Clark, Lake Maxinkuckee, 1920, p. 442, pl. 42; Clemens, Dymond and Bigelow, Univ. Toronto Studies, (Biol.) 25, 1924, p. 143.

Poecilichthys iowae Hankinson, Copeia, No. 115, 1923, p. 33; Bull. Buff. Soc. Nat. Sci., 13, 1924, p. 87.

Etheostoma quappelle Eigenmann and Eigenmann, Am. Nat., 1892, p. 963; Eigenmann, Bull. U. S. Fish Comm., 14, 1894, p. 117; Boulenger, Cat. Fishes Brit. Mus., Ed. 2, 1, 1895, p. 74 (spelling altered to *quappellae*).

Etheostoma fusiforme Hay, Ann. Rept. Ind. Dept. Geol. & Nat. Res., 19, 1894, p. 282 (in part); Osburn, Univ. Bull. Ohio St. Univ. (5), No. 20, 1901, p. 102; Evermann, Bull. U. S. Fish Comm., 21, 1901 (1902), p. 96; Michael, Bull. Mich. Fish Comm., No. 8, 1906, p. 34; Turner, Ohio Jour. Sci., 20, 1920, p. 142; *ibidem*, 22, 1921, p. 50 (L. Erie record). (Not *Boleosoma fusiformis* Girard.)

Boleichthys fusiformis Leathers, Mich. Geol. & Biol. Surv., 4, 1911, pp. 247, 254 (see also Ruthven, *l. c.*, pp. 25, 27). (Not of Girard.)

Etheostoma aubeenaubei Evermann, Rep. U. S. Comm. Fish., 1899 (1900), p. 367, pl. 17; Blatchley, Ann. Rep. Ind. Dept. Geol. Nat. Res., 25, 1900 (1901), p. 257.

Etheostoma iowae aubeenaubei Evermann and Clark, Lake Maxinkuckee, 1920, p. 444, fig.

Etheostoma hildebrandti Evermann and Clark, Proc. Biol. Soc. Wash., 23, 1910, p. 87.

Most of the material forming the basis of the preceding synonymy, including the types of most of the nominal species has been examined. In determining this synonymy of the species currently known as *Etheostoma* or *Poecilichthys iowae*, and in disentangling it from the synonymy of "*Boleichthys*" *fusiformis*, the following conclusions have been reached:

1. The types of *Boleichthys exilis* Girard are conspecific with those of *Etheostoma iowae*.

2. In the type specimens the cheeks and opercles are both scaled, contrary to the statement in the original description.

3. Since *exilis* is the type species of *Boleichthys*, the latter name is no longer available for the group typified by *Boleosoma fusiformis* Girard.

4. In the division of the genera of Etheostominae here followed, *Boleichthys* becomes a synonym of *Poecilichthys*.

5. The name *Boleichthys* would become available for a subgenus (or genus), if this should be regarded as separable from *Oligocephalus* Girard (*lepidus*). Otherwise the latter name will take precedence.

6. The species *Boleosoma fusiformis* Girard, thus left without a distinctive generic name, may be provisionally referred to the genus *Copelandellus* Jordan and Evermann (*quiescens*).⁹⁷

7. The association or confusion of *exilis* with *fusiformis*, either as related species, subspecies or synonym, is therefore without warrant.

8. All of the records of *exilis*, so far as could be determined, refer to the present species.

9. The types of *Boleichthys warreni* Girard are lost, as Jordan has stated.

10. Nevertheless it is evident that *warreni* is a synonym of *exilis*.

11. Jordan should be quoted as the author of *Boleichthys eos*, since Nelson, in first publishing a recognizable account, accredits the species to him.

12. The types of *eos* are conspecific with those of *B. exilis* and of *E. iowae*.

13. The association or confusion of *B. eos* with *C. fusiformis*, either as related species, subspecies or synonym, is therefore without warrant.

14. The confusion of the present species with *C. fusiformis* lies at the basis of the current misconception that *fusiformis* is an unusually variable species.

15. All of the records of *eos*, so far as could be determined, refer to the present species.

16. The types of *Poecilichthys borealis* also represent the present species.

17. The subgenus *Nivicola* Jordan and Evermann, based on *borealis*, is therefore a strict synonym of *Boleichthys*.

18. The subsequent records of *Etheostoma boreale* were also based on *P. exilis*.

19. *Etheostoma iowae* was therefore the fifth name to be applied to the present species.

20. Much of the material which has been recorded as *iowae*, including practically all from the Great Lakes region, has been re-examined and found to be correctly determined.

⁹⁷ Palmer and Wright (Proc. Iowa Acad. Sci., 27, 1910) even refer *Copelandellus quiescens* to the synonymy of *Boleichthys fusiformis*, claiming that the supposedly distinctive feature (the scaly top of head in *Copelandellus*) does not hold. While this character is indeed very variable in *C. quiescens*, and the two forms are very similar otherwise, and possibly may intergrade, they are certainly distinct.

21. *Etheostoma quappelle* Eigenmann and Eigenmann is clearly a synonym of *exilis*.

22. The records of *fusiforme* from the Great Lakes drainage, as listed in the synonymy, were doubtless all based on specimens of *exilis*, nearly all having been re-examined.

23. *Etheostoma aubeenaubei* Evermann is likewise a strict synonym of *exilis*. In most of the types the cheeks are fairly well scaled. The squamation of the cheek is often more or less incomplete in *exilis*, but the variation is either purely individual, or local and sporadic.

24. *Etheostoma hildebrandti* is based on a slight local variation in which the squamation (if correctly described) is slightly more complete than usual.

Genus 77. CATONOTUS Agassiz

As stated above, under Poecilichthys, and as indicated in the key to the genera, *Catonotus* should apparently be recognized as a distinct genus.

132. *Catonotus flabellaris* Rafinesque

Fan-tailed darter

Two subspecies of *flabellaris* may be distinguished in the Great Lakes region. West of Lake Michigan the color pattern consists of stronger and more definite longitudinal lines (form *lineolatus*) than it does to the east of that lake (typical *flabellaris*). In Illinois the two types doubtless meet and probably intergrade, since Forbes and Richardson did not separate them.

132a. *Catonotus flabellaris flabellaris* Rafinesque

132b. *Catonotus flabellaris lineolatus* Agassiz

Genus 78. MICROPERCA Putnam

133. *Microperca punctulata* Putnam

Least darter

Genus 79. ETHEOSTOMA Rafinesque

As explained under the heading of Poecilichthys, the generic name *Etheostoma* must be transferred from the group with which it has lately been associated, to the one hitherto known as *Diplesion*, which name it replaces.

134. *Etheostoma blennioides* Rafinesque

Green-side darter

This species is certainly one of the most extremely specialized of the darters, and may well take the terminal position in the classification of the group.

Family 23. CENTRARCHIDAE

As Jordan has indicated in his Classification of Fishes (1923, p. 189) it is not necessary to discard this family name in favor of Eucentrarchidae or Micropteridae.

KEY TO THE GENERA

- a¹.—Body elongate, bass-shaped (depth about one-third length; in rare cases, the body is rather deep). Scales rather small (about 60 to 85). Pyloric caeca 11 or more. Anal spines very small, the longest less than half as high as longest soft ray; the last spine bound down rather tightly to the soft rays. Precaudal vertebrae 15 (rarely 16).—Anal spines 3 (very rarely 2 or 4). Anal fin less than half as long as dorsal. Opercle bilobed. Supplementary maxillary well developed. (Subfamily Micropterinae)
- b¹.—Pyloric caeca typically unbranched (a single caecum rarely branched). Preopercle scaleless; fins better scaled. Dorsal fin shallowly emarginate, the shortest spine more than two-thirds as long as longest, the top of the spinous portion being gently rounded.—Dorsal soft rays 14 (rarely 13 or 15); caudal vertebrae 17 (rarely 16); scales on cheek much reduced in size; mouth of moderate size (the upper jaw extending beyond middle of pupil but not to hind margin of eye). Color pattern consisting chiefly of short vertical bars (in Great Lakes species).....80. *Micropterus*
- b².—Most of pyloric caeca in any one fish always bifid. Preopercle partially scaled; dorsal and anal scaled only at very base. Dorsal fin almost divided, the outline of the spinous portion being sharply curved. Dorsal soft rays 12 or 13. Caudal vertebrae 17 or 18. Scales on cheek only moderately reduced in size. Mouth large (upper jaw extending beyond hind margin of eye in adult). Color pattern consisting chiefly of a dark lateral streak.....81. *Aplites*
- a².—Body chubbier, sunfish-shaped (depth ordinarily about half or two-fifths the length). Scales of moderate size (35 to 55). Pyloric caeca 5 to 11. Anal spines larger and stronger, the longest more than half as high as soft fin; the last well separated by membrane from first soft ray. Precaudal vertebrae 11 to 14.—Pyloric caeca typically unbranched. Dorsal fin at most shallowly emarginate. (Subfamily Lepominae)
- c¹.—Anal spines 3 (very rarely 4). Anal fin less than half as long as dorsal. Precaudal vertebrae typically 12 (rarely 11 or 13). Operculum rounded.—Dorsal spines 9 to 12; dorsal soft rays 9 to 13; anal soft rays 8 to 12.
- d¹.—Tongue, hyoid and pterygoids toothed. Preorbital serrate. Mouth large, the upper jaw extending beyond middle of eye.—Supplementary maxillary well developed. Lower pharyngeal narrow, with conic teeth. Operculum scarcely produced, with stiff margin. Ctenii of scales well developed. Caudal vertebrae typically 17. Gill-rakers well developed.....82. *Chaenobryttus*

- d².—Tongue, hyoid and pterygoids toothless. Preorbital strictly smooth. Mouth smaller, the upper jaw not extending to middle of eye (except sometimes *Apomotis*).
- e¹.—Upper jaw extending nearly to (rarely a little beyond) middle of eye. Supplementary maxillary bone well developed. Ctenii of scales obsolescent. Anal spines low, little more than half as high as soft fin. Air-bladder scarcely bilobed behind, extending into the first caudal segment only. Lower pharyngeals narrow, with conic teeth. Operculum scarcely produced, with stiff margin. Caudal vertebrae typically 17. Gill-rakers well developed (about half as long as eye).....83. *Apomotis*
- e².—Upper jaw not nearly reaching middle of eye. Supplementary maxillary variously reduced or absent. Ctenii of scales well developed. Anal spines higher, more than two-thirds as high as soft portion of fin. Air-bladder strongly bilobed behind, extending into 3 or 4 caudal segments on each side of the vertebral column.
- f¹.—Lower pharyngeals narrow (the width about one-third the length of the toothed portion); the outer margin straight or nearly so; the teeth mostly long, slender, more or less conic. Operculum more or less produced as a flap, becoming very thin and flexible toward the margin; membranous border without a distinct red spot.
- g¹.—Pectoral fins pointed; about as long as head. Dorsal spines typically high. Caudal vertebrae typically 17. Gill-rakers well developed, about one-third as long as eye.....84. *Helioperca*
- g².—Pectoral fins rounded; much shorter than head. Dorsal spines typically low. Caudal vertebrae typically 18. Gill-rakers rudimentary, soft, less than one-sixth as long as eye.....85. *Xenotis*
- f².—Lower pharyngeals broad (the width about half the length of the toothed portion); the outer margin strongly gibbous; the teeth mostly short, broad molars. Operculum scarcely produced; the margin stiff, contrasting sharply with the membranous border, which always bears a conspicuous red spot.—Caudal vertebrae typically 18. Gill-rakers rudimentary86. *Eupomotis*
- c².—Anal spines 5 to 7. Anal fin more than half as long as dorsal. Precaudal vertebrae typically 13. Opercular flap bilobed.—Tongue, hyoid and pterygoids toothed. Mouth large. Supplementary maxillary well developed.
- h¹.—Anal fin distinctly shorter than dorsal. Dorsal spines 10 to 12, usually 11; dorsal soft rays only 9 to 11; anal soft rays 10 or 11. Preopercle with serrae obsolescent, and confined to angle; preorbital smooth. Gill-rakers moderately developed, rather thick; fewer than 10 (not counting rudiments). Air-bladder rather shallowly and bluntly bilobed behind. Several anterior interhaemals closely approximated, almost in contact. End of kidney and ureter extended around end of air-bladder.....87. *Ambloplites*
- h².—Anal fin about as long as dorsal. Dorsal spines 5 to 8 (very rarely 9 or 10); dorsal soft rays decidedly more numerous than the spines (13 to 16); anal soft rays 16 to 19. Preopercle strongly serrate on entire lower margin as well as around angle; preorbital more or less strongly serrate. Gill-rakers long and slender; more than 20. Air-bladder deeply and sharply bilobed behind. Anterior interhaemals widely separated. End of kidney and ureter diverted downward directly between first two interhaemals88. *Pomoxis*

Genus 80. MICROPTERUS Lacépède

This genus in many respects appears to be the most primitive in the family.

135. *Micropterus dolomieu* Lacépède

Small-mouth black bass

Genus 81. APLITES Rafinesque

In view of the fundamental difference in the structure of the pyloric caeca,⁹⁸ in the form of the dorsal fin and in other characters, the two northern species of black bass can hardly be maintained in the same genus.

136. *Aplites salmoides* Rafinesque

Large-mouth black bass; green bass

Genus 82. CHAENOBRYTTUS Gill

137. *Chaenobryttus gulosus* Cuvier and Valenciennes

Warmouth bass; mud bass

Genus 83. APOMOTIS Rafinesque

McKay,⁹⁹ Bollman,¹⁰⁰ Richardson¹⁰¹ and Bean and Weed,¹⁰² have each thought it necessary to unite with *Lepomis* the several genera of "sun-fishes" here adopted. Each have claimed that the characters used are too unstable and variable to permit of generic separation within the group.¹⁰³ It seems evident now, however, that these genera should be recognized, on the basis partially of lately discovered or utilized characters, and partially of the old characters. The supposed intergradation of characters, particularly those of the pharyngeals, is chiefly caused by the hybridization of distinct species. I have already introduced evidence which seems to show conclusively that *Lepomis* or *Eupomotis euryorus* is not a valid species, but a hybrid between *cyanellus* and *gibbosus*.¹⁰⁴ We have now taken in the Great Lakes region specimens which appear to be hybrids of five combinations:

⁹⁸ The pyloric caeca of various Centrarchidae have been critically studied by Johnson (Trans. Wis. Acad. Sci., 15, 1907, p. 713-732).

⁹⁹ McKay, Proc. U. S. Nat. Mus., 4, 1881, p. 88-92.

¹⁰⁰ Bollman, Rept. U. S. Comm. Fish., 1888 (1891), p. 565-576.

¹⁰¹ Richardson, Bull. Ill. St. Lab. Nat. Hist., 7, 1904, p. 27-35.

¹⁰² Bean and Weed, Proc. U. S. Nat. Mus., 40, 1911, p. 369-376.

¹⁰³ Richardson alone of the writers quoted accepted *Eupomotis* as a valid genus.

¹⁰⁴ See particularly: Hubbs, Aquatic Life, 5, 1920, p. 101-103.

Apomotis cyanellus × *Eupomotis gibbosus*
Apomotis cyanellus × *Xenotis megalotis peltastes*
Eupomotis gibbosus × *Helioperca incisor*
Eupomotis gibbosus × *Xenotis megalotis peltastes*
Helioperca incisor × *Chaenobryttus gulosus*

138. *Apomotis cyanellus* Rafinesque

Green sunfish; blue-spotted sunfish

Genus 84. HELIOPERCA

The names *Helioperca* and *Erichaeta* were both proposed apparently for the first time, in Klippart's First Report of the Ohio Fish Commission (1877). The name *Erichaeta* was a manuscript name of Jordan's, later altered to *Helioperca*; the latter name has been used by all subsequent authors.

139. *Helioperca incisor* Cuvier and Valenciennes

Blue-gill; roach; bream

I concur in the current view that the name *palladus* (or *pallidus*) has been erroneously associated with this species.

Genus 85. XENOTIS Jordan

The question of the validity of the several genera of sunfishes here adopted is discussed above. The characters of each genus are indicated in the key.

140. *Xenotis megalotis peltastes* Cope

Long-ear sunfish

Although by no means free from variation within the region, *Xenotis megalotis* is represented in the Great Lakes territory by a small form with the opercular flap of moderate development and broadly margined with red. It is the northern dwarffish variety into which more typical *megalotis* grades in northern Illinois.¹⁰⁵ Abundant topotypic material from the Huron River, in Michigan, shows that the name *peltastes* is applicable to this subspecies.

Genus 86. EUPOMOTIS Gill and Jordan

141. *Eupomotis gibbosus* Linnaeus

Sunfish; pumpkin-seed

Genus 87. AMBLOPLITES Rafinesque

142. *Ambloplites rupestris* Rafinesque

Rock bass; red-eye

¹⁰⁵ Forbes and Richardson, *Fishes of Illinois*, 1908, p. 255.

Genus 88. POMOXIS Rafinesque

KEY TO THE SPECIES

- a¹.—Dorsal spines 6 (occasionally 5, rarely 7). Caudal vertebrae usually 18. Origin of dorsal farther back, and mouth less oblique, so that a line perpendicular to upper jaw passes in front of first dorsal spine. Dark markings largely arranged to form vertical bands143. *Pomoxis annularis*
- a².—Dorsal spines 7 (occasionally 8; rarely 6, 9 or 10). Caudal vertebrae usually 19. Origin of dorsal farther forward, and mouth more oblique, so that a line perpendicular to upper jaw passes behind third dorsal spine. Dark markings not forming bands144. *Pomoxis sparoides*

143. *Pomoxis annularis* Rafinesque

White crappie

144. *Pomoxis sparoides* Lacépède

Black crappie; calico bass

Family 24. ATHERINIDAE

Genus 89. LABIDESTHES Cope

145. *Labidesthes sicculus* Cope

Brook silverside; skipjack

Family 25. SCIAENIDAE

Genus 90. APLODINOTUS Rafinesque

146. *Aplodinotus grunniens* Rafinesque

Sheepshead; fresh-water drum

Family 26. COTTIDAE

KEY TO THE GENERA

- a¹.—Gill-membranes free from isthmus, and uniting at an acute angle below eye. Bones of head thinner, cavernous. Second preopercular spine conspicuous, directed backward. Scales when present represented by small round plates. Soft rays, especially of second dorsal, elongated and spinous in males. Dorsal fins widely separated91. *Trigloopsis*
- a².—Gill-membranes attached to side of wide isthmus far behind eye, not even forming a fold. Bones of head thicker, not cavernous. Second preopercular spine concealed by skin; directed downward. Scales when present represented by prickles. Soft rays not elongated or spiny in males. Dorsal fins scarcely separated.....92. *Cottus*

Genus 91. TRIGLOPSIS Girard

It is difficult to distinguish between some specimens of *Trigloopsis* from the Great Lakes and examples of certain river forms of the Arctic sculpin

commonly called *Oncocottus quadricornis*. In view of the intergradation of characters, it appears quite impossible to maintain their generic separation. *Trigloopsis*, being the older name, will apply to the combined group.

147. *Trigloopsis thompsoni* Girard

Deep-water sculpin; cockatash

We have good series of this interesting relict fish from all of the Great Lakes but Erie. Although wide variation exists, it seems quite impossible to follow Jordan and Thompson¹⁰⁶ in recognizing more than one species.

Genus 92. COTTUS Linnaeus

KEY TO THE SPECIES AND SUBSPECIES

- a¹.—Preopercular spine short and little curved. Head broadly rounded, semioval as seen from above. Lateral line normally terminating below base of second dorsal. Body never wholly prickly.
- b¹.—Pelvic rays typically I,4 (very rarely I,3 or I,5, on one side only). Palatine teeth normally present. Colors (not intensity of pigment) less variable and skin less slimy in life (148. *C. bairdii*).
- c¹.—Distance between tip of snout and anus when measured backward extending to a point nearer base than end of caudal (except in some very large specimens from northern end of range).^{106a} Body usually rather robust. Dark bars definitely developed148a. *C. bairdii bairdii*
- c².—Distance between tip of snout and anus when measured backward extending to a point nearer end than base of caudal. Body averaging slenderer. Dark bars less distinctly developed148b. *C. bairdii kumlieni*
- b².—Pelvic rays I,3, or the fourth soft ray variously reduced on one or both sides. Palatine teeth typically not developed (sometimes present). Colors more variable, running into rather definite greenish and reddish phases; dark bars usually much broken up. Skin distinctly slimier in life.....149. *C. cognatus*
- a².—Preopercular spine long and spirally curved. Head subspatulate in outline when viewed from above. Lateral line complete. Pelvic rays 1, 4. Palatine teeth undeveloped. Body sometimes wholly prickly150. *C. ricei*

Upon recently finding and examining the types of several nominal species of *Cottus*, in the National Museum, it became evident that Girard and others inaccurately described and figured several of them. Largely on this account, I employed several names erroneously in my revision of the Michigan species.¹⁰⁷ The name *bairdii* now replaces *meridionalis*; the form called *bairdii* in 1919 becomes *kumlieni* (a form inaccurately referred to "Uranidea" by authors). The species earlier called *gracilis* and *franklinii* are apparently inseparable; both are now referred to the synonymy of *Cottus cognatus* Richardson.

¹⁰⁶ Proc. U. S. Nat. Mus., 38, 1910, pp. 75-78.

^{106a} If the body has been at all distorted in preservation, care must be taken to force it into normal form before this measurement is made.

¹⁰⁷ Hubbs, Occ. Pap. Mus. Zool., Univ. Mich., No. 65, 1919, pp. 1-9.

148. *Cottus bairdii* Girard

This species is represented in the Great Lakes region by two distinct subspecies.

148a. *Cottus bairdii bairdii* Girard

Muddler; miller's thumb; sculpin; bullhead

In my 1919 review, the name *bairdii* was used for another subspecies, the lake representative properly called *Cottus bairdii kumlieni*. The basis of this error was inaccuracies in Girard's figures of *bairdii* and *wilsonii*, which showed the characters of the lake species. I have since located some of Girard's types of these nominal species in the National Museum, and have found that they represent the stream form which we have been calling *C. meridionalis*. Since the names *bairdii* and *meridionalis* were first proposed in the same paper, and since *bairdii* has been the name chosen for the combined group by all authors who have regarded the species as identical, the name *bairdii* has precedence over *meridionalis*. The reasons for discarding the name *ictalops* have already been cited (1919).

Large numbers of specimens of this subspecies from North Carolina, Georgia, Alabama, Arkansas and Missouri, from the Potomac and the upper Susquehanna basins, from the Ohio basin in Tennessee, West Virginia, Pennsylvania, New York, Ohio and Indiana, from Lake Erie, and from streams and smaller lakes throughout the Great Lakes region, and from Quebec have been examined. Throughout this wide area the species is fairly uniform in its characters. A few large specimens from the northern end of the range, however, resemble *kumlieni*, and intergradation between the two subspecies takes place at the mouths of certain streams in Wisconsin and Michigan.

148b. *Cottus bairdii kumlieni* Hoy

Great Lakes sculpin

Deceived by Girard's erroneous figures, I formerly (1919) transferred the name *bairdii* to this form. That name, however, properly belongs with the preceding subspecies.

This subspecies, as shown in 1919 (*l.c.*), represents *bairdii* in the waters of the Great Lakes, while tributary streams are inhabited by the southern form. The type of *kumlieni*, examined in the National Museum, is clearly the form erroneously called *bairdii* in 1919. It has four well developed soft rays in each pelvic fin. The supposed projection of the lower jaw in the type specimen is the result of injury. The invariable association of the name *kumlieni* with the Uranidea group (that is, with *C. cognatus*) has been strictly improper.

149. *Cottus cognatus* Richardson

Muddler; miller's thumb; northern sculpin

It is no longer possible to separate the Great Lakes form called *franklinii* from the northern stream sculpin usually called *gracilis*. Furthermore both of these nominal species appear to be synonymous with *Cottus cognatus* Richardson of the far north.

Of this wide-ranging and variable species series of specimens from Lake Bennett in Alaska; Slave and Athabasca lakes in northern Canada; various localities in Labrador; Lakes Nipigon, Superior, Michigan, Huron and Ontario, and tributary waters of each, and many Atlantic Coast streams from Maine to West Virginia have been studied. The specimens examined include topotypes of the various nominal species in the long synonymy of *C. cognatus*.

Although local differences in fin ray number, proportions and colorations are apparent, I have been unable to define or delimit any of the nominal species as different from *cognatus*, the first named. The anal rays vary from 9 to 13, counting the last as branched, the most frequent number being 10, 11 or 12, according to locality. In general about one specimen in four has the innermost pelvic ray of more than rudimentary size, but this proportion varies with locality. In some places the rays are almost as frequently I,4 as I,3; elsewhere, very seldom I,4.

In certain cold trout streams in Michigan *C. b. bairdii* and *C. cognatus* occur together. Here not every specimen can be identified with positive assurance, but on account of the excessive variation exhibited by each species, I can not be sure whether these intermediates are simply variants, or hybrids. It is clear, however, that the two species do not regularly intergrade.

150. *Cottus ricei* Nelson

Rice sculpin

Specimens of this rare and peculiar fish from Lake Nipigon and from Hudson Bay have been examined. To the synonymy as given in 1919 (*l.c.*) there should apparently be added *Cottus onychus* Eigenmann and Eigenmann, from the Saskatchewan basin. The type of *onychus* has not, however, been found.

Family 27. GASTEROSTIDAE

KEY TO THE GENERA

- a¹.—Gill-membranes confluent, forming a broad free fold across isthmus. Lateral plates wholly absent. Pelvic spines not distinctly serrulate. Dorsal spines 5 to 11.
- b¹.—Dorsal spines 5 or 6, scarcely divergent. Pelvic plate sharply ridged. Tail without trace of keel; the caudal peduncle deeper than wide, and moderately robust. Caudal fin rounded93. *Eucalia*

- b².—Dorsal spines 8 to 11, strongly divergent. Pelvic plate concave. Tail with a sharp lateral keel; the caudal peduncle much wider than deep, very attenuate. Caudal fin lunate94. *Pungitius*
- a².—Gill-membranes united medially to isthmus, and not forming a free fold. Lateral plates developed, in part at least. Pelvic spines normally 3, not divergent.—Pelvic plate flat. Tail keeled; caudal peduncle rather robust. Caudal fin lunate.....95. *Gasterosteus*

Genus 93. EUCALIA Jordan

151. *Eucalia inconstans* Kirtland

Brook stickleback

This species is excessively variable, and possibly may be divisible into subspecies. At present, however, this can not be done. It is evident that the subspecies *pygmaea*¹⁰⁸ and *cayuga* can not be maintained, at least as currently delimited and described.

Genus 94. PUNGITIUS Coste

This name, as Gill, Kendall and Jordan¹⁰⁹ have shown, should replace *Pygosteus* Brevoort. I have examined Coste's paper, and agree with the authors cited that the name *Pungitius* was properly proposed.

152. *Pungitius pungitius* Linnaeus

Nine-spined stickleback

Genus 95. GASTEROSTEUS Linnaeus

153. *Gasterosteus aculeatus cuvieri* Girard

Stickleback

This partially mailed derivative of *Gasterosteus aculeatus aculeatus* occurs in Lake Ontario.

The fully plated marine *Gasterosteus* of the Atlantic Coast of North America, toward the northward especially, is scarcely separable from the European form, typical *Gasterosteus aculeatus aculeatus*. Toward the southward it variously approaches and here and there intergrades with the partially armored fresh-water form, *G. a. cuvieri* (= *atkinsii*). The latter usually differs from the analagous types of Europe and the Pacific in the slenderer body and longer fin spines.

Family 28. GADIDAE

Genus 96. LOTA Oken

154. *Lota maculosa* Le Sueur

Lawyer; burbot; ling

¹⁰⁸ See Wagner, Science, 32, 1910, p. 28.¹⁰⁹ A Classification of Fishes, 1923, p. 174.

CARL L. HUBBS

PLATE I

The three species of *Nocomis*

Figure 1 (top). *Nocomis biguttatus*: a breeding male caught by Metzelaar and Hubbs in the East Branch of the Au Sable River, Michigan, on June 23, 1924.

Figure 2. *Nocomis leptcephalus*: a nuptial male from South Carolina, in the collections of the National Museum; most of the tubercles have been lost, but their size and position are indicated by the scars.

Figure 3. *Nocomis micropogon*: a nuptial male from the Huron River at Ann Arbor, Michigan.

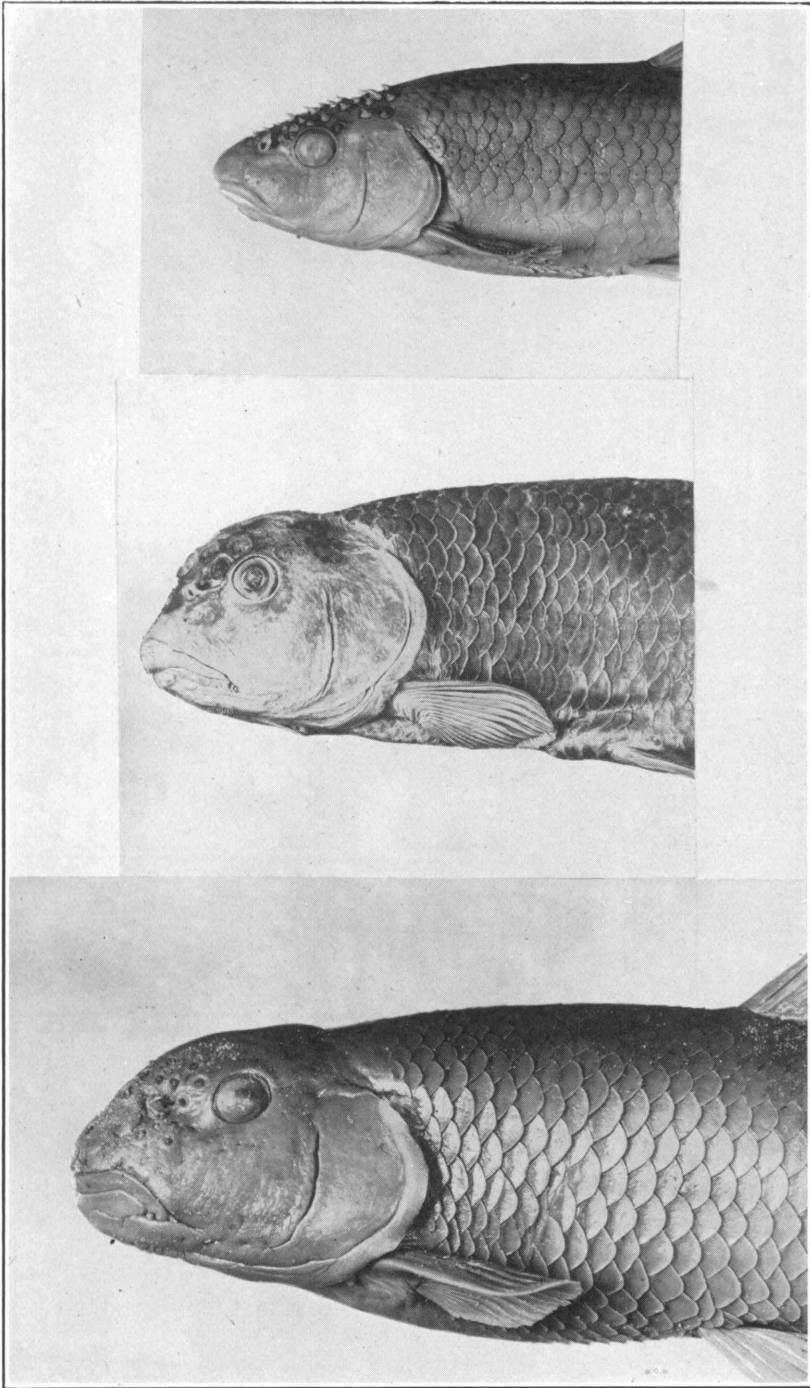


PLATE I. THE THREE SPECIES OF NOCOMIS

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PLATE II

The three species of *Nocomis*

Figure 1 (top). *Nocomis micropogon*: half-grown specimen from Upper South Branch of Thunder Bay River, Michigan.

Figure 2. *Nocomis leptcephalus*: half-grown specimen from near South Hill, South Carolina.

Figure 3. *Nocomis biguttatus*: half-grown specimen from East Branch of Au Sable River, Michigan.

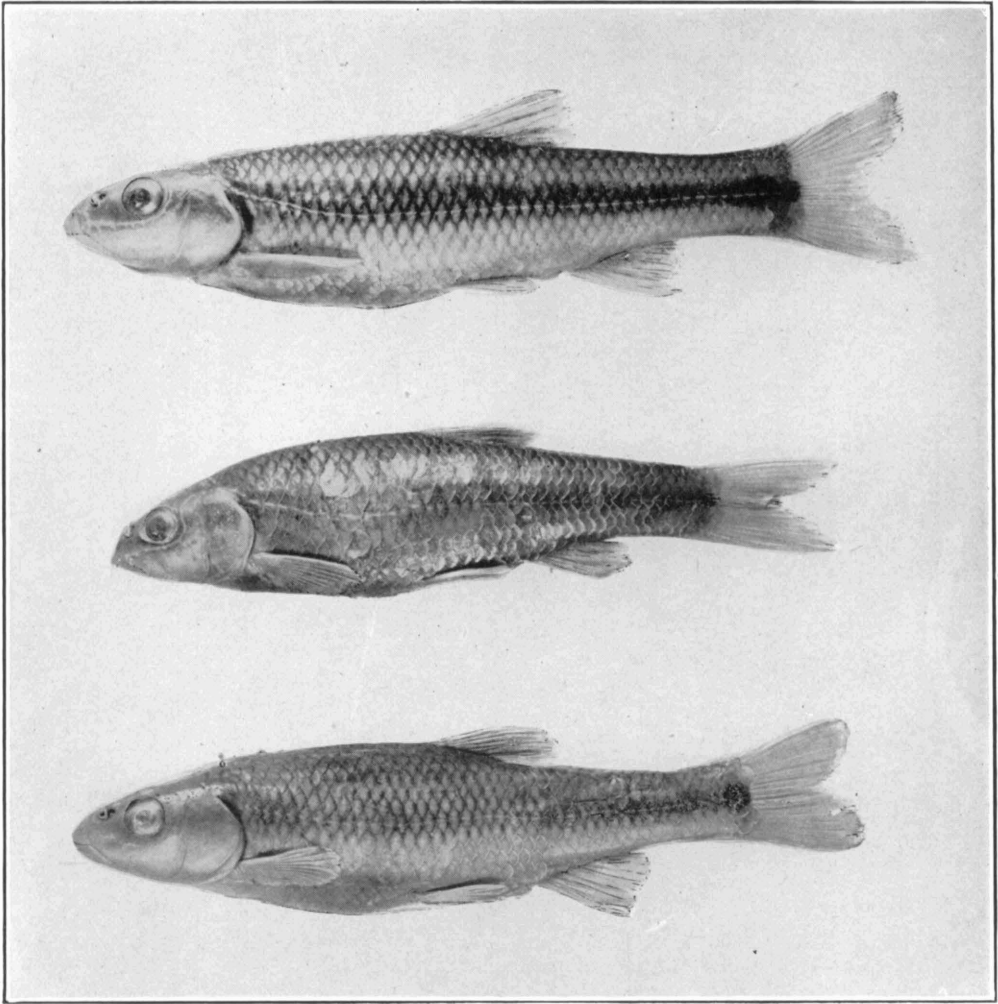


PLATE II. THE THREE SPECIES OF NOCOMIS

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PLATE III

Two subspecies of *Notropis heterodon*

Figure 1 (top). *Notropis heterodon heterodon*: adult from Au Sable River, Ioseo County, Michigan.

Figure 2. *Notropis heterodon richardsoni*: an adult paratype from the type-locality.

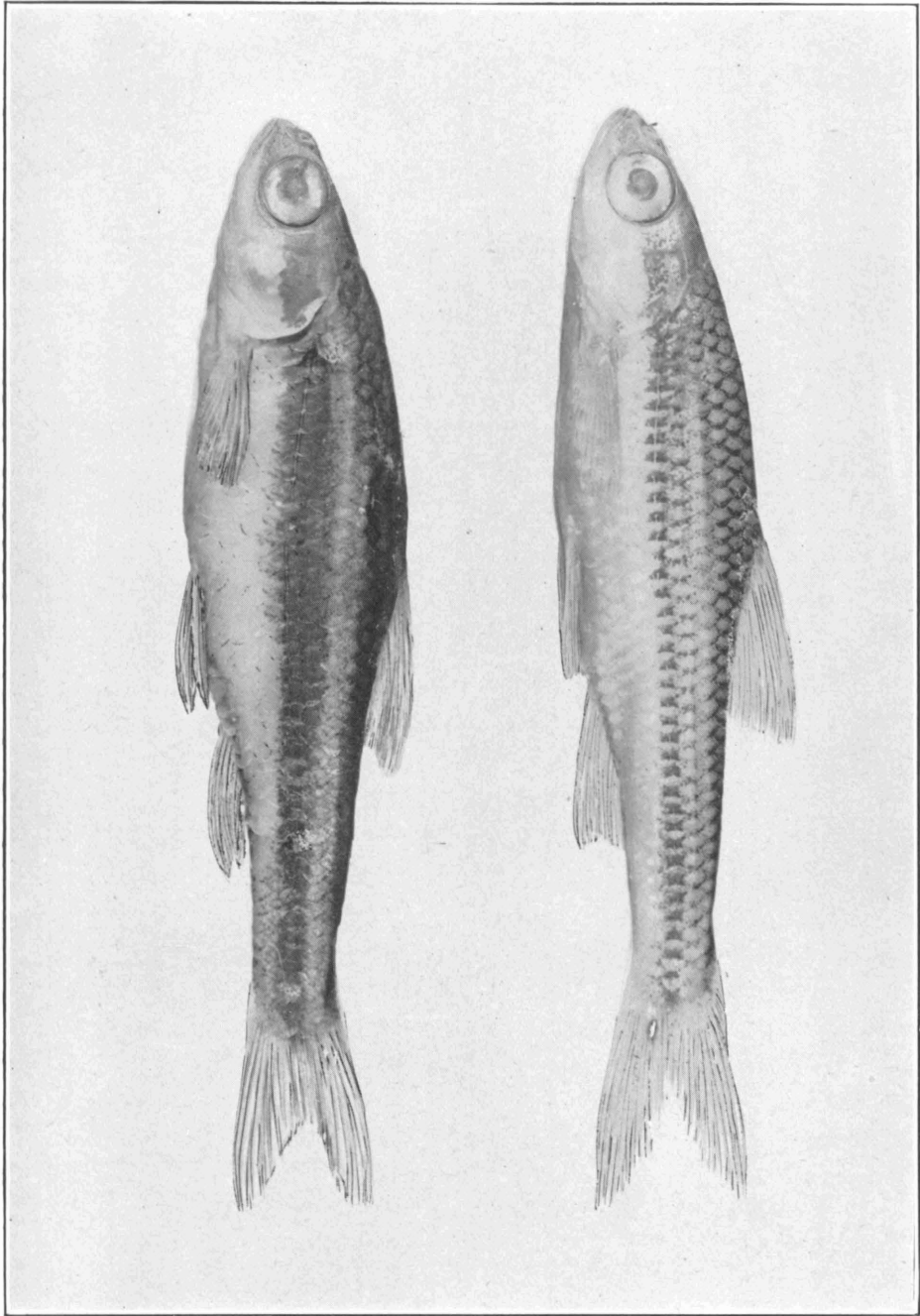


PLATE III. TWO SUBSPECIES OF NOTROPIS HETERODON

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PLATE IV

Yellow pike and blue pike of Lake Erie

Figure 1 (upper figure). *Stizostedion vitreum*: a small adult from off Port Clinton, Ohio.

Figure 2. *Stizostedion glaucum*: a paratype from off Erie, Pennsylvania.

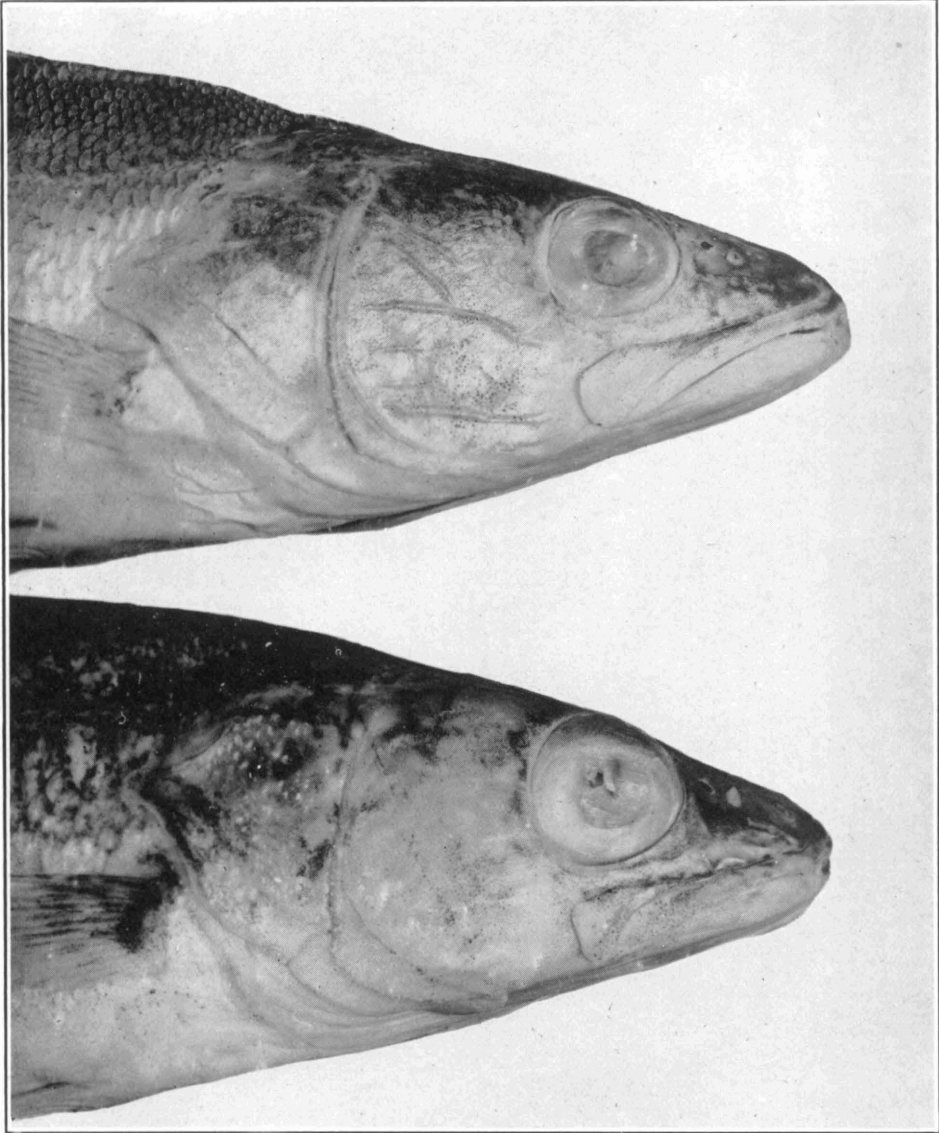


PLATE IV. YELLOW PIKE AND BLUE PIKE OF LAKE ERIE

