
A REVIEW OF THE SALMONOID FISHES OF THE GREAT LAKES
WITH NOTES ON THE WHITEFISHES OF OTHER REGIONS



By David Starr Jordan and Barton Warren Evermann



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In the investigations of the fisheries of the Great Lakes region conducted in 1908 and 1909 by the International Fisheries Commission the writers had opportunity to examine great numbers of specimens of the food fishes and especially of the Coregoninæ, known as whitefish and lake herring. It has been clearly shown that the fauna of each of the Great Lakes exhibits peculiarities of its own, and especially that each lake has one or more species of the group called lake herrings or ciscoes peculiar to itself. In this paper the species of these and other groups of fresh-water Salmonidæ are treated and figured somewhat fully. The specimens described are in the United States National Museum, with series of duplicates in the museum of Stanford University. The following species are described as new:

Leucichthys supernas, *Leucichthys cyanopterus*, *Leucichthys manitoulinus*, *Leucichthys ontariensis*,
Leucichthys harengus arcturus.

Three others from the same collections have been previously described and figured (Proc. U. S. Nat. Mus., vol. xxxvi, p. 165-172) by Jordan & Evermann:

Leucichthys huronius, *Leucichthys eriensis*, *Leucichthys zenithicus*.

Genus SALVELINUS (Nilsson) Richardson.

Salvelinus fontinalis (Mitchill). *Eastern Brook Trout*.

The common brook trout occurs in all cold streams and in some lakes throughout this region. It occurs freely in Lake Superior but not in any other of the Great Lakes. In the streams of Isle Royale a variety almost jet-black in color is said to occur.

^a In the preparation of this paper the authors have had the assistance of William Francis Thompson, of Stanford University. Most of the text figures were drawn by William Sackston Atkinson, and the colored plates are from paintings made by Charles Bradley Hudson.

Genus CRISTIVOMER Gill & Jordan.

Cristivomer namaycush (Walbaum). *Lake Trout; Great Lakes Trout; Mackinaw Trout; Togue; Longe; Namaycush; Siscowet.* (Pl. 1.)

The Great Lakes trout or Mackinaw trout occurs throughout the Great Lakes region, and in the lakes northwestward to the Yukon and the Arctic Sea. It is subject to many variations in color and in degree of plumpness, but we find no tangible differences on which the genus can be separated into species or subspecies.

A notable variant is found in the siscowet (*Salmo siscowet* Agassiz, Lake Superior, p. 333, 1850; *Salmo siskawitz* Agassiz in Herbert, "Frank Forester's Fish and Fishing, p. 143, fig. on p. 144, 1849). This is a pale trout, excessively fat and with the skeleton feeble for its size, found in Lake Superior and in waters of 50 to 80 fathoms. It is never seen in shallow water. It differs in no technical respect from the ordinary lake trout, and it is connected with the latter by perfect intergradations known locally as half-breeds. The siscowet is taken in schools of the deep-water ciscoes, the bluefin (*Leucichthys cyanopterus*), the cisco (*L. supernas*) and the Lake Superior longjaw (*L. zenithicus*), themselves also soft-bodied and very fat. There is every reason to believe that the siscowet is an ordinary trout which has fed

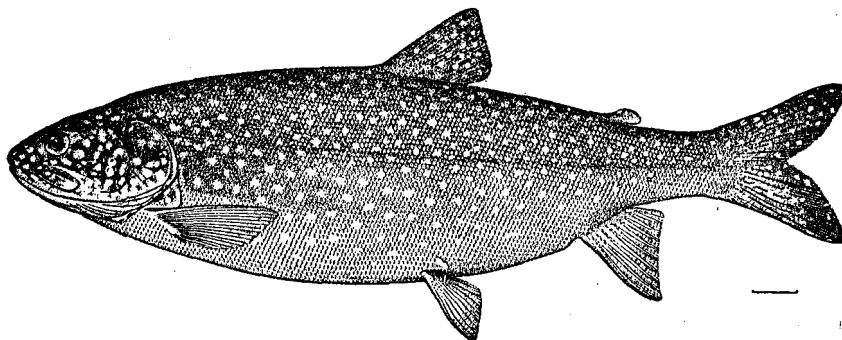


FIG. 1.—*Cristivomer namaycush siscowet*. Siscowet. (Drawn from specimen 18 inches long, taken in Lake Superior off Marquette, Mich.)

on these soft fat fishes and which has followed them into deep water. If so, it should not be regarded as a distinct species or subspecies.

The siscowet is not badly flavored but too fat to be digestible, and it almost melts away in frying. Salted, it is more satisfactory, but there is little market for it. Sometimes the walls of the abdomen are over half an inch in thickness.

Our text figure is taken from a small but very fat example of the typical siscowet taken in a school of bluefins in about 60 fathoms off Marquette. The colored plate is from a typical lake trout from Lake Michigan off Berrien County, Mich.

Commercially the lake trout is of great importance. The catch in American waters for the Great Lakes in 1908, according to the Bureau of the Census, was as follows:

State.	Pounds.	Value.
Indiana	129,600	\$9,640
Michigan	6,798,000	424,080
Illinois	150,400	12,550
Minnesota	215,000	11,690
Wisconsin	4,710,100	340,360
Total	12,003,100	798,320

Genus LEUCICHTHYS Dybowski.

The Lake Herrings.

- Argyrosomus* Agassiz, Lake Superior, p. 339, 1850 ("*clupeiformis*" of De Kay, not of Mitchill=*harengus*); not of M. de la Pylaie, which, according to Doctor Gill, is *Pseudosciæna aquila*.
Leucichthys Dybowski, Fische des Baikal-Wassersystemes, Verh. K. K. Zool.-Bot. Gesell. Wien, bd. xxiv, 1874, p. 390 (*Salmo omul* Pallas).
Allosomus Jordan, Manual Vertebrates, ed. 2, p. 361, 1878 (*Coregonus tullibee* Richardson).
Thrissomimus Gill Ms., November, 1909 (*Coregonus arledi* Le Sueur).
Cisco Jordan & Evermann, new subgenus (*Argyrosomus nigripinnis* Gill).

We are indebted to Prof. Theodore Gill for the information that the name *Argyrosomus* was first given to the "maigre" of the Mediterranean, and in advance of its use by Agassiz for the genus of lake herring. The maigre should therefore stand as *Argyrosomus aquila* instead of *Pseudosciæna aquila*. The following statement is given by Professor Gill:

The name *Argyrosomus* first appears in the "Comptes Rendus du Congrès Scientifique de France," 2nd session in 1834, pages 524 to 534 (published in 1835). The article is entitled "Recherches en France sur les poissons de l'Océan pendant les années 1832 et 1833, par M. de la Pylaie de Fougères."

On page 534, Professor Gill informs us, M. de la Pylaie has the following:

Sous le tribu des Persèques, nous voyons . . . l'*Argyrosomus procerus*, nouveau genre que j'ai formé avec le *Sciæna aquila* Cuv., et auquel j'associe une nouvelle espèce, l'*Arg. sparoides*, de la baie de Bourq Neuf.

No other reference is made to *Argyrosomus* or these species. The species *Sciæna aquila* must be taken as the type of *Argyrosomus*. The name thus antedates *Pseudosciæna* Bleeker, given in 1863 to the same species, *aquila*.

The name *Leucichthys*, first given by Dybowski in 1874 to two Siberian species of the genus *Argyrosomus* Agassiz, must apparently replace the latter for the lake herring ciscoes with their old world congeners. *Leucichthys*, based on *Coregonus omul* and *Coregonus tugun*, is separated by Dybowski from "*Coregonus sensu strictiore*" by the terminal mouth. The first species named, *Coregonus omul*, may be taken as its type.

Dybowski thus records these species:

2. Gruppe, *Leucichthys*, Der Mund vorderständig oder halb oberständig. Die Symphyse des Unterkiefers mit einer höckerartigen Anschwellung.

19. Art. *Leucichthys omul* Pall., l. c., Taf. VIII, Fig. 2. Der Kopf nach vorn zugespitzt, die Schnauze verlängert. Der Unterkiefer ein wenig vorstehend. Die Nase schwach gewölbt, etc.

20. Art. *Leucichthys tugun* Pall. Der Kopf nach vorn zugespitzt, die Schnauze wenig verlängert, der Unterkiefer etwas vorstehend, etc.

In both these species the jaws and tongue are said to be "mit schwacher Zähnen besetzt."

Pallas, however, says of *L. omul*, "os plane edentulum," and of *L. tugun*, "maxilla . . . utraque edentula." We find no teeth in the jaws of the American species, and only minute asperities on the tongue. There is no hook on the end of the lower jaw in any of our species, although a slight prominence in *L. johannæ*, *L. prognathus*, and *L. cyanopterus* suggests it. In view of all this there is some doubt as to whether our American species should be referred to the same genus as *Leucichthys omul*. We may note, however, that both Guldenstadt and Pallas deny the presence of teeth in *Stenodus leucichthys*. Our specimens of the latter from the Volga River at Sammara, Russia, show small teeth in both jaws and on the vomer, palatines, and tongue, as supposed by Doctor Günther and as shown by the American species, *Stenodus mackenzii*. The use of *Leucichthys* as a generic name by Dybowski may indicate that he had this species, *Stenodus leucichthys*, in mind as the type of *Leucichthys*. But he mentions only the two species *omul* and *tugun*. As both of these are said to have teeth, and to have the lower jaw produced and hooked, it may be that they constitute a separate subgenus, intermediate between *Stenodus* on the one hand and the American on the other. To this subgenus the European species *Leucichthys vandesius* may possibly belong, as that species is said to have minute teeth on the jaws and tongue, and a projecting lower jaw and uncurved chin as in *Leucichthys omul*. On the other hand, the British species, *Leucichthys pollan*, much resembles the American species.

We therefore provisionally adopt the name *Leucichthys* for the entire group, considering the subgenus *Leucichthys* proper as composed entirely of old world species, and placing the American species in three subgenera, *Thrissomimus*, *Cisco*, and *Allosomus*.

We further note that in *Leucichthys omul* 6 to 8 rows of pearly bodies are present in the breeding season, as in certain species of *Coregonus*. None of the American species of lake herring shows these structures, although slight warty elevations are shown in some of our specimens of *L. johanna*.

This genus *Leucichthys* includes the species known in America as lake herring, cisco, and tullibee, and the corresponding forms in northern Europe and northern Asia, known as laksild, sik, vendace, pollan, etc. These forms are related to the whitefish, *Coregonus*, agreeing with the latter in the large silvery scales and obsolescent teeth. In *Leucichthys*, however, the mouth is larger, with longer jaws, the lower jaw being at least as long as the upper, and the premaxillaries set nearly horizontally. The gillrakers are long and slender, about 30 on the lower limb. The jaws are toothless in all of our species. There are no teeth on the palate but minute teeth are seen on the tongue when dry.

The species are much more active than those of *Coregonus* and feed more generally on small fishes. In general, they are less valued as food than the whitefishes, but at least one of them ranks with the very best of food fishes. The group separates naturally into three subdivisions which may be called subgenera.

To the first of these, *Thrissomimus* (which is the earlier *Argyrosomus* of Agassiz, the name unfortunately preoccupied), belong the typical lake herring, or laksild, both of Europe and America, fishes with slender bodies, silvery scales, relatively firm flesh and firm skeleton, and the general form of herring, to which these fishes bear much external resemblance that indicates no real affinity. All the species of *Thrissomimus* have the jaws toothless, which separates them from the Asiatic genus or subgenus *Leucichthys*. None of this group or the next one is found in the basin of Lake Winnipeg, which includes the Lake of the Woods, the Saskatchewan, the Rainy River, and the Red River of the North. The only species of the genus in this vast basin is the tullibee, *Leucichthys tullibee*.

To the second group, which we call *Cisco*, belong the ciscoes, bluefins, blackfins, bloaters, and longjaws, species living in 50 or more fathoms of water, with the mouth larger than in the lake herring, and with the skeleton relatively feeble and the flesh softer, often saturated with fat. These forms are all very closely related and probably sprang from a common stock which is near the species called *L. supernas*. It is not clear that they are derived from any of the existing shore species.

To the third group, *Allosomus*, belong the tullibeas, robust, compressed fishes with the tail very short, the mouth small and the color in general more dusky than silvery. The scales are firm and the texture of the flesh more solid than in the lake herrings. The species of this group are mostly confined to the region northwest of Lake Michigan, and they are found mainly in the smaller lakes to the northwestward of Lake Huron, their distribution being chiefly in the Winnipeg basin. The tullibeas are not greatly valued as food fishes, the flesh being soft and watery and inferior to that of most other Salmonidæ.

The Siberian species, *Leucichthys peled* (Lepechin) (= *Salmo cyprinoides* Pallas) is doubtless a tullibee or typical *Allosomus*.

Besides the species found in the Great Lakes region, we give here an account of all the species of *Leucichthys* known from North America. It may be noticed that the species of each group are closely related to one another, that the differences are more evident in the mass, as in a boat or fish market, than in individual preserved specimens, that measurements are liable to fluctuation, that individual differences are unusually great, and finally, that in those characters usually most trustworthy in fishes, such as the number of scales, fin-rays, gillrakers, etc., the different species are practically in agreement.

ANALYSIS OF SPECIES OF LEUCICHTHYS FOUND IN THE GREAT LAKES REGION.

- a. Caudal peduncle relatively long and slender, its length along lateral line above last ray of anal more than .75 length of head, its length from last ray of anal to first of caudal more than its depth; scales silvery, more or less loosely inserted; body more or less elongate, the depth 3.25 to 5.5 in length; minute teeth on tongue, none on jaws or palatines.

THRISOMIMUS:

- b. Species of shore waters, spawning in late autumn, the flesh firm, the skeleton well developed, the mouth small, the maxillary not reaching past middle of eye.
- c. Adipose fin very small, usually shorter than eye; body elongate, the caudal peduncle slender, its least depth about 3 in head; body slender, the depth 4.33 to 4.66 in length; body anteriorly long, the pectoral not reaching nearly halfway to ventrals; back lustrous bluish in life, usually not marked with lengthwise streaks. *harengus*; *osmeriformis*
- cc. Adipose fin well developed, longer than eye.
- d. Body elongate, the depth 4.33 to 4.5 in length; caudal peduncle slender, its least depth about 3 in head; body anteriorly long, the pectoral not reaching halfway to ventrals in the adult; back dark lustrous blue in life, usually marked with dark lengthwise streaks.
- e. Body subcylindrical, little compressed, its depth about 4.5 in length, its greatest depth usually before dorsal. *sisco*; *huronius*
- ee. Body more robust and more compressed, its depth about 4 in length, the greatest depth usually near insertion of dorsal. *ontariensis*; *lucidus*; *laurettae*; *alascanus*; *pusillus*
- dd. Body deep and compressed, the depth 3.33 to about 4 in length; caudal peduncle stout, its least depth nearly half head; pectoral reaching more than halfway to ventrals; adipose fin larger, longer than eye; back olive-gray, without distinct dark streaks.
- f. Body moderately robust, depth 3.5 to 4 in length; angle at the nape slight, scales relatively thin and loosely attached. *artedi*; *bisselli*
- ff. Body very robust, depth 3.33 to 3.5 in length, with a strong angle at the nape; scales large, regular, and firmly attached; flesh rich, of excellent flavor. *eriensis*

CISCO:

- bb. Deep-water forms found in 50 fathoms and upward, spawning in midsummer, the flesh soft and fat, the skeleton relatively feeble, the mouth relatively large; adipose fin rather large.
- g. Mouth moderate, the maxillary not extending to middle of eye; premaxillary nearly horizontal, the upper jaw not truncate; head broad, the width between temples rather more than half length of top of head; caudal peduncle stout.
- h. Lower jaw distinctly projecting, its tip somewhat produced upward; head thick; eye large; pectoral extending more than halfway to ventrals; depth about 4 in length; adipose fin small; fins with little dark.
- i. Head short and slender, 4.66 in length; mouth relatively small; adipose fin rather small. *supernas*
- ii. Head long and thick, 4 to 4.25 in length; mouth large; adipose fin small.
- j. Gillrakers more than 40. *prognathus*
- jj. Gillrakers fewer than 40. *johannæ*
- hh. Lower jaw included; head long, about 4.5 in length; body moderate, the depth about 4.2 in length; caudal peduncle thick; fins all broadly edged with black.
- k. Gillrakers 16 to 19+31 to 35. *nigripinnis*
- kk. Fins slightly bluish or dusky at tip; gillrakers 14+25. *cyanopterus*
- gg. Mouth larger, the maxillary extending about to middle of eye; snout long, subtruncate at tip, the premaxillaries more or less vertically placed, lower jaw included; body slender, the depth more than 4 times in length; caudal peduncle slender; head slender, its breadth at temples half its length above. Color pale, often some dark on fins except the ventrals.
- l. Pectoral not reaching halfway to base of ventrals; snout about equal to eye, about 4 in head; depth of tail much greater than snout; snout more truncate than in next species; scales about 70; color very silvery. *hoyi*
- ll. Pectoral reaching more than halfway to base of ventrals; depth 4.6 to 4.66 in length; snout less truncate than in *L. hoyi*, 3 to 3.5 in head, longer than eye; depth of tail not equal to snout; scales about 77. Color brassy-silvery, with dark points on all fins save ventrals. *zenithicus*

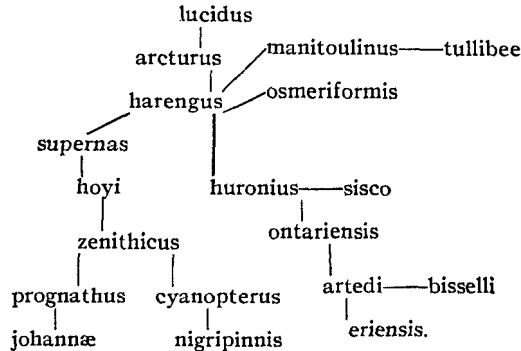
ALLOSOMUS:

aa. Caudal peduncle short and thick, its length along lateral line above last ray of anal about half head, its length from last ray of anal to first of caudal less than its depth; skeleton and flesh firm; scales dusky, firmly inserted; body deep, compressed, the depth 2.25 to 3.4 in length; no teeth. Colors dark, back and fins dusky.

m. Depth 3.2 to 3.33 in length; adipose fin very small, shorter than eye; caudal peduncle moderate, its depth 2.5 in head *manitoulinus*

mm. Depth 2.5 to 3 in length; adipose fin large, longer than eye; body short and deep; caudal peduncle very short and deep, its depth 2 to 2.25 in head *tullibee*

The relationships of the species may be indicated graphically as follows:



Subgenus THRISSOMIMUS Gill.

Leucichthys harenus (Richardson). *Saginaw Bay Herring; Georgian Bay Herring.*

Salmo (*Coregonus*) *harenus* Richardson, Fauna Boreali-Americana, III, p. 210, pl. xc, fig. 2, 1836, Georgian Bay at Penetanguishene, Ontario.

Coregonus clupeiformis, Agassiz, Lake Superior, p. 339, 1850, the Pic (Michipicoten Island); not of Mitchell.

Coregonus albus, Agassiz, op. cit., p. 342, the Pic; not of Le Sueur.

Argyrosomus artedi, Evermann & Smith, Rept. U. S. Fish Comm. 1894, p. 305, pl. 21, in part, Bayfield, Wis.

Distribution: Bays and shallow waters of Lake Huron and Lake Michigan; Georgian Bay, Saginaw Bay, Green Bay, etc.

The herring of Georgian Bay, hitherto confounded with *Leucichthys artedi*, is a distinct species, well separated from all the other species of this group found in the Great Lakes by the very small adipose fin, length of which is about 5 in head. This character is well shown in Richardson's figure of the species. In form the Georgian Bay herring is much more slender than *L. artedi*, approaching in that regard the herring of Lake Huron (*Leucichthys sisco huronius*). As a food fish *Leucichthys harenus* is distinctly superior to either *L. artedi* or *L. sisco huronius*, though by no means equal to *A. eriensis*.

Doctor Richardson's specimens came from Penetanguishene at the southern end of Georgian Bay. We obtained many specimens from the neighboring port of Collingwood, one of which we have figured, and which is the type of the following description. This may be regarded as typical of *Leucichthys harenus*. We have seen specimens from near Mackinac which seem to belong to this species.

The herring of Saginaw Bay is also in all respects identical with the specimens from Collingwood. It is not only slender, as usual in this species, but reaches only a small size, the average weight when mature being 6 ounces, those examined by us, from Bayport, ranging from 2.5 to 9.5 ounces. The maximum length is 12 inches and the usual from 9 to 10.

A small copepod which Dr. Charles B. Wilson is describing as a new species of Lernæopoda is parasitic on the gills of the Saginaw Bay herring.

Of all the species of *Leucichthys* this must be the most numerous in individuals, occupying as it does most of the open waters of Lake Huron and Lake Michigan. It is taken in great abundance in Saginaw Bay, where it is largely salted for commercial purposes. It is the most important fish in the fisheries of Saginaw Bay, the catch in 1908 amounting to 3,871,345 pounds, while the total catch of all species was 7,104,703 pounds.

This species is said to range down the shores of Lake Huron to Port Huron, and to be taken occasionally in Lake Erie, having come down the Detroit River. It is also said that the shore lake herring of Green Bay in Lake Michigan are of the same type. These Saginaw herring differ from the ordinary blueback of Lake Huron and Lake Michigan in their gray color, less cylindrical body, smaller size, and especially in the much smaller adipose fin.

Specimens from near Pine, Ind., at the southern end of Lake Michigan, seem to belong to this species rather than to *Leucichthys sisco huronius*. These are small in size, gray in color, and with the adipose fin not larger than in *L. harengus*.

Head 4.33 in body without caudal; depth 4.33; length of caudal peduncle measured from last anal ray to first of caudal, 2.12 in head; depth 3; eye 4; snout 3.75; interorbital space 3.75; maxillary measured from tip of snout 3; dorsal 11, anal 12; scales 10-83-9, between occiput and dorsal, 33; branchiostegals 9; gillrakers 16+31, length 0.87 eye diameter.

Body elongate, not much compressed, more cylindrical than in most species. Width 1.75 in its depth, more convex ventrally; caudal peduncle long, terete, not deep nor much compressed; back above occiput

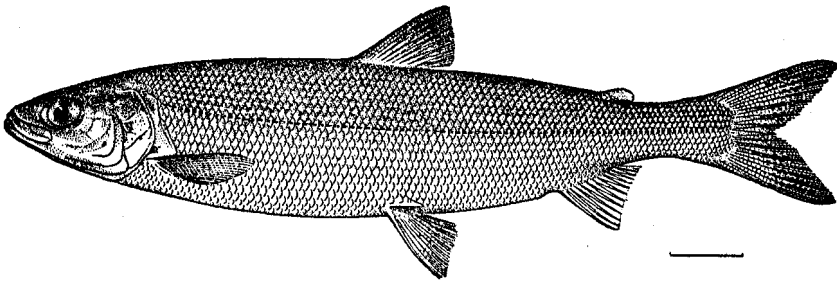


FIG. 2.—*Leucichthys harengus* (Richardson). Saginaw Bay herring. (Drawn from a specimen 11 inches long, collected in Georgian Bay, Lake Huron, Collingwood, Ontario.)

only moderately arched; head small; under jaw projecting somewhat; maxillary not quite extending below the anterior edge of pupil, thrice as long as broad; teeth on tongue only, very minute and few in number; distance from snout to occiput always less than half distance from occiput to dorsal insertion; dorsal inserted midway between snout and base of caudal, somewhat small, its longest ray 1.75 in head, its base about half length of head, usually shorter than eye, rarely longer; adipose small, its length from insertion to tip 5 in head, low, its height 0.33 its length, but variable in different specimens; in general its greatest length is 4 to 4.5 times in the distance from the depressed tip of the dorsal to its base; ventrals somewhat shorter than pectoral, the latter about 0.66 length of head; anal small, its base equal to that of dorsal, its longest ray 2.33 in head; lateral line straight; scales moderate in size.

Color in spirits, dark along the center of the back and on the dorsal surface of the head, coffee-colored on the remainder, silvery laterally and colorless ventrally; dorsal black on distal half; caudal dark, edged with black; pectoral and ventral lightly touched with dark along first rays; anal dark on distal half.

Specimens from Blind River on the North Channel of Lake Huron differ from the Collingwood specimens in having the colors darker, the surface suffused by dusky, as usual in "muskeeg" waters, or water darkened by drainage from sphagnum swamps. These are also more slender and smaller, but do not differ otherwise. A figure of one is presented.

The ordinary herring of Lake Superior are placed provisionally under *Leucichthys harengus*, of which they constitute a tangible variety or subspecies, distinguished by the larger size, the more cylindrical

form, and in general by the still smaller adipose fin. But these characters are average only, and are subject to much variation, hence we refrain from regarding the Lake Superior herring as a distinct species. Specimens having these characters were taken at Sault Ste. Marie, both above the Rapids (Point aux Pins) and below (St. Marys River). Specimens exactly similar were secured from Peter Anderson, a fisherman at Marquette. These are rather larger than the specimens from Collingwood, but exactly like them in form and color. The figure of Evermann & Smith taken from a specimen from Bayfield, Wis., seems to be the same, although named *Argyrosomus artedi* in their plate.

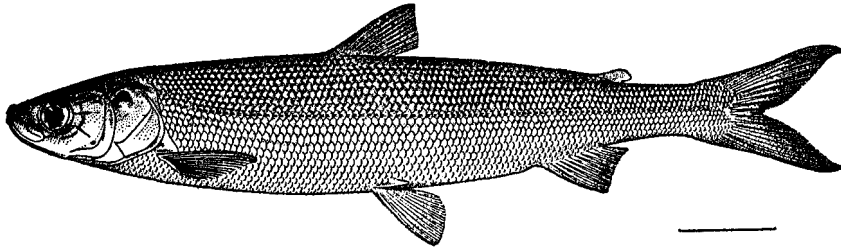


FIG. 3.—*Leucichthys harengus* (Richardson). Saginaw Bay herring. (Drawn from a young example, 9 inches long, collected in Blind River, North Channel, Lake Huron.)

In the work of the International Fisheries Commission it was claimed by the fishermen about Duluth that a mesh of less than 2.5 inches was necessary for the capture of the lake herring. The fishermen about Marquette were entirely satisfied with this mesh. It was claimed at Duluth that the herring there were more slender than those to the eastward of Keweenaw Point. Examination of specimens shows this to be true. The lake herring examined from Duluth, Knife River, Port Arthur, and all points on the northwest shore of Lake Superior, are more slender, less compressed, and more spindle-shaped than those from Georgian Bay and Marquette. On a single specimen no great difference is shown, but in a boat load of herring it is notable. Possibly the difference is due to scantier food on

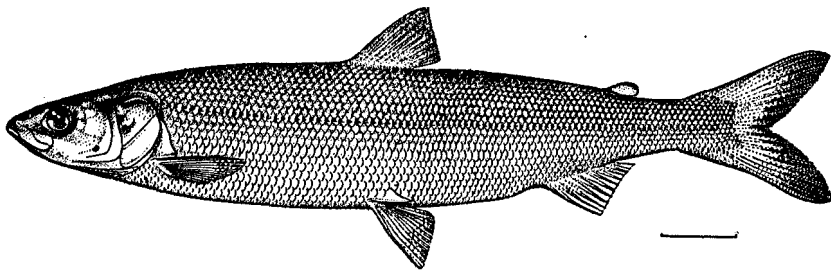


FIG. 4.—*Leucichthys harengus arcturus* Jordan & Evermann, new subspecies. (Drawn from the type, a specimen 11.5 inches long, collected in Knife River, Lake Superior, near Duluth.)

the narrow rocky shelf inhabited by these fishes along the north shore. Possibly it has a certain taxonomic value. The lake herring is a shore fish, and the great depth of the waters of Lake Superior more or less completely isolates the fishes of Isle Royale and neighboring shores from those of the eastern and southern part of the lake.

We present a figure of a specimen from Knife River, near Duluth, typical of the subspecies which we call *Leucichthys harengus arcturus*. This form agrees exactly with the ordinary *harengus* of Georgian Bay in the small size of the adipose fin. The fishes from Michipicoten Island ("the Pic") in Lake Superior, called by Agassiz *Coregonus albus*, may belong to this slender type.

Comparison of specimens of *Leucichthys harengus*.

	Lake Huron, <i>L. harengus</i> .		Lake Superior, <i>L. harengus arclurus</i> .			Lake Michigan, <i>L. harengus</i> .	
	Colling- wood.	Blind River.	Mar- quette.	Knife River.	Duluth.	Pine, Ind.	
<i>Specimen no.</i>	5267	5283	5271	5256	5210	5288	5290
Length without caudalmm.	243	215	255	253	238	215	245
Dorsal rays	10	11	10	11	11	10	10
Anal rays	12	11	12	12	12	12	12
Scales	10-83-9	9-85-9	9-80-8	10-79-8	9-86-8	9-90-8	9-80-8
Scales between occiput and dorsal fins	33	34	34	33	35	38	38
Branchiostegals	9	9	9	9	9	9	8
Gillrakers	16+31	16+29	16+30	16+30	16+30	18+35	17+31
Comparative measurements: ^a							
Head	0.23	0.22	0.225	0.23	0.22	0.23	0.235
Depth of body . . . . .	.23	.20	.21	.22	.20	.21	.205
Caudal peduncle, length from anal to point of caudal rays . . . . .	.10	.12	.12	.11	.11	.11	.103
Caudal peduncle, depth (least) . . . . .	.075	.07	.07	.07	.07	.07	.07
Eye . . . . .	.055	.05	.05	.05	.05	.05	.05
Snout from eye . . . . .	.055	.05	.06	.06	.05	.055	.06
Interorbital space . . . . .	.065	.06	.065	.065	.06	.06	.065
Maxillary length from tip of snout . . . . .	.075	.07	.08	.08	.075	.07	.075
Snout to occiput . . . . .	.16	.15	.16	.155	.15	.155	.16
Ventrals to pectorals . . . . .	.35	.31	.32	.32	.32	.325	.31
Pectoral length in ventral-pectoral distance	2.25	2.20	2.125	2.25	2.00	2.00	2.00
Pectoral length . . . . .	.16	.14	.15	.14	.155	.155	.16
Ventral length . . . . .	.14	.13	.14	.14	.14	.15	.15
Dorsal height . . . . .	.14	.12	.135	.135	.14	.14	.15
Adipose length . . . . .	.05	.04	.055	.055	.06	.05	.055
Anal height . . . . .	.09	.085	.09	.08	.09	.09	.09

^a Measurements in hundredths of body lengths unless otherwise specified.

***Leucichthys osmeriformis* (Smith).** *Seneca Lake Herring; Seneca Lake Smelt.*

Coregonus osmeriformis Smith, Bull. U. S. Fish. Comm., vol. xiv, 1894, pl. 1, 2, Seneca Lake; Skaneateles Lake. Evermann & Smith, Rept. U. S. Fish Comm. 1894, p. 305, 1896; same specimens.

Distribution: Lakes of central New York, tributary to Lake Ontario.

We have examined the type (from Seneca Lake, New York) and the 4 cotypes (from Skaneateles Lake, New York) of this species, which is locally known as smelt. It is one of the smallest species and is allied to *Leucichthys harengus*, with which it agrees in the slender body and very small adipose fin. It differs from that species, however, in the considerably longer maxillary, longer and decidedly projecting lower jaw, larger eye, and longer head.

The following is the substance of the account given by Doctor Smith, whose figure we copy (fig. 21, p. 40):

Head 3.9; depth 5; eye 3.9; dorsal 9; anal 13; scales 9-83-10; maxillary 2.6. Body elongate, slender, back not elevated; head rather large, its width equal to half its length; length of top of head 2.25 in distance from occiput to dorsal; greatest depth considerably less than length of head; eye large, equal to snout; gillrakers very long and slender, as long as eye, 20+35; dorsal fin rather high, its height equal to 0.8 depth of body and 1.5 times length of base of fin, its origin nearer base of caudal than snout, its free margin nearly vertical, straight; longest anal ray 0.8 length of base of fin; ventral long, equal to height of dorsal, its length equal to 0.75 of distance from ventral origin to vent; ventral origin midway between base of caudal and pupil; adipose dorsal very small, described as long and slender, of same width throughout, its width 0.33 its length. Mouth large, the lower jaw projecting, the snout straight; maxillary 3 in length of head, its posterior edge extending to line drawn vertically through anterior margin of pupil; mandible 0.5 length of head, its angle under the pupil; teeth present on the tongue. Color above grayish silvery; sides bright silvery; below white; tips of dorsal and caudal dark. Length 10 inches. Known from Seneca and Skaneateles lakes, but probably occurring in other deep lakes of central New York.

Leucichthys sisco (Jordan). *Cisco of Lake Tippecanoe.*

Argyrosomus sisco Jordan, Amer. Nat. 1875, p. 135, Lake Tippecanoe at Warsaw, Ind.; collector, J. H. Carpenter; Rept. Geol. Survey Indiana, 1876, p. 4, with a crude figure, Lake Tippecanoe, Lake Geneva.

Argyrosomus artedi sisco, Jordan & Evermann, Fishes North and Mid. Amer., pt. 1, 1898, p. 469, and elsewhere.

Habitat: Small glacial lakes of northern Indiana and southern Wisconsin formerly tributary to Lake Michigan (lakes Tippecanoe, Barber, Shriner, James, Oconomowoc, Green, La Belle, etc.).

Comparison of the Lake Michigan herring with the "sisco" of Lake Tippecanoe convinces us that no specific difference can be made out by which the two can be separated.

The cisco of Lake Tippecanoe is merely a landlocked form of the ordinary Michigan herring, smaller, softer in flesh, and more plump, but showing no technical differences whatever. This was the judgment of Jordan & Evermann in 1898, but we then made the mistake of supposing the Lake Michigan species to be the true *artedi*. If the common Michigan herring is to receive a distinctive name, it may be provisionally called *Leucichthys sisco huronius*. As a matter of fact, however, *sisco* is the variety and in strictness each separate lake has its own variety of "cisco," as such changes as the form has undergone since post glacial times must have taken place separately in each of the several lakes in which the

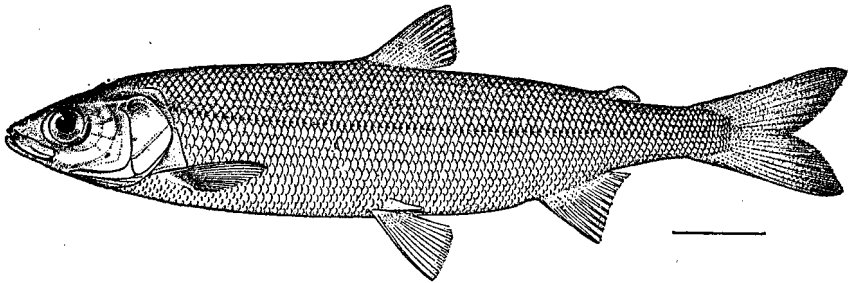


FIG. 5.—*Leucichthys sisco* (Jordan). Cisco of Lake Tippecanoe. (Drawn from specimen 9 inches long, collected in Lake Geneva, Wisconsin.)

cisco is left. As a whole this species differs little from *L. harengus* except in the larger adipose fin, which is, however, subject to considerable variations. In general it is longer than the eye and is contained 3.5 times in the distance from the depressed tip of the dorsal to its base. On the whole *harengus* is the more slender fish and paler in color. Ultimately *ontariensis* and *sisco*, with possibly the deep water *supernus*, may be regarded as subspecies of *harengus*.

The name *Argyrosomus sisco* was applied in 1875 to the cisco of Lake Tippecanoe, a small lake herring, inhabiting the depths of the glacial lakes in northern Indiana and southern Wisconsin, formerly tributary to Lake Michigan. These fishes are known to occur in lakes Tippecanoe, Barber, Crooked, Shriner, Twin, Cedar and James in northern Indiana, and in lakes Geneva, Oconomowoc, and La Belle in Wisconsin. If these are relics of an earlier fauna, as is probable, the cisco in Indiana and the cisco of Wisconsin must have been separately derived from a common ancestor of which *huronius* is the direct descendant, and from which neither has obviously changed. The name *sisco* applied to the first species of fish described by the present senior writer is much older than that of *huronius*, and as elsewhere stated, the common lake form must stand as the subspecies if the two are separated. We do not know the origin of the word "cisco" nor do we know whether it is related to "siscowet." We now adopt the current spelling of "cisco" instead of "sisco," the form under which the cisco of Lake Tippecanoe first became known to us. The following is the substance of the original description of the type of *A. sisco* from Lake Tippecanoe:

Head 4.33 to 5 in length; depth 4.1 (4 to 4.25); eye 3.6 in head; maxillaries 3.33 in head, not reaching center of eye; length of mandible 2.125 in head, much more than least depth of tail; scales 84; dorsal 9 or 10; pectoral 15; ventral 12; anal 12. Form regular, spindle-shaped, slightly elevated at beginning of the dorsal, the form essentially as in the common Lake Michigan herring. Lower jaw the longer; distance from occiput to snout 2.33 in distance from occiput to dorsal; depth at occiput

1.5 in length of head. Scales thin but firm. Dorsal short, rather high, its height 1.5 in head, the longest ray 3 times the shortest; adipose fin "rather slender," reaching slightly beyond anal; pectoral long and pointed, not reaching nearly to ventrals; ventrals more than 0.66 length of head, falling much short of vent, the accessory scale short and triangular, not half length of fin; depth at vent 5.75 in body; caudal deeply forked; vent to base of caudal below, 4.6 times in length.

Color, deep steel blue, becoming gradually paler below to lateral line, where it changes to silvery; scales above dotted with black, with traces of lines along rows of scales; vertical fins and tips of paired fins also thickly punctate; dark dots on skin of head. Length 9.5 inches. Said occasionally to reach a weight of 1.5 to 2 pounds.

A single specimen from Lake Geneva was described at the same time as more slender; the depth 5, the head 4.66 in length, and the eye 4 in head; maxillary 2.87 in head, the depth at the vent 6.75 in length, the distance from the vent to base of caudal below 4 times in length. Scales 77.

The following account was given of the habits of the fish in Lake Tippecanoe by Judge Carpenter:

Some years ago, probably five, these fish were discovered on the north side of Tippecanoe Lake by Isaac Johnson, and at each return of their spawning season, which is the last of November, they have reappeared in large numbers. They are not seen at any other season of the year, keeping themselves in the deep water of the lakes. The general opinion is that they will not bite at a hook, but Mr. Johnson says that he has on one or two occasions caught them with a hook. To my knowledge they have never been found in but two of our lakes, Tippecanoe and Barber, which are both large lakes and close together, as will be seen by reference to the map.

The spawning season lasts about two weeks and they come in myriads into the streams which enter the lakes. There are large numbers of persons who are engaged night and day taking them with small dip nets. They are caught in quantities that would surprise you, could you witness it. Those who live in the neighborhood put up large quantities of them, they being the only fish caught in the lakes that will bear salting. Some gentlemen who have been fishing to-day (Dec. 8) inform me that the run is abating and that in a few days the fishes will have taken their departure for the deep water of the lakes and will be seen no more until next November.

We here present a description of a specimen in the U. S. National Museum, from Lake Geneva, with a figure taken from the same fish. It will be noticed that the differences already noted between Wisconsin and Indiana specimens do not hold in this case, and the same specific name must suffice for both. In the specimen before us the ventral seems to be placed farther forward than in the Michigan herring. This appearance is doubtless fallacious, due to the flabbiness of the fish after spawning and the now rather soft condition of the specimen. In life it would doubtless appear more elongate.

Specimen from Lake Geneva, Wisconsin: Body length without caudal, 8 inches; head 4.33 in body; depth 4.33; length of caudal peduncle 2 in head, its depth 3.33; eye 4 in head; snout 4; interorbital space 3.66; maxillary measured from tip of snout 4; width of opercle 4 in head, subopercle 6.5; dorsal 10; anal 12; scales 8-80-8, between occiput and dorsal 36; branchiostegals 10; gillrakers 18+32.

Body elongate; dorsal and ventral outlines similar, nearly parallel in central third of body; caudal peduncle slender, long, little compressed; head moderate in size, pointed; dorsal outline straight; lower jaw longer than upper; maxillary extending under anterior edge of pupil; teeth on tongue only, very small and few; distance from snout to occiput more than twice in distance from occiput to dorsal.

Scales thin, rather small, not varying much in size between anterior and posterior; lateral line straight, nearest to dorsal contour.

Dorsal inserted slightly nearer caudal than tip of snout, its ray 1.66 in head (specimen mutilated, probably slightly longer); adipose from insertion to tip contained 4 in head, its height 10; anal truncate, its longest ray 2.75 in head; ventral insertion below first rays of dorsal; length 1.66 in head, its scale 2.33 in ventral length; pectoral short, 2.33 in distance between pectoral and ventral bases; caudal deeply forked.

Color in spirits light, darker above, silvery on sides from slightly above lateral line, colorless ventrally; all fins colorless (as far as can be seen in the poor state of specimen).

We have also received three fine specimens of the Indiana cisco, from Lake James, Steuben County, Ind., through the courtesy of Willis S. Blatchley, state geologist of Indiana. These specimens agree with the preceding accounts and we are quite unable to see that they differ in any regard whatever from examples of *huronius* from Port Huron. The adipose fin varies somewhat, but in all it is a little

longer than eye, and 3.5 times in the distance from the depressed dorsal to its base. The gillrakers are 16 to 18+31 or 32. The eye, as in *huronius*, is smaller than in the original *sisco* from Lake Tippecanoe.

It is astonishing how long the slight characteristics of the Lake Michigan and Lake Huron herring (*huronius*) persist in these separated waifs of the glacial lakes, once part of this lake system.

Leucichthys sisco huronius (Jordan & Evermann). *Lake Huron Herring*. (Pl. II.)

Argyrosomus huronius Jordan & Evermann, Proc. U. S. Nat. Mus., xxxvi, p. 167, fig. 2, March 3, 1909, Port Stanley, Ontario.

This is the common blueback or Michigan herring of Lake Huron and Lake Michigan. It occasionally enters Lake Erie, where it is recognized as the Lake Huron herring. We found no specimens in Lake Superior, but have recently received 4 from Warton, on Georgian Bay, through the kindness of the Doyle Fish Company, of Toronto. The original type of *huronius* figured by Jordan & Evermann was obtained at Port Stanley, on the north shore of Lake Erie, where about a dozen of this species were found mixed with about a thousand of *Leucichthys eriensis*. We have also specimens obtained at Erie, Pa., by Dr. Seth E. Meek, and numerous young examples from Lake Michigan. We are not able to see that these differ from Lake Huron specimens. Numerous specimens were taken at Port Huron and Mackinac. These vary considerably in the number of scales (80 to 90), but the form and general coloration of lustrous blue is seen in all examples. In all, the adipose fin is large, and the space between pectoral and ventral more than twice length of pectoral. The caudal peduncle is almost as

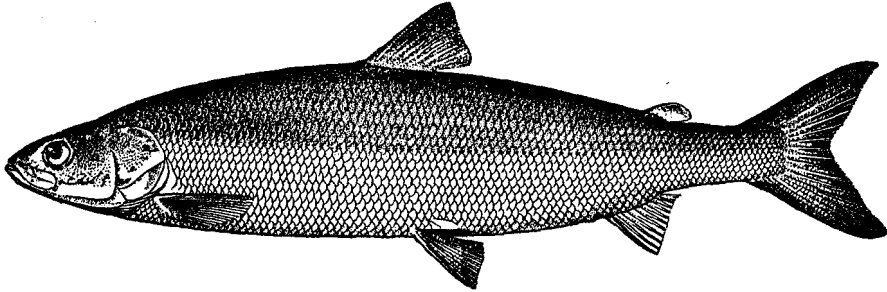


FIG. 6.—*Leucichthys sisco huronius* (Jordan & Evermann). Lake Huron Herring. From the type.

slender as in *harengus*. We may note that but a single specimen of *artedi* as accurately determined has been seen by us from Lake Huron.

The Lake Huron herring may be described as follows: Head 4.66 in length to base of caudal; depth 4.25; length of caudal peduncle from anal to first caudal rays 2 in head; depth of caudal peduncle 2.9; eye 5; snout 4; interorbital space 3.33; length of maxillary from tip of snout 3; dorsal 10 or 11; anal 11 or 12; scales in lateral line 75 to 85; between lateral line and origin of dorsal 8; between occiput and dorsal 36; gillrakers 14 to 16+29 to 31.

Body notably elongate, elliptical, with slender, pointed head and slender tail, less compressed than in the other species of the genus; head small, the snout long and pointed, distance from tip of snout to posterior edge of orbit equaling 0.5 length of head;^a lower jaw not closing within the upper, but extending slightly beyond it; maxillary reaching a point below center of pupil, its width contained 3 times in the length; teeth on tongue only, minute, seen only by drying; gillrakers on first arch very slender, those near angle equal in length to diameter of eye; lateral line almost straight; scales large and rather loosely attached; dorsal inserted midway between anterior border of eye and base of caudal; height of first ray contained about 1.6 times in length of head; adipose fin large, longer than eye; length of base about equal to its height; origin of ventrals below middle of dorsal, the rays slightly shorter than those of dorsal; length of first anal ray 2.5 in head; caudal deeply forked; pectoral short, about 1.5 in head.

^a Our drawing is not accurate as to this character.

Color in life, clear metallic blue above, silvery below; in spirits, silvery, dusky above, light below; a very indistinct, narrow, dusky stripe along each row of scales on upper half of body; dorsal with a broad dusky margin; caudal largely dusky; a mere trace of dark color on paired fins and the anal.

The type, no. 62516, U. S. National Museum, a female, measures 14.75 inches in length and was taken at Port Stanley, Ontario, by the writers, on July 29, 1908. A cotype, no. 13082, Stanford University collection, measuring 17 inches long, has 10 rays in the dorsal and a slightly longer pectoral.

The flesh of this species is rather dry and flavorless, something like that of the Menominee whitefish, *Coregonus quadrilateralis*, and it is not to be compared as a food fish with the Erie herring.

Comparison of specimens of *Leucichthys sisco huronius*.

Specimen no.	Erie, Pa.		Port Huron.		
	4932	4912	5226	5222	5224
Length without caudal..... mm.	310	290	290	325	220
Dorsal rays (fully developed).....	10	10	10	10	11
Anal rays.....	12	11	11	12	12
Scales.....	8-84-7	8-85-7	8-75-7	8-82-7	8-82-8
Scales between occiput and dorsal fin.....	34	38	35	38	36
Branchiostegals.....	9	9	9	9	9
Gillrakers.....	16+31	16+31	14+29	14+29	16+31
Sexual condition.....	Spawning ♀	Spawning ♀			
Ova diameter..... mm.	1.8	1.8			
Comparative measurements: ^a					
Head.....	0.21	0.22	0.22	0.22	0.23
Depth.....	.24	.24	.21	.21	.22
Caudal peduncle, length from anal to first caudal rays.....	.10	.11	.12	.125	.11
Caudal peduncle, depth.....	.07	.07	.075	.07	.07
Eye.....	.045	.04	.045	.04	.055
Snout.....	.05	.055	.055	.055	.06
Interorbital space.....	.065	.06	.065	.06	.065
Maxillary length from tip of snout.....	.075	.075	.075	.075	.07
Snout to occiput.....	.14	.15	.15	.15	.16
Ventrals to pectorals.....	.35	.35	.34	.28	.33
Pectorals in pectoral-ventral distance.....	2.50	2.33	2.20	2.00	2.20
Pectoral length.....	.14	.14	.15	.15	.15
Ventral length.....	.14	.14	.14	.14	.14
Dorsal height.....	.125	.13	.14	.135	.14
Adipose length.....	.065	.06	.06	.06	.065
Anal height.....	.08	.09	.095	.095	.08

^a Measurements in hundredths of body length unless otherwise specified.

Leucichthys ontariensis Jordan & Evermann, new species.

Coregonus clupeiformis, De Kay, New York Fauna, Fishes, p. 248, pl. 60, fig. 198, 1842, Lake Ontario; not of Mitchill.

Habitat: Lake Ontario and Cayuga Lake, New York.

The ordinary lake herring of Lake Ontario is allied to *Leucichthys artedi*, but is more elongate, the caudal peduncle more slender, the pectoral not reaching nearly halfway to ventrals and the color much darker, the back, as in *Leucichthys sisco huronius*, being lustrous blue. In all these regards the form stands intermediate between *L. sisco* and *L. artedi*, though doubtless nearer the former, toward which it seems to vary. The adipose fin, as in *huronius* and *artedi*, is large. From *huronius* it differs in being more compressed and stouter in every part.

The specimens before us, five in number, were taken by Dr. Seth E. Meek at Deseronto, Ontario, the Bay of Quinte. The type is no. 64673, U. S. National Museum (collector's number 29-2). This description is based on the type and four other specimens from Deseronto.

Head 4.5 in body without caudal; depth about 4 (3.75 to 4.25); length of caudal peduncle from last rays of anal to first of caudal 2.5 in head, depth 2.66; eye 4.75 in head; snout 4; interorbital space 3.75; maxillary, measured from tip of snout, 3; width of opercle 3.66 in head, subopercle 6.75; dorsal 10; anal 11; scales 9-76-8, between occiput and dorsal 35; branchiostegals 9; gillrakers 14+27.

Body elongate, more so than in *Leucichthys artedi*; dorsal and ventral outlines similar, convex; body compressed, width 2.12 in depth; depth varying in other specimens to 4 in body length, in which case the width is 1.75 to 2 in depth; caudal peduncle not greatly compressed, longer than deep; head

pointed, lower jaw slightly projecting, not usually included in the upper; maxillary extending to below anterior edge of pupil, its width 3 in its length, supplementary bone 3 in its length. Very minute teeth on tongue, none elsewhere. Scales moderate, not firmly attached, nearly equal in size posteriorly above anal, but not quite to those above tip of pectoral; lateral line nearly straight. Dorsal inserted midway between snout and caudal, its longest ray 1.66 in head; adipose fin moderate, measured from insertion to tip 4 in head, its height 9; anal concave, its longest ray 2.5 in head; ventral length 1.62 in head, its scale 2.5 in ventral length; pectoral short, reaching less than halfway to insertion of ventrals, its length 2.33 in distance between pectoral and ventrals.

Color in spirits dark; a dark blue shading under the scales dorsally, silvery laterally and colorless ventrally; dorsal darkened on distal end; caudal dark, edged with darker; anal, ventrals, and pectorals nearly clear.

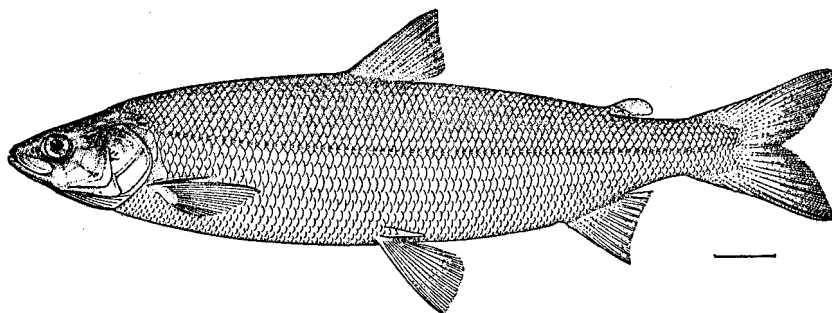


FIG. 7.—*Leucichthys ontariensis* Jordan & Evermann, new species. (Drawn from a specimen 13 inches long, collected in Lake Ontario off Deseronto, Ontario.)

This species is intermediate between *sisco* and *artedi*, differing from the latter chiefly in the greater elongation of the body and the relatively shorter pectoral fin. It is claimed by fishermen that a mesh of $2\frac{3}{8}$ inches is required for these fishes, while $3\frac{1}{8}$ is adequate for the capture of *artedi* or *eriensis*.

Reed & Wright^a say that this fish, which they identified as *L. osmeriformis*, is taken in Cayuga Lake in fairly large numbers, but that it is not as common as formerly. They were informed by old fishermen that it has never been abundant since the introduction of the alewife, which occurred about 1872, or earlier.

Comparison of specimens of Leucichthys ontariensis from Deseronto.

	<i>Specimen no.</i>		
	495	492	4918
Length without caudal.....	300	300	310
Dorsal rays.....	10	10	11
Anal rays.....	11	11	13
Scales.....	9-76-8	8-72-7	9-77-7
Scales between occiput and dorsal fin.....	35	31	35
Branchiostegals.....	9	10-8	9
Gillrakers.....	14+27	16+29	16+29
Comparative measurements: ^b			
Head.....	0.22	0.21	0.22
Depth.....	.28	.24	.28
Caudal peduncle, length from anal to first of caudal.....	.095	.11	.09
Caudal peduncle, depth.....	.08	.08	.09
Eye.....	.05	.05	.05
Snout from eye.....	.06	.05	.06
Interorbital space.....	.06	.06	.06
Maxillary length from tip of snout.....	.075	.07	.07
Snout to occiput.....	.15	.15	.15
Ventrals to pectorals.....	.34	.34	.37
Pectoral length in pectoral-ventral distance.....	2.33	2.33	2.66
Pectoral length.....	.14	.15	.15
Ventral length.....	.14	.15	.15
Dorsal height.....	.14	.14	.15
Adipose length.....	.055	.065	.06
Anal height.....	.08	.085	.10

^a The vertebrates of the Cayuga Lake basin, New York, by Hugh D. Reed & Albert H. Wright, Proceedings American Philosophical Society, vol. XLVIII, no. 193, 1909, p. 398.

^b Measurements in hundredths of body length unless otherwise specified.

Leucichthys lucidus (Richardson). *Great Bear Lake Herring.*

Salmo (*Coregonus*) *lucidus* Richardson, Fauna Bor.-Amer., vol. III, p. 207, pl. xc, fig. 1, 1836, with figure, Great Bear Lake.

Coregonus lucidus, Günther, Cat., vol. VI, p. 198, 1866, Great Bear Lake. Gilbert, Bull. U. S. Fish. Comm., vol. XIV, 1894, p. 24, Great Bear Lake.

Argyrosomus lucidus, Jordan & Evermann, Fishes North and Mid. Amer., pt. I, p. 471, 1898; after Gilbert. Scofield Report Fur-Seal Invest., pt. III, p. 495, 1898, Arctic Sea off Herschel Island.

Habitat: Mackenzie River Basin.

The herring of Great Bear Lake is known from Richardson's description and excellent figure, and from specimens taken in 1893 by the artist, Miss Elizabeth Taylor. From these specimens now before us the following description has been prepared. Two specimens were also obtained by Scofield & Seale in the Arctic Sea off Herschel Island. The species has a very long, compressed body and a large adipose fin. It is nearest in its relationship to *L. ontariensis*, but the differences are obvious. In Richardson's figure the adipose fin is represented as far too small and too far back, but it is to be remembered that this figure is taken from a dried skin.

Head small, 5 to 5.33; depth 4.33 to 4.6; eye 5; dorsal 11 or 12 developed rays; anal 11 or 12; scales 85 to 87, 11 or 12 in an oblique series downward and forward from front of dorsal to lateral line. Eye slightly less than length of snout, 1.5 times in interorbital width. Body slender, elongate, the curve of back and belly about equal, the greatest depth exceeding length of head; snout narrow, almost vertically truncate when mouth is closed, the lower jaw fitting within the upper, but the mouth not inferior; distance from snout to nape 2.60 to 3 in distance between nape and front of dorsal; head much smaller in one of our specimens than in the other; mouth oblique, with rather slender maxillary, which extends to vertical midway between front and middle of pupil, its length from tip to articulation equaling distance from end of snout to front of pupil, and contained 3.66 to 3.8 in length of head; supplemental maxillary bone probably broader than in *L. artedi*, from .6 to .66 greatest width of maxillary; suborbitals very narrow, their least width less than half diameter of pupil; supraorbital bone large, its width 2.5 to 2.66 in its length. Gillrakers very long and slender, the longest slightly more than .66 length of eye, 16+28 in number in each specimen. Front of dorsal slightly nearer tip of snout than base of upper rudimentary dorsal rays (the fins are mutilated, so that their length can not be given); adipose fin large, inserted vertically above last anal rays, its height from tip to posterior end of base equaling vertical diameter of eye. Color silvery. As pointed out by Doctor Günther, this northern form differs from *L. artedi* in its shorter head and smaller eye. It seems also to have the premaxillaries placed at a greater angle than in *L. artedi*.

Leucichthys laurettæ (Bean) *Lauretta Whitefish.*

Coregonus laurettæ Bean, Proc. U. S. Nat. Mus., vol. IV, 1881, p. 156, Point Barrow, Alaska; type no. 27695; coll. Capt. Calvin L. Hooper.

Argyrosomus laurettæ, Jordan & Evermann, Fishes North and Mid. Amer., pt. III, p. 471, 1898. Evermann & Smith, Rept. U. S. Fish. Comm. 1894, p. 374, pl. 25 (1896) Point Barrow. Evermann & Goldsborough, Bull. Bureau Fisheries, vol. XXVI, 1906 (1907), p. 235, Point Barrow, Port Clarence, Yukon River at Nulato, Meade River, Kuaru River, Elson Bay, Nushagak River, Naknek River.

Habitat: Lakes and streams of northern and western Alaska.

This species is apparently common in northern Alaska. It seems to be an ally of *L. lucidus*, having the adipose fin large, the caudal peduncle slender, and the pectoral not reaching halfway to ventrals. The fins are perhaps larger than in *L. lucidus*, the head smaller and the body deeper.

The following is the substance of Doctor Bean's account of this species:

Head 5; depth 4; eye 4.5 to 5; dorsal 12; anal 11; ventral 12; scales 10-84 to 95-10, 84 to 87 in specimens examined. Body robust, the back elevated; head small and slender, the small eye not longer than snout; distance from nape to front of snout 2.5 times in its distance from dorsal; maxillary about reaching middle of eye, 3.5 in head, its supplemental bone half its length; lower jaw very slightly longer than upper; mandible 2.33 in head; lingual teeth present; gillrakers long and numerous, 10+25; ventral scale not half length of fin; pectoral short, not reaching halfway to ventrals. Scales smaller than in *L. artedi*, 16 cross series under base of dorsal. Alaska, from Yukon River northward to Point Barrow, generally common. Apparently very close to *L. lucidus*, but the base of dorsal longer.

Leucichthys alascanus (Scofield). *Arctic Lake Herring.*

Argyrosomus alascanus Scofield, in Jordan & Evermann, Fishes North and Mid. Amer., pt. III, p. 2817, Nov. 28, 1898, and in Jordan, Report Fur-Seal Invest., pt. III, p. 495, pl. XLII, 1898, Point Hope, Grantley Harbor, Arctic Sea.

Habitat: Arctic Alaska, entering the sea.

This species is allied to *Leucichthys sisco*, but has the body less elongate and the caudal peduncle stouter. The pectoral, as in *L. artedi*, reaches more than halfway to the ventrals. The adipose fin is said to be large, but in Scofield's type and as shown in his figure, it is slender and moderately long, midway in size between *sisco* and *harengus*. The ventrals are short, but they reach more than halfway to the anal, a character which will probably separate the species from *harengus*.

It is not certain that this species differs from *Leucichthys laurettae* of the same region. The body in the latter is deeper and the head smaller, but these may not be trustworthy characters.

The species is known only from the specimens taken by Scofield & Seale. It is described as follows by Scofield:

Head 4.25; depth about 4; dorsal 12; anal 12; scales 10-85-9; eye a little shorter than snout, 5 in head, 1.33 in interorbital space; head wedge-shaped, the upper and lower profiles straight and meeting with a sharp angle at the snout. Viewed from above the snout is blunt, almost square, the narrow, pale, rounded tip of the lower jaw slightly projecting; mouth oblique, the distance from tip of snout to tip of maxillary equal to distance from tip of snout to center of pupil; the maxillary from its anterior articulation is contained 3.5 in the head, its width 3 in its length, its upper anterior edge closing under maxillary; mandible 2.33 in head, its articulation with the quadrate bone beneath the posterior edge of the eye; width of supplemental bone a little more than .5 width of maxillary; preorbital broad, its greatest width equaling .37 of its length, or diameter of pupil; width of supraorbital equaling .28 of its length; gillrakers 12 to 14+21 to 23, long and slender, the longest .66 diameter of the eye; tongue, vomer, and palatine without teeth; distance from tip of snout to nape equaling .5 distance from nape to front of dorsal, or .66 length of head; adipose fin large, ventral scale .5 length of fin; longest dorsal ray 1.5 in head; longest anal ray 2 in head; pectoral reaching more than halfway to ventrals; ventrals reaching .66 distance to vent; caudal forked for a little more than .5 its length. Color dusky above, silvery beneath; the dorsal, adipose fin, tips of caudal rays, and upper side of anterior pectoral rays dusky; fins otherwise pale. But three specimens of this fish were obtained—one in salt water at Point Hope, the other two in brackish water at Grantley Harbor. The largest one is 10.5 inches in length.

Leucichthys pusillus (Bean). *Least Lake Herring.*

Coregonus pusillus Bean, Proc. U. S. Nat. Mus., vol. XI, 1888, p. 526, Kobuk River, Alaska. type, 38366; coll. Chas. H. Townsend.

Argyrosomus pusillus, Jordan & Evermann, Fishes North and Mid. Amer., pt. I, p. 470, 1898, after Bean. Evermann & Smith, Rept. U. S. Fish Comm., 1894, p. 312, pl. 23 (1896). Scofield, Fur-Seal Invest., pt. III, p. 494, 1898, Grantley Harbor, Barter Island, Naknek River, Nushagak River. Evermann & Goldsborough, Bull. Bureau Fisheries, vol. XXVI, 1906 (1907), p. 235, Lake Bennett at Caribou Crossing; coll. Jordan & Evermann, with description.

Habitat: Lakes of Yukon basin and Alaska generally.

This is one of the smallest of the American species, rarely reaching a foot in length, and the flesh, which is said to be bony, is mainly used as food for dogs. The fish is said to be widely distributed throughout northern and western Alaska. Our specimens are from Grantley Harbor. Scofield & Seale found it in the Arctic Sea and about Bristol Bay. It is a slender species with long lower jaw, large adipose fin, the pectoral reaching more than halfway to the ventrals, and usually the dorsal fin is spotted and the fins are all high. It is a well-marked species, probably nearest *L. alascanus*.

The following is the substance of Doctor Bean's account:

Head 5; depth 5; eye 3.75 in head; dorsal 10; anal 12; ventral 11; scales 10-91-9. Body rather elongate, compressed. Form of mouth as in *L. artedi*, the lower jaw considerably projecting; maxillary broad, with rather broad supplemental bone, three times as long as wide, extending not quite to middle of the very large eye, its length 3.33 in head; preorbital extremely narrow; mandible 2.33 in head. Teeth none, or reduced to minute asperities on the tongue. Gillrakers numerous, very long and slender, 49 in all. Dorsal very high, much higher than long, its last rays rapidly shortened, the first rays twice length of base of fin; caudal large, well forked; anal small; ventral inserted under middle of dorsal, very long, .83 length of head; pectoral the same length. Scales as in *L. artedi*. Steel-bluish

above, with many dark points; belly white; dorsal and caudal mostly blackish; pectorals and ventrals tipped with black; eye blackish, the iris silvery. Length a foot or less. Yukon River to Bering Sea and northward, ascending rivers.

To this Evermann & Goldsborough add the following from specimens from Lake Bennett at Caribou Crossing:

Head 4.67 in body; depth 5.5; eye 3.75 in head; dorsal 10; anal 12; ventral 11; scales 10-90-8.

Body rather elongate, compressed; mouth oblique, gape rather small, extending back about half the length of the maxillaries; lower jaw considerably projecting; maxillary broad, somewhat curved, not extending much beyond the anterior margin of orbit, its length 3.13 in head; mandible long, reaching to below middle of pupil, 2.3 in head; teeth almost microscopic in both jaws, none on tongue; gillrakers long, slender, and numerous, 10+26 and 13+28; dorsal high, its longest ray (about the third) about 1.3 in head and about twice length of base; base of dorsal 2.5 in head; dorsal rays shortening rapidly after third and fourth, leaving the margin of the fin very slightly concave; insertion of dorsal midway between tip of snout and a point about halfway between adipose and caudal fins; caudal large, equally forked, both lobes and indentation acutish; anal low, its longest ray 2.25 in head, its base 2 in head, its posterior margin slightly concave; ventrals inserted somewhat behind origin of dorsal, reaching about .66 distance to origin of anal, the length of their longest rays about 1.3 in head; pectoral equaling ventral.

Bluish above, with minute black punctulations; sides below lateral line and a short distance above silvery, belly white; dorsal and caudal almost imperceptibly dusky; other fins wholly plain; iris silvery a narrow blackish ring about the orbit plainest above and below.

Leucichthys artedi (Le Sueur). *Lake Herring; Erie Herring; Common Lake Herring; Grayback.*

Coregonus artedi Le Sueur, Journ. Ac. Nat. Sci. Phila., vol. 1, 1818, p. 231, Lake Erie (at Buffalo) and Niagara River (Lewistown); description inadequate. Jordan & Gilbert, Synopsis, p. 301, 1883.

Argyrosomus artedi, Evermann & Smith, Rept. U. S. Fish Comm. 1894, p. 305, in part (not plate). Jordan & Evermann, Fishes North and Mid. Amer., pt. 1, p. 468, 1898. Of recent authors generally.

Coregonus clupeiiformis, Günther, Cat., vol. VI, p. 198 (not *Salmo clupeiiformis* Mitchell).

The name *artedi* applied by Le Sueur to specimens from near Buffalo must be retained for the common lake herring of Lake Erie.

This species is characterized by its relatively deep elliptical form with compressed sides and rather stout caudal peduncle, in connection with the large adipose fin. All the other species of this subgenus, *bisselli* and *eriensis* excepted, are much more slender in all their parts. The average length of this species in Lake Erie is 12 to 14 inches and the weight about 14 or 15 ounces. The fishermen of Lake Erie are in general entirely satisfied with a mesh of $3\frac{1}{8}$ inches to catch *artedi* and *eriensis*, while for the other species a mesh of $2\frac{1}{2}$ inches is required, and this is too coarse for the form called *supernas*. This species is also paler in color than any of the others, *eriensis* excepted, and lacks the blue shades characteristic of *huronius* and *ontariensis*. The flesh in *artedi*, as in *huronius*, is much inferior to that of *eriensis*.

This is the most abundant of the lake herrings so far as market fishing is concerned. It abounds in Lake Erie, especially in its southern parts. It ascends to Lake St. Clair, and we have one fine example from Lake Huron at Port Huron, where it was taken with a multitude of *huronius*. We have also examples obtained by Dr. Seth E. Meek at Toronto. As Doctor Meek was present at the capture of the Toronto specimens, there is no doubt that they came from Lake Ontario, but we know also that whitefish and herring fry have been often transferred from Lake Erie to other lakes, and it is possible that *L. artedi* is not native to Lake Ontario.

The specimens here figured are from Cleveland and Toronto. The fish from the latter place is a ripe female with unusually deep body. Others at hand for comparison are five from Erie, one from Port Maitland, three from Toronto, and one from Port Huron (Lake Huron). The presence of a specimen at the latter locality indicates the tendency of these closely allied species to invade one another's territory.

The Lake Erie herring is described as follows, from eleven specimens, between 8.3 inches and 11.8 inches long, from Lake Erie off Cleveland:

Head 4.4 in body to base of caudal; depth of body 3 to 4; length of caudal peduncle from last rays of anal to first of caudal 2 to 2.75 in head, its depth 2 to 2.5; eye about 4.4; snout 4; interorbital space slightly greater than length of snout; maxillary measuring from tip of snout 2.87 in head;

width of opercle 3.33; dorsal rays (fully developed) 10 or 11; anal 12; scales 8—69 to 75—7, between occiput and dorsal 30 to 35; branchiostegals 8 or 9; gillrakers 15 or 16+27 to 31 on first gill-arch.

Body not elongated, but somewhat compressed and usually deep; dorsal and ventral outlines similar and usually symmetrical, greatest depth at insertion of dorsal; width about 2.12 in depth; caudal peduncle compressed, deep, frequently deeper than long. Head small, pointed, with narrow snout; jaws subequal, the premaxillaries variably oblique; maxillary moderate in length, extending to or slightly beyond perpendicular from front margin of pupil, its width about 3 in length; supple-

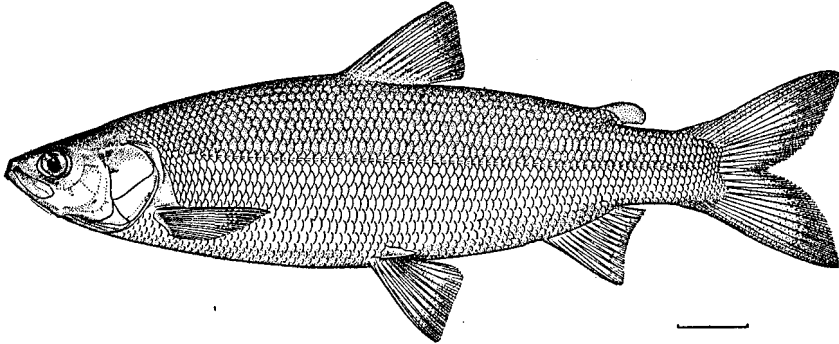


FIG. 8.—*Leucichthys artedi* (Le Sueur). Lake herring. (Drawn from a specimen 12 inches long collected in Lake Erie off Cleveland.)

mentary bone large, well developed; very minute teeth on tongue, absent elsewhere; distance from snout to occiput less than half distance from occiput to dorsal. Scales moderately large, firm, slightly broader anteriorly; lateral line straight, prominent, nearer back than belly.

Dorsal fin inserted midway between snout and base of caudal, its base about 2 in head, its height about twice maxillary length, but variable, margin truncate or slightly concave; adipose large, its length from insertion to tip contained 3 to 4 in head; pectoral usually long, reaching at least half

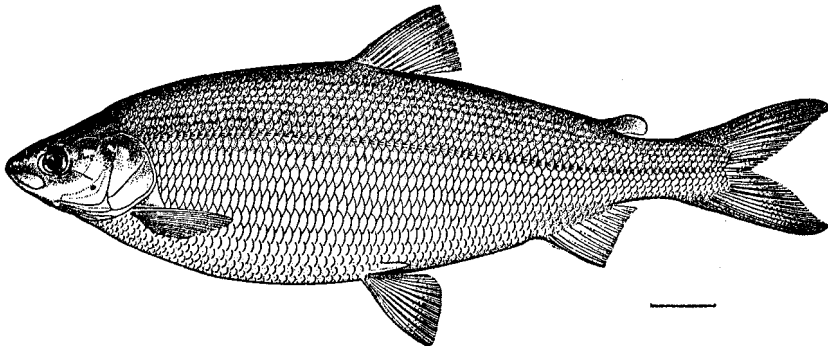


FIG. 9.—*Leucichthys artedi* (Le Sueur). Lake herring. Female. (Drawn from a specimen 12 inches long from the Toronto market.)

distance to ventrals (contrasting with *L. ontariensis*), but very variable; ventral equal or slightly less in length than height of dorsal, rather shorter than usual; anal very short, its longest ray usually somewhat longer than depth of caudal peduncle, its base about equal to that measurement, margin concave; caudal rather short, not very deeply forked.

Color in spirits silvery, darker above; somewhat less silvery and colorless ventrally; dorsal and caudal slightly edged with black, but comparatively pale; pectorals, anal, and ventrals colorless, save for an occasional stipple of black.

Comparison of specimens of *Leucichthys artedi*.

Specimen no.	Cleveland.		Erie, Pa.	Port Huron.	Port Maitland.	Toronto.	
	5252	5251	523	5223	5225	4930	4937
Length without caudal mm	252	245	260	235	200	262	205
Dorsal rays	11	11	10	11	10	10	11
Anal rays	12	12	12	12	12	11	12
Scales	8-74-7	8-76-7	8 1/2-71-7	9-69-8	8-72-7	8-71-7	8-75-7
Scales between occiput and dorsal fin	33	35	33	30	31	31	30
Branchiostegals	8	8	9	8	8	9	8 or 7
Gillrakers	16+27	16+29	16+29	Evisc.	15+29	16+29	16+31
Comparative measurements: ^a							
Head	0.22	0.23	0.23	0.235	0.23	0.225	0.24
Depth . . . . .	.28	.30	.30	.26	.23	.28	.27
Caudal peduncle—							
Length ^b . . . . .	.092	.11	.09	.10	.095	.11	.11
Depth . . . . .	.10	.10	.10	.09	.085	.09	.09
Eye . . . . .	.05	.05	.055	.055	.055	.05	.05
Snout from eye . . . . .	.055	.055	.06	.055	.055	.06	.06
Interorbital space . . . . .	.065	.07	.07	.065	.06	.065	.06
Maxillary length from tip of snout . . . . .	.08	.08	.08	.09	.075	.08	.08
Snout to occiput . . . . .	.15	.155	.16	.165	.155	.145	.15
Ventrals to pectorals . . . . .	.31	.34	.33	.335	.30	.35	.31
Pectoral length in ventral-pectoral distance	2.00	2.00	2.00	1.89	1.75	2.00	1.89
Pectoral length . . . . .	.17	.175	.17	.17	.17	.165	.17
Ventral length . . . . .	.17	.175	.17	.17	.17	.165	.17
Dorsal height . . . . .	.18	.19	.18	.16	.175	.16	.17
Adipose length . . . . .	.07	.08	.06	.06	.07	.075	.07
Anal height . . . . .	.105	.12	.115	.10	.12	.05	.10

^a Measurements made in decimal fractions of body length without caudal unless otherwise specified.
^b Length from anal to first caudal rays.

Comparison of *L. artedi* and *L. eriensis*.

Specimen no.	<i>L. artedi</i> , Erie, Pa.		<i>L. eriensis</i> , Port Stanley.
	491	493	13083 (cotype).
Length without caudal mm	285	305	310
Dorsal rays (fully developed)	10	10	11
Anal rays	11	11	11
Scales	8-65-7	8-73-7	7 1/2-81-8
Scales between occiput and dorsal fin	29	31	33
Branchiostegals	8	9	9
Gillrakers	14+31	14+31	17+32
Sexual condition	Spawning.	Spawning.	Not ripe.
Ova diameter mm	2	2	
Comparative measurements: ^a			
Head	0.22	0.22	0.22
Depth . . . . .	.32	.34	.28
Caudal peduncle—			
Length ^b . . . . .	.09	.08	.08
Depth . . . . .	.10	.11	.095
Eye . . . . .	.05	.055	.04
Snout . . . . .	.055	.05	.05
Interorbital space . . . . .	.065	.07	.065
Maxillary length from tip of snout . . . . .	.075	.075	.07
Snout to occiput . . . . .	.14	.15	.14
Ventrals to pectorals . . . . .	.34	.30	.33
Pectorals in pectoral-ventral distance	2.00	2.20	2.00
Pectoral length . . . . .	.17	.17	.165
Ventral length . . . . .	.165	.17	.15
Dorsal height . . . . .	.10	.17	.15
Adipose length . . . . .	.065	.075	.075
Anal height . . . . .	.11	.11	.12

^a Measurements in hundredths of body length to base of caudal.
^b From last anal to first caudal rays.

Leucichthys artedi bisselli (Bollman). *Rawson Lake Herring; Bissell's Herring.*

Coregonus tullibee bisselli Bollman, Bull. U. S. Fish Comm., vol. VIII, p. 223, 1888, Rawson Lake and Howard Lake, Michigan.

Argyrosomus tullibee bisselli, Jordan & Evermann, Fishes North and Mid. Amer., pt. 1, p. 473, 1898.

Habitat: Glacial lakes of southern Michigan once tributary to Lake Erie.

A large plump lake herring was described by Charles Harvey Bollman in 1888, from Rawson and Howard lakes at Schoolcraft, Kalamazoo County, Mich., in connection with his survey of the fish fauna of southern Michigan. Because of its robust form it was regarded by Bollman as a subspecies of *the tullibee*. Its relationships are, however, wholly with *artedi*, of which it may be regarded as a subspecies. The accompanying description and figure are taken by us from Bollman's type, no. 40619, U. S. National Museum:

Head contained 4.5 in length without caudal; depth 3.5; depth of caudal peduncle 2.33 in head; eye 5.2; snout 5; interorbital space 3.66; length of maxillary from tip of snout 3.25 in head; dorsal 11; anal 11; scales in lateral line 77, between dorsal and lateral line 10, between ventral and lateral line 9, and between occiput and dorsal 30; branchiostegals 9. Gillrakers 16+29, 0.75 diameter of eye in length.

Body strongly compressed, its width from side to side contained 1.83 in head; dorsal outline arched upward strongly from head; ventral outline convex; head flat dorsally, pointed; snout rounded;

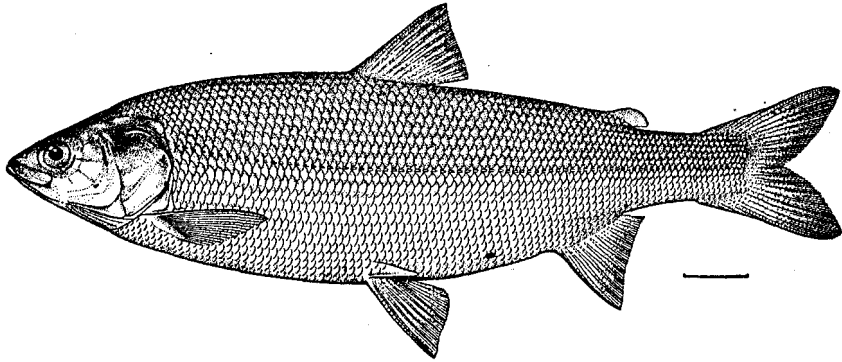


FIG. 10.—*Leucichthys artedi bisselli* (Bollman). Rawson Lake herring. (Drawn from a specimen 13 inches long, collected in Howard Lake, Michigan.)

lower jaw slightly longer than upper; maxillary extending to below anterior edge of pupil, the supplemental parts three times as long as broad; width of opercle 3 in head. Dorsal inserted midway between snout and caudal base, its longest ray 1.5 in head; adipose base 6 in head, length from insertion to tip 3.33 in head; anal base 2.33 in head, longest ray 2.25, and its scale 2.5 in ray length.

Color in spirits, light olive, somewhat darker above; sides silvery; dorsal fin clear, edged with dark, other fins clear.

This subspecies is slightly more robust than *L. artedi*, but no differences of importance set it off from the lake form from which it is no doubt derived.

Leucichthys eriensis (Jordan & Evermann). *Jumbo Herring; Erie Great Herring.*

Argyrosomus eriensis Jordan & Evermann, Proc. U. S. Nat. Mus., vol. xxxvi, March 3, 1909, p. 165, fig. 1, Lake Erie at Port Stanley.

Habitat: Lake Erie, northward.

This species inhabits especially the north shore of Lake Erie, where it is extremely abundant. As a food fish it is far superior to the other lake herrings and is as good as the best whitefish. The original type came from Port Stanley. Besides the type we have examples from Port Burwell and Point Rondeau. Reports of jumbo herring from Toronto have reached us, but these probably refer to large examples of the local species. As the fishes from Port Stanley are largely sold in Toronto, it is possible that the reference is to Lake Erie examples of the present species.

The jumbo herring has been confounded with the tullibee, with which it has nothing in common save the robust form. The name "mongrel whitefish" belongs to *eriensis*, not to the tullibee. The nearest relative of *L. eriensis* is *L. artedi*, from which it differs in the much more robust form, deeper nape, smaller head, and firmer scales.

The following is the original account:

Head 4.4 in length, measured to base of caudal; depth 3.4; depth of caudal peduncle 2.2 in head; eye 5.2; snout 3.75; interorbital space 3.25; length of maxillary from tip of snout 3; dorsal 10; anal 12; scales in lateral line 71; between lateral line and origin of dorsal 8; between occiput and dorsal 32.

Body very deep, its width contained 1.4 times in head; dorsal outline curved abruptly upward behind occiput; dorsal contour of head straight; snout pointed, though rather blunt at tip; jaws about equal, the lower closing just beneath the upper at tip; maxillary extending to a point beneath anterior edge of pupil, the supplemental part about 3 times as long as wide. Gillrakers on first arch 16+29, very slender, the longest equal in length to diameter of orbit. Scales firmly attached. Dorsal inserted about midway between tip of snout and base of caudal, the highest (first) ray contained 1.5 times in length of head; height of adipose dorsal equal to 1.5 times the length of its base; height of anal contained 2 times in length of head; outline of both dorsal and anal slightly concave; origin of ventral below anterior part of dorsal, length of fin contained 1.5 in head; pectoral 1.4 in head.

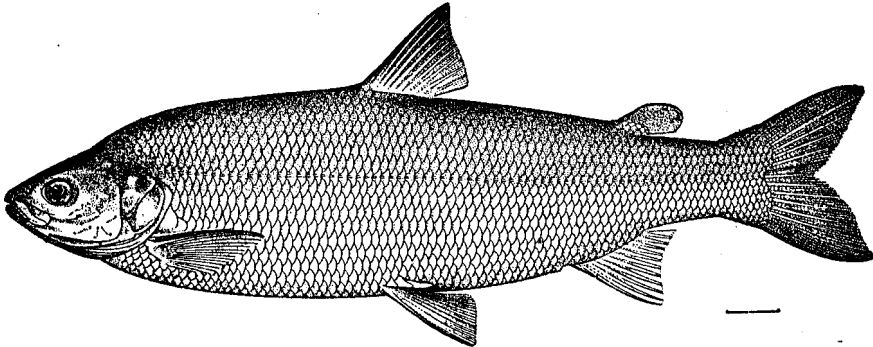


FIG. 11.—*Leucichthys eriensis* (Jordan & Evermann). Lake Erie Herring; Jumbo Herring. From the type.

Color in spirits silvery, dusky on upper parts, but without blue shades in life; distal portion of dorsal, outer part of caudal, and edge and tip of pectoral dusky; other fins white.

Type (no. 62515, U. S. Nat. Mus.) from Lake Erie at Port Stanley, Ontario, measuring 16½ inches in length, and collected by the writers. This represents the maximum size of the species as seen by us. Its weight when fresh was 2¾ pounds. A cotype, 14½ inches long, no. 13083, Stanford University collection, obtained at the same time, is a little smaller and slightly darker in color, the anal having a terminal dusky cloud. It has 11 dorsal and 11 anal rays.

This species is very abundant along the northern shore of Lake Erie about the first of August. It is also occasionally taken in the southern part of Lake Huron, but it seems to be unknown in Lake Superior, and we did not hear of it in Lake Ontario. On the date of our visit to Port Stanley, July 29, 1908, about 1,500 pounds were taken in the gill nets. The largest of these weighed 2¾ pounds and were about 18 inches in length. The bulk of the catch was, however, about 14 inches in length. It is said of this species that there is a "great spurt," or large run, in the spring and a short one in the autumn before the spawning time in November.

The jumbo herring was also seen at Port Burwell, where large numbers are smoked, having an excellent flavor as thus prepared. Many others from Point Rondeau, Ontario, were seen in the Detroit market.

Leucichthys eriensis is characteristic of the northern part of Lake Erie, although other species, *Leucichthys artedi*, the common lake herring, and *Leucichthys sisco huronius* are found in the same lake. It is said to have been virtually unknown until ten years ago, but is rapidly increasing in abundance.

Fishermen claim that it is found in middle water, not at the surface nor at the bottom. As a food fish it is far superior to any other lake herring, being as delicate and rich as the best whitefishes, *Coregonus albus* and *Coregonus clupeaformis*. It is therefore a species worthy of careful attention from the propagators of fishes. Most of the fishermen claim never to have seen examples of 2 or 3 pounds until within four or five years. It is locally known as the jumbo herring because it reaches a larger size than any other lake herring except the tullibee of the northwestern lakes (*Leucichthys tullibee*).

It is believed by many fishermen that the jumbo herring is the product of a cross between the Erie whitefish (*Coregonus albus*) and the lake herring (*Leucichthys artedi*). This belief is without foundation. It rests on the fact that at the Put-in Bay hatchery attempts have been made to fertilize whitefish eggs with the milt of the lake herring, in default of the milt of its own species. To test this matter Mr. Frank N. Clark, of the hatchery at Northville, Mich., undertook the same experiment under carefully prepared conditions. In no case was the egg of a whitefish fertilized by the milt of the lake herring, and the hybridization of the two species is quite improbable.

Subgenus CISCO Jordan & Evermann, new subgenus.

Cisco Jordan & Evermann, new subgenus (type, *Argyrosomus nigripinnis* Gill).

The depths of the Great Lakes are inhabited by species of *Leucichthys*, locally known as blackfin, bluefin, cisco, longjaw, bloater, kiyi, chub, etc., differing somewhat from any of the shore species of the genus. In nearly every favorable locality three forms of these fishes are found, representing the three principal species, *prognathus* (with *supernas* and *johannæ*), *nigripinnis* (with *cyanopterus*), and *hoyi* (with *zenithicus*). These fishes are much softer in flesh and more delicate than the ordinary lake herring. They spawn earlier, in summer, and are rarely taken in water of less than 60 fathoms. None has been found in Georgian Bay or Lake Erie. They inhabit the western part of Lake Ontario, the northwestern part of Lake Huron, the whole length of Lake Michigan, and the middle southern part of Lake Superior.

***Leucichthys supernas* Jordan & Evermann, new species. *Cisco* of Lake Superior.**

Type, no. 64679, U. S. National Museum, a specimen about 11 inches long, from Lake Superior off the mouth of Knife River, near Duluth; coll., Doctor Jordan.

Habitat: Deep waters of Lake Superior.

The cisco, as it is called about Lake Superior, is a fine silvery species, found in waters of 50 fathoms or more, and is regarded as an excellent food fish. It is near *Leucichthys prognathus* and *L. johannæ*

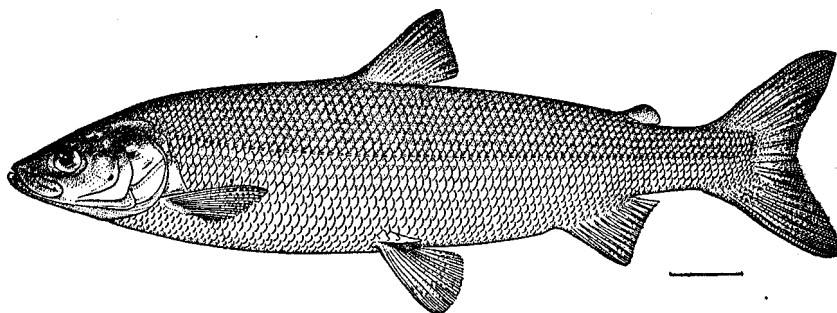


FIG. 12.—*Leucichthys supernas* Jordan & Evermann, new species. *Cisco* of Lake Superior. (Drawn from the type, a specimen, 11.5 inches long, collected in Knife River, Lake Superior, off Duluth, Minn.)

but is a better food fish than these, is of firmer flesh, and reaches a larger size. It also approaches somewhat *Leucichthys harengus* of the shore waters of the same region.

Leucichthys supernas is especially characteristic of the waters to the west of the Keweenaw peninsula, where it is found in company with the bluefin, *Leucichthys cyanopterus*, and the longjaw, *Leucichthys zenithicus*, and also the siscowet, which preys on all three. The bluefin is a still better fish, reaching a larger size, while the longjaw is inferior and much less fat

Description of type: Head 4.4 in body to base of caudal fin; depth of body 4; length of caudal peduncle from last anal to first caudal rays 2 in head, its depth 2.87; eye 4.6; snout 3.87 to 4; inter-orbital space 3.5; length of maxillary from tip of snout 2.87; dorsal 10 (developed rays); anal 12; scales 8-76-7; branchiostegals 9; gillrakers 15+29, length .66 eye diameter.

Body somewhat elongate, moderately deep, and compressed, very much resembling *L. artedi*; arched between snout and insertion of dorsal more than from insertion of dorsal to caudal, slightly more convex ventrally; caudal peduncle long, not deep as in *L. artedi* (some specimens of which it approaches, however), and compressed; head smaller than in *L. prognathus*, not full at nape; snout pointed, compressed, its outline continued by premaxillaries, lower jaw slightly projecting; maxillaries short in proportion to snout, reaching to anterior edge of pupil; distance from snout to occiput slightly less than half distance from occiput to dorsal insertion.

Lateral line straight, scales moderate, thin.

Dorsal fin inserted midway between snout and base of caudal, low, more so than in *L. artedi*, its longest ray a trifle less than .66 head, its base .66 of ray length; adipose fin rather small, as long as snout, measuring from insertion to free end; caudal widely forked; anal rather low, its longest ray 2.3 in head, its base equal to ray length, its margin nearly truncate; pectorals and ventrals rather shorter than in *L. artedi*, being slightly longer than longest dorsal ray, the former not reaching more than half way to ventrals.

Color in spirits silvery, slightly darker above, especially on removal of scales; cheeks silvery; dorsal fin dark on distal half, caudal broadly edged with black, other fins colorless save for very slight stipple on pectoral.

As already indicated, this species, although a deep-water form, is very close to *L. harengus*, of which it is probably a deep-water variant. It is perhaps through *L. supernas* that the other deep-water forms are derived. Compared with *L. harengus*, *L. supernas* has a slightly deeper tail and the body is less slender. Two specimens of cisco, from off Knife River, near Duluth, differ from the others in the number of gillrakers, the number being about 11+21. Such variations were also noted by Evermann & Smith. These specimens are a little more robust than the others, with the adipose fin perhaps a trifle larger. For the present we can only record them as a variant of *L. supernas*. They differ from *L. johannæ* in the slightly shorter snout, broader interorbital space, deeper body, and firmer scales.

A copepod, apparently the same, is parasitic on both *L. supernas* and *L. harengus*.

Leucichthys prognathus (H. M. Smith). *Cisco of Lake Ontario; Ontario Longjaw; Bloater; "Chub."*

Coregonus prognathus Smith, Bull. U. S. Fish Comm., vol. xiv, 1894, p. 4, pl. 1, fig. 3, Lake Ontario at Wilson, New York; type no. 45568, U. S. National Museum; coll., John S. Wilson.

Argyrosomus prognathus, Evermann & Smith, Rept. U. S. Fish Comm. 1894, p. 314, 1896, pl. 26, Lake Ontario; Jordan & Evermann, Fishes North and Mid. Amer., pt. 1, p. 471, 1898 (after Smith).

Habitat: Deep waters of Lake Ontario, in depths of 60 fathoms and more.

This species is abundant in the western part of Lake Ontario in deep water. Whether any fishes from Lake Huron or Lake Michigan (here recorded as *L. johannæ*) should be referred to this species is uncertain. It is distinguished by its projecting lower jaw and by the thick body. When taken from deep water the viscera become inflated under reduced pressure, hence the name "bloater" given to this and to the related species in the upper lakes. Our specimens of this species were taken by Dr. Seth E. Meek in Lake Ontario off Toronto.

The following description is from a ripe female, 8½ inches long, from off Toronto, no. 4922 in the table on page 26.

Head 4 in length to base of caudal; depth 3.5 (greater on account of ripe condition); length of caudal peduncle from last anal to first caudal ray 2.5 in head, depth nearly 3.5; eye 4; snout 4; inter-orbital space 3.57; length of maxillary from tip of snout 2.6; dorsal 10 (developed rays); anal 11; scales 8-71-7; branchiostegals 8; gillrakers 15+29.

Body moderately elongate, more convex ventrally, appearing, despite ripe condition of specimen, deeper than specimens from Lake Huron; caudal peduncle slender, tapering much, especially on ventral outline from anus; head large, thick at opercle, nape full and humped or strongly curved from occiput

to insertion of dorsal; snout bluntly rounded, broad; lower jaw projecting markedly, a slight angle at symphysis of dentaries, giving jaw a slightly hooked appearance; premaxillaries not breaking contour of head noticeably; lateral projection of anterior ends of preorbitals and maxillaries greater than usual; maxillaries extending to below middle third of eye, their supplementals one-half their breadth and length; distance from snout to occiput long, half distance between dorsal and occiput; opercular breadth equal to snout.

Lateral line rising slightly anteriorly, but nearly straight; scales moderate, slightly larger anteriorly, easily detached.

Dorsal fin inserted nearer base of caudal than snout, moderately high, its longest ray about 1.5 in head, its base 2.5, its margin truncate; adipose moderate (somewhat shrunken in preservation), slightly shorter from insertion to tip than snout; ventrals and pectorals a trifle, the latter noticeably, longer than dorsal, pectoral reaching half way to ventrals; anal slightly concave; adipose eyelids and pectoral fold not prominent; caudal forked widely but not deeply.

Color in spirits, suffused with brownish, darker above than in Lake Huron specimens; lateral line marked with line of distinct black in specimen at hand; fins clear, dorsal and caudal dusky on distal halves; ventrals, anal, and pectorals with only slight traces of black stipples on first rays and margins.

From the bloater of Lake Michigan, which we here call *Leucichthys johannæ*, the Ontario fish differs in its darker coloration, the more projecting lower jaw, the slenderer caudal peduncle, the greater depth of the body, and the greater distance between the pectorals and ventrals. From typical examples of *Leucichthys johannæ*, it also differs in the much larger number of gillrakers. But as stated later, part of our specimens from Lake Huron, referred to *L. johannæ*, have the gillrakers much as in *L. prognathus*. What this difference means is a matter demanding further study.

***Leucichthys johannæ* (Wagner). Lake Michigan Cisco; Bloater of Lake Michigan. (Pl. III.)**

Argyrosomus johannæ Wagner, Science, n. s., vol. xxxi, no. 807, p. 957-958, June 17, 1910, Lake Michigan, in about 25 fathoms, some 18 miles off Racine, Wis. Type no. 372d, Wisconsin Geological and Natural History Survey.

The bloater is very common in the northwestern part of Lake Huron in deep water, and also for the whole length of Lake Michigan. On these lakes it is not often taken to the markets, and is not highly valued as food. It is a great nuisance to the fishermen, large schools entering the nets and tangling them, although the mesh is large enough to allow escape.

Whether the form in Lake Huron and Lake Michigan is really distinct from the *prognathus* of Lake Ontario is a matter we can not finally determine. Some examples of *johannæ* may be known at once by the few gillrakers, but this character is lost in Lake Huron examples, which, for the present, we are forced to refer to the same species.

The following is a description from four specimens, 7 to 10 inches in length, two from Lake Michigan near Chicago and two from Lake Huron off Cheboygan, Mich.:

Head 4.2 in body length to base of caudal; depth of body equal to head; length of caudal peduncle from last anal to first caudal ray 2.4 in head, its depth 3.5; eye 4.4; snout 3.75 in head; interorbital space equal to snout; length of maxillary from tip of snout 2.66 in head; dorsal 11 (developed rays); anal 12; scales 8-76-8 (8-74 to 80-7 or 8), branchiostegals 9; gillrakers on first arch 11+23.

Body moderately elongate, not greatly compressed nor deep, its depth 1.66 its width; more convex ventrally (possibly on account of being brought from a depth and blown out by reduced pressure); without nuchal hump; caudal peduncle long, not deep, somewhat compressed; head moderately long, somewhat less than the average of *L. zenithicus*; distance from snout to occiput moderately long, equal to half distance from occiput to insertion of dorsal; eye moderate; maxillary rather long, reaching to below anterior third of pupil, without decurving strongly on free edge from junction with premaxillaries; premaxillaries continuing contour of head at but slight angle; snout rather long and rounded, lower jaw projecting beyond it somewhat with a small symphyseal angle; suborbitals narrow, preorbitals rather broad. Lateral line straight, scales moderate in size, thin and flexible. Dorsal fin inserted midway between snout and base of caudal, moderately high, border truncate, adipose moderate, from insertion to free end somewhat longer than snout; pectoral and ventral rather short, latter not

reaching beyond halfway to former, about equal to distance between snout and occiput. Anal rather short, 2.4 in head, concave.

Color in spirits silvery, suffused with brownish and slight dark above lateral line, below silvery white or colorless, cheeks silvery; fins colorless, save for slight edging of black on dorsal and caudal.

Besides these specimens, which resemble each other closely and belong to the same species, we have others not differing at all externally, in which the average number of gillrakers runs from 12+25 to 14+28. All these are from Lake Huron, off Cheboygan, and approach *Leucichthys prognathus*. Evermann & Smith (Report U. S. Fish Commission for 1894, p. 311) note the finding of similar examples, five from Lake Michigan and three from Lake Superior, which they refer provisionally to *hoyi*, although recognizing the close relation to *prognathus*. They say: "In the numerous specimens of *hoyi* examined, the average number of gillrakers was found to be 39, while for the 8 specimens here considered the average is but 31½." These specimens from Lake Michigan we refer to *L. johanna*, those from Lake Superior provisionally to *L. supernas*. The specimens from Lake Michigan which differ from the type of *Leucichthys johanna* we may regard for the present as a variation of the latter. We here present a description of this form.

Description of the bloater of Lake Huron with many gillrakers (*Leucichthys johanna*, var. B.):

Seven specimens from 6.25 to 9 inches in length; one 8.5 inches in length, no. 5277 here described; all from Lake Huron, off Cheboygan, Mich.

Head 4 in length to base of caudal; depth 4; length of caudal peduncle from last ray of anal to first of caudal 2.4 in head, depth 3.25; eye 4; snout 3.57; interorbital space 4; length of maxillary from tip of snout 2.3 in head; dorsal 10 (developed rays); anal 12; scales 8-79-7; branchiostegals 9; gillrakers 14+26.

Body moderately elongate, more convex in ventral outline, not greatly compressed, its width 1.66 in body depth; caudal peduncle rather long and slender, its width 1.5 in depth; ventral outline along base of anal tapering more abruptly to caudal peduncle than dorsal outline; head long as in *L. zenithicus*; dorsal surface slightly arched from snout to occiput, and from eye to eye; snout bluntly rounded, not tapering much; underjaw projecting; dentaries meeting at a slight angle to form a dorsal tubercle at symphysis; premaxillaries breaking contour of head but slightly; anterior ends of preorbitals and maxillaries protruding laterally somewhat to give bluntly rounded appearance to snout; maxillaries not lying closely to head along their whole length, extending to below middle third of eye; supplementals 0.5 maxillary breadth (in other specimens 0.66); distance from snout to occiput long, from 0.5 to 0.57 of distance between occiput and dorsal fin; opercular breadth slightly more than length of snout; lateral line straight; scales moderate in size, easily detached, and smaller posteriorly.

Dorsal fin inserted nearer base of caudal than tip of snout, moderately high, its longest ray about 1.5 in head, its base 2.5, border truncate; adipose moderate, from insertion to tip nearly equal to snout, its height 0.33 length; ventrals and pectorals as long as dorsal ray, pectorals reaching halfway to ventrals; anal somewhat concave; caudal forked widely.

Color in spirits not very silvery, suffused with brownish, but slightly darker above; fins clear, save for dusky margin of dorsal and caudal; slight trace of black on pectorals; lateral line sometimes marked distinctly, sometimes very faintly with a line of black.

Whether *Leucichthys johanna* can be separated as a species from *L. prognathus* is uncertain; as there can be no connecting forms, it is a distinct species or nothing.^a

^a The following is Mr. Wagner's original description of this species:

Head, 4.1 in length to base of caudal; depth, 3.8; eye, 6.5 in head; depth of caudal peduncle, 3.1; snout, 3.4; maxillary, 2.6; mandible, 2; height of dorsal fin, 1.5; distance from snout to dorsal, 1.9 in length; gillrakers, 10+19; longest, 1 in eye; dorsal, 10; anal, 12; scales, 9-80-8.

Body deep, not greatly compressed, back strongly arched, rising rapidly for one-half the distance from snout to dorsal, then more gradually. Caudal peduncle high, not greatly compressed. Head small, sharply wedged-shaped, its height at occiput 1.9 in height of body. Eye small. Lower jaw even with upper; maxillary reaching nearly to center of eye. Gillrakers coarse and widely set. Lateral line straight. Scales large and thick, nondeciduous.

Color (in formalin): Lips and head pale; body dark above but not nearly to lateral line; quite pale below. Dorsally some indication of stripes, longitudinally. Dorsal and caudal fins with black edges, other fins pale.

Comparison of Leucichthys prognathus and Leucichthys johanna.

Specimen no.	<i>L. prognathus</i> , Toronto.		<i>L. johanna</i> , Cheboygan.		
	4922	5280	5281	5279	5277
Length to base of caudal mm.	205	210	164	160	215
Dorsal rays	10	10	11	9	10
Anal rays	11	12	12	11	12
Scales	8-71-7	8-78-7	8-70-7	8-73-7	8-79-7
Branchiostegals	8	9	8	8	9
Gillrakers	15+29	12+25	13+26	14+28	14+26
Sexual condition	Ripe ♀	?	?	Ripe ♂	Unripe ♀
Comparative measurements: ^a					
Head	0.26	0.26	0.26	0.26	0.25
Depth . . . . .	.30	.27	.26	.25	.23
Caudal peduncle—					
Length . . . . .	.095	.105	.095	.11	.11
Depth . . . . .	.07	.08	.075	.075	.08
Eye . . . . .	.065	.06	.07	.072	.06
Snout . . . . .	.068	.07	.075	.07	.07
Interorbital space . . . . .	.07	.065	.065	.07	.065
Maxillary from tip of snout . . . . .	.10	.10	.105	.105	.11
Opercular breadth . . . . .	.07	.07	.075	.075	.07
Subopercular breadth . . . . .	.03	.02	.03	.03	.035
Snout to occiput . . . . .	.185	.185	.19	.19	.185
Ventrals to pectorals . . . . .	.39	.36	.35	.35	.34
Pectorals in pectoral-ventral distance	2.125	2.20	2.00	1.80	2.00
Pectoral length . . . . .	.19	.17	.17	.19	.18
Ventral length . . . . .	.18	.17	.18	.19	.18
Dorsal height . . . . .	.165	.17	.17	.19	.165
Adipose length . . . . .	.06	.07	.07	.08	.08
Anal height . . . . .	.11	.10	.11	.11	.10

^a Measurements in hundredths of body lengths unless otherwise specified.

***Leucichthys nigripinnis* (Gill). Blackfin of Lake Michigan. (Pl. IV.)**

Argyrosomus nigripinnis Gill Ms., in Hoy, Trans. Wis. Ac. Sci., 1, p. 100, 1872, Lake Michigan off Racine; name only. Hoy, Rept. U. S. Fish Comm. for 1872-73 (1874), p. 87, Lake Michigan off Grand Traverse. Jordan, Rept. Geol. Surv. Ind. 1875, p. 5, Lake Michigan. Jordan & Evermann, Fishes North and Mid. Amer., pt. 1, p. 472, 1898, Lake Michigan, Lake Mendota, and Lake Miltona, Wisconsin. Evermann & Smith, Rept. U. S. Fish Com. 1894, p. 317, pl. 27 (1896), Lake Michigan.

Habitat: Deep waters of Lake Michigan and certain small lakes in Wisconsin.

This is the largest of the deep-water ciscoes, and is a food fish of fine quality and of large commercial importance in Lake Michigan. It reaches a larger size than any of the other species of *Leucichthys* except *eriensis*, and is readily known by its black fins, in connection with its plump body and rather large eye and mouth. In Lake Michigan the fins are all chiefly black and the fish is called blackfin. In Lake Superior the species is replaced by the paler closely allied bluefin, *Leucichthys cyanopterus*.

The following description is from our single specimen, 13 inches long, taken in Lake Michigan, off Kenosha:

Head slightly less than 4 in body length to base of caudal; depth slightly more than 4; length of caudal peduncle from last rays of anal to first of caudal 3 in head, depth slightly greater; eye 4.66; snout 4; interorbital space 3.5; maxillary from tip of snout 0.5 longer than snout, 2.66 in head; dorsal 11 (fully developed rays); anal 12; scales 8-75-8, between occiput and dorsal 34; branchiostegals 8; gillrakers 18+33.

Body moderately elongate, dorsal and ventral outlines symmetrical, not greatly compressed, its width 2.33 in greatest depth; caudal peduncle short and deeper than its length. Head moderate in length; snout not conical viewed from above, but rounded and broad; premaxillaries projecting very obliquely forward; lower jaw longer, with slight symphyseal angle; maxillary not quite reaching anterior edge of pupil; distance from snout to occiput short, less than twice in distance from occiput to dorsal, and 2.5 times opercular breadth, which is slightly shorter than snout. Lateral line straight, nearer dorsal outline; scales moderate, of equal size anteriorly and posteriorly.

Dorsal inserted slightly nearer head than base of caudal, relatively high, equal in length of first developed ray to the distance between the snout and occiput, a trifle more than 1.5 in head, all ray tips

coinciding when fin is supine, edge truncate, nearly perpendicular, base 2 in head; adipose moderate, equal in length, from insertion to tip, to interorbital space; caudal broad, widely forked, anal moderately high, its edge concave, first developed ray not reaching tip of last when supine; ventrals long, slightly more so than dorsal; pectoral still longer, 1.66 in distance from pectoral to ventrals.

Color in spirits silvery, dark blue-black above, on tip of mandibles and snout, black on all fins, saving their bases, which are clear; ventrals, pectorals, and anal with less black than other fins; body colorless ventrally.

***Leucichthys cyanopterus* Jordan & Evermann, new species. Bluefin.**

Type, no. 64672, U. S. National Museum, a specimen 16 inches long, from Lake Superior, off Marquette, Mich.; coll., Mr. August J. Anderson.

Habitat: Deep waters of Lake Superior.

This species, closely allied to the blackfin, *L. nigripinnis*, is here described from the type and 9 cotypes from off Marquette in Lake Superior.

Head a trifle less than 4 in body length to base of caudal; depth of body 3.75; length of caudal peduncle from last anal ray to first of caudal 2.25 in head, its depth 2.8; eye 5; snout 3.5; interorbital space slightly more than snout; length of maxillary from tip of snout 2.8 in head; dorsal 10 or 11 (developed rays); anal 11 or 12; scales 8-76 to 87-7, between occiput and dorsal about 33; branchiostegals 9; gillrakers 13 or 14+24 to 27.

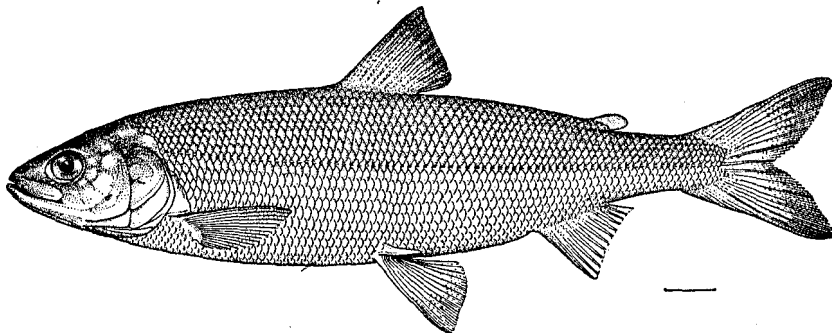


FIG. 13.—*Leucichthys cyanopterus* Jordan & Evermann, new species. Bluefin. (Drawn from the type, a specimen 16 inches long, collected in Lake Superior off Marquette, Mich.)

Body less elongate than usual, dorsally and ventrally equally curved; depth greater than usual not greatly compressed; width of body a trifle over twice in depth; caudal peduncle moderately long and deep, tapering from the proximal end to the caudal, and not more compressed than the body; head somewhat smaller than in related deep-water forms, but larger than in *L. artedi*; snout rounded, lower jaw usually the longer, but meeting the projecting premaxillaries; maxillaries extending nearly to a vertical from the front margin of pupil, and lying close to dentaries, so as to give them an oblique relation to the ventral body plane, distance from snout to occiput slightly more than half the distance from occiput to insertion of dorsal; opercular breadth about equal to snout or somewhat greater; eye rather large, less than interorbital space, the latter very slightly convex, straight in profile; snout slightly arched in profile.

Lateral line straight, slightly nearer dorsal outline; scales moderate in size, equal, save on the caudal peduncle and on belly, showing blue-green luster when magnified. Dorsal fin inserted nearer snout than base of caudal, moderately high, its longest ray about 1.66 in head, its base somewhat over 2, its margin straight or slightly concave, first and last ray tips coinciding when supine; adipose rather large but variable, about 4.33 in head, and moderately high; caudal broad, widely forked, moderately deep; anal similar to dorsal in shape, but about 0.66 its height, its margin more concave, its base about equal to that of dorsal; ventrals long, reaching 0.75 distance to anal, and broad; pectoral also long, reaching halfway or more to insertion of ventrals, and longer than the latter.

Color in spirits silvery, darker above, with a bluish tint; dorsal fin dark on first ray and on distal half, but not dense black, as in *L. nigripinnis*; caudal broadly margined with black in varying degrees;

pectorals and anal margined with fainter black, the latter less; ventrals usually pale, but not always.

This species is exceedingly close to *Leucichthys nigripinnis*, from which it differs by a somewhat shorter snout, fewer gillrakers (18+33 in our specimen of *L. nigripinnis*) and the less pronounced black of the fins. In the measurements given by Evermann & Smith in the Report of the U. S. Commission of Fish and Fisheries for 1894, page 318, the gillrakers for 17 specimens of *L. nigripinnis* of Lake Michigan ranged from 16+30 to 19+34, whereas in our specimens (10 in number) of *L. cyanopterus* the range is from 13+24 to 14+27. From *L. zenithicus*, to which it is almost as closely related as to *L. nigripinnis*, it differs in the shorter maxillary, smaller mouth and deeper body.

The most marked differences are in the length of the maxillary, which in *L. zenithicus* ranges from 0.10 to 0.11 of the body length, while in *L. cyanopterus* it is only 0.083 to 0.095, and in the greater depth of body, the former ranging between 0.21 and 0.245 (with one specimen 0.26), while the latter varied from 0.245 to 0.28. All our specimens of *L. cyanopterus* were taken at Marquette, whence they were sent us by Mr. August J. Anderson, a prominent fish dealer at Marquette. Four specimens of *L. zenithicus* came from Marquette and 6 from near Duluth. The length of our specimens of *L. cyanopterus* is in every case greater than that of any specimen of *L. zenithicus*. In quality of flesh there is a marked difference, the *L. cyanopterus* taken at Marquette being very fat with thick abdominal walls, while *L. zenithicus* is generally lean and with thin abdominal walls. The greater depth of *L. cyanopterus* may be due to accumulations of fat.

Other specimens are from Duluth and from off Knife River, at the head of Lake Superior. The species abounds in the deep waters of the lake, its value exceeding that of the other deep-water species. A large specimen apparently belonging to *L. cyanopterus* was found in the Toronto market. Its fins were almost without dark markings. It must have come from Wiarton, on Georgian Bay. It is very unlikely that any Lake Superior fish would be mixed with these.

Comparison of specimens of Leucichthys cyanopterus from Marquette, Lake Superior.

Specimen no..	5242	5228	5246	5243	5248	5247	5244	5240	5245	5249
Length without caudal.....mm..	285	295	305	322	325	330	335	340	345	345
Dorsal rays.....	10	10	11	10	11	10	11	11	11	10
Anal rays.....	11	12	12	11	14	12	11	12	11	11
Scales.....	8-79-7	8-78-7	8-86-7	8-85-7	8-82-7	8-87-7	8-81-8	8-76-7	8-83-8	8-82-7
Scales between occiput and dorsal fin.....	35	32	35	35	33	36	32	32	33	33
Branchiostegal.....	9	9	9	9	9	9	9	9	9	9
Gillrakers.....	14+27	.....	13+24	14+24	13+24	14+27	14+27	13+25	14+26	14+26
Sex.....	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀
Comparative measurements: ^a										
Head.....	0.24	0.265	0.255	0.245	0.24	0.25	0.262	0.25	0.23	0.245
Depth.....	.25	.245	.28	.26	.27	.275	.265	.26	.25	.27
Caudal peduncle—										
Length.....	.10	.115	.12	.11	.115	.10	.10	.115	.12	.115
Depth.....	.075	.07	.08	.08	.085	.08	.08	.075	.08	.085
Eye.....	.05	.05	.054	.05	.052	.052	.052	.05	.05	.05
Snout.....	.07	.08	.07	.067	.07	.067	.075	.065	.065	.07
Maxillary from tip of snout.....	.09	.095	.09	.087	.083	.095	.095	.09	.09	.09
Snout to occiput.....	.17	.18	.18	.17	.165	.175	.18	.18	.165	.173
Pectoral length.....	.17	.19	.17	.19	.175	.18	.185	.19	.19	.195
Ventral length.....	.165	.16	.17	.18	.16	.18	.17	.17	.175	.16
Dorsal height.....	.15	.155	.15	.16	.15	.165	.15	.15	.14	.14
Adipose length.....	.065	.07	.07	.07	.06	.065	.065	.075	.062	.07
Anal height.....	.10	.095	.105	.10	.10	.10	.10	.10	.10	.11

^a Measurements in hundredths of body lengths unless otherwise specified.

Leucichthys hoyi (Gill). *Cisco of Lake Michigan; Kiyi; Chub; Mooneye Cisco.* (Pl. v.)

Argyrosomus hoyi Gill Ms., in Hoy, Trans. Wis. Ac. Sci., vol. 1, 1872, p. 100, Lake Michigan off Racine; no description. Milner, Rept. U. S. Fish Comm. for 1872-73 (1874), p. 86; in part; no description. Jordan, Rept. Geol. Surv. Ind. 1875, p. 5, Racine, Wis., specimen received from Doctor Hoy. Jordan & Evermann, Fishes of North and Mid. Amer., pt. 1, p. 469, 1898, Racine and Kenosha. Evermann & Smith, Rept. U. S. Fish Comm. 1894, p. 310, pl. 22 (1896), Lake Michigan.

Habitat: Lake Michigan, in deep water.

This beautiful cisco is very abundant in the deep waters of Lake Michigan and is an excellent food fish, very delicate in flavor. We have examined specimens from Racine (Doctor Hoy's type),

from Kenosha (here figured), and from Green Bay, off Escanada. Thus far it has not been certainly recognized outside of Lake Michigan, the closely related *L. zenithicus* replacing it in Lake Superior and probably in Lake Huron.

Description of *Leucichthys hoyi* from a cotype, a specimen 11 inches in length taken off Kenosha, Lake Michigan, sent to Doctor Jordan by Doctor Hoy, no. 11919, Stanford University collection:

Head about 4 in body length without caudal; body depth equal to head; length of caudal peduncle from last anal to first caudal rays 2.2 in head, depth of same 3.25; eye 4.5; snout 3.5; interorbital space slightly less than snout; maxillary 2.5 in head; dorsal 10 (fully developed rays); anal 11; scales 7-72-7; branchiostegals 9; gillrakers 14+25 (gill-arch mutilated slightly, however).

Body somewhat elongated and compressed; yet not deep; dorsal and ventral outlines similar, without nuchal hump or fullness; caudal peduncle long, somewhat compressed, and not deep; head moderately large (not as long as in *L. zenithicus* or *L. prognathus*, but larger than in *L. harengus* or *L. artedi*); snout rather long, blunt, because of almost vertical position of premaxillaries, which approach those of a true *Coregonus* in position; jaws subequal, the lower slightly included; maxillaries broad and long, extending slightly beyond vertical from center of pupil; eyes fairly large; distance from snout to occiput long, 0.5 distance from occiput to dorsal fin insertion. Gillrakers numerous, their length 0.5 eye diameter, slightly serrated on edges. Lateral line straight, scales moderate, smaller

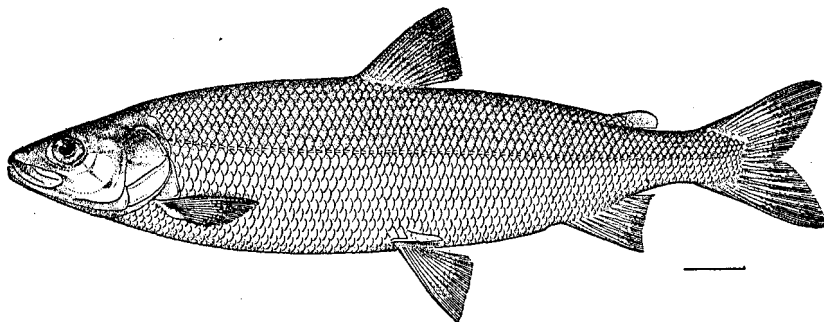


FIG. 14.—*Leucichthys hoyi* (Gill). Cisco of Lake Michigan. (Drawn from a specimen 11.5 inches long, collected in Lake Michigan at Kenosha, Wis.)

posteriorly. Dorsal fin inserted midway between snout and base of caudal fin, low, its longest ray 1.2 in head, its base 0.66 ray length, its margin truncate; adipose rather small; caudal widely forked; anal low, its longest ray 2.6 in head, its base slightly shorter or equal; pectorals and ventrals equal in length, and equal to longest dorsal ray, the former not reaching quite half way to ventrals in specimen at hand.

Color in spirits silvery, slightly darker above; cheeks silvery; fins colorless, save for slight black on edge of dorsal and caudal.

***Leucichthys zenithicus* (Jordan & Evermann). Longjaw of Lake Superior.**

Argyrosomus hoyi, Milner, Rept. U. S. Fish Comm. 1872-73 (1874), p. 86, Lake Superior at Outer Island, Wisconsin; not of Gill, Hoy, or Jordan, and not original type.

Argyrosomus zenithicus Jordan & Evermann, Proc. U. S. Nat. Mus., vol. xxxvi, March 3, 1909, p. 169, fig. 3, Lake Superior, between Duluth and Isle Royale.

Habitat: Lake Superior, in deep water; possibly in other lakes.

Description of *Leucichthys zenithicus*, from 11 specimens, 8.5 to 12 inches in length, 4 from Marquette, Lake Superior, and 7 from Duluth, Lake Superior:

Head 3.8 to 4 in length to base of caudal; depth 4 to 4.75; length of caudal peduncle from last anal ray to first caudal 2.2 to 2.5 in head, depth about 3.5; eye, 4.6; snout, 3.5; interorbital space about equal to snout; length of maxillary from tip of snout 2.6 in head; dorsal 10 or 11 (developed rays); anal 11 or 12; scales 8-77 to 83-7, between occiput and origin of dorsal, 32 to 34; branchiostegals 9; gillrakers 14 to 16+24 to 28.

Body rather elongate, somewhat compressed, its width about 2.4 in length of head; depth greatest cephalad of insertion of dorsal, seeming to taper posteriorly from somewhat larger head, but not always; caudal peduncle moderately elongate and not deep, compressed; head rather large, larger than in *L. cyanopterus* on average, but about same as *L. prognathus*, which is larger than usual; snout proportionately long; maxillaries long, extending almost to below center of pupil, gape large; lower jaw equal to or longer than upper; distance from snout to occiput long, slightly more than half distance from occiput to dorsal. Eye large in proportion to the larger head; dorsal surface of head slightly arched and convex between orbits. Lateral line straight near center of body, scales moderate in size, loosely attached. Dorsal inserted nearer base of caudal, high, its longest ray about 1.6 in head, its base 2.5, its margin straight or slightly concave, the longest, first developed ray reaching beyond tip of last ray when supine; adipose rather large, but variable; caudal deeply forked; anal short, its longest ray about 0.66 that of longest dorsal ray; ventrals long, reaching about 0.66 distance to anal; pectoral longer, reaching more than halfway to ventrals, the fin length variable, merging into that of other closely related species.

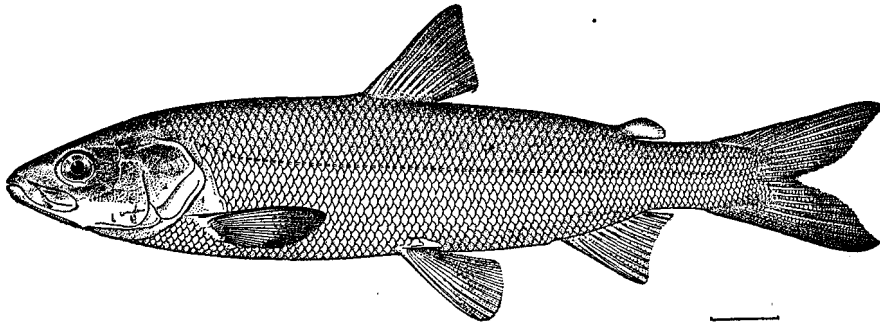


FIG. 15.—*Leucichthys zenithicus* (Jordan & Evermann). Lake Superior Longjaw. From the type.

Color in spirits silvery, darker above, no stripes clearly visible along rows of scales; dorsal and anal broadly edged with dusky; other fins clear, save for occasional stipples of black. In life, clear metallic blue above, silvery below.

Comparison of specimens of *Leucichthys zenithicus*.

Specimen no.	Marquette, Lake Superior.				Duluth, Lake Superior.						
	5238	5236	5241	5237	5215	5221	5219	5216	13084	5269	5257
Length without caudal. mm	230	247	252	253	205	255	235	240	275	240	250
Dorsal rays	11	11	10	10	11	11	11	10	11	11	10
Anal rays	11	11	11	12	11	11	12	12	11	11	12
Scales	8-80-7	8-78-7	8-77-7	8-83-7	77	83	81	78	79	80	77
Branchiostegals	9	9	9	9	9	9	9	9	9	9	9
Gillrakers	16+26	14+28	14+26	15+26	14+26	14+25	14+24	14+26	14+27	14+26	14+26
Sexual condition	♀	♀	Ripe ♀	♀	♀	Ripe ♀	♀	♀	Ripe ♀	♀	♀
Comparative measurements: ^a											
Head	0.26	0.25	0.26	0.25	0.26	0.26	0.26	0.255	0.25	0.26	0.253
Depth . . . . .	.21	.23	.26	.21	.22	.245	.22	.22	.21	.225	.21
Caudal peduncle—											
Length ^b . . . . .	.10	.115	.105	.11	.11	.105	.11	.11	.10	.115	.11
Depth . . . . .	.07	.075	.075	.075	.075	.08	.08	.075	.075	.075	.07
Eye . . . . .	.06	.055	.055	.06	.06	.06	.06	.055	.055	.058	.055
Snout . . . . .	.075	.07	.075	.075	.075	.075	.075	.07	.075	.08	.08
Maxillary from tip of snout . . . . .	.10	.11	.11	.10	.105	.10	.11	.10	.105	.11	.105
Snout to occiput . . . . .	.19	.18	.18	.20	.185	.18	.185	.185	.18	.18	.19
Pectoral length . . . . .	.17	.18	.175	.19	.17	.17	.19	.185	.16	.17	.17
Ventral length . . . . .	.15	.17	.17	.18	.17	.17	.17	.17	.15	.165	.17
Dorsal height . . . . .	.15	.16	.165	.16	.17	.16	.165	.16	.15	.16	.17
Anal height . . . . .	.10	.10	.11	.09	.10	.09	.10	.11	.095	.10	.10

^a Measurements in hundredths of body lengths unless otherwise specified.

^b From last of anal to first of caudal.

Subgenus ALLOSMUS Jordan.

Leucichthys manitoulinus Jordan & Evermann, new species. *Manitoulin Tullibee*.

Argyrosomus tullibee, Evermann & Smith, Rept. U. S. Fish Comm. 1894, p. 320, pl. 28; in part.

Type no. 64670, U. S. National Museum, a specimen 11 inches long, from Blind River, North Channel, Lake Huron; coll., Dr. Seth E. Meek.

Habitat: North Channel of Lake Huron and probably lakes of Minnesota.

Head 3.89 in length without caudal; depth 3.4; depth of caudal peduncle 2.5 in head; eye 4.5; snout 4; interorbital space 3.25; length of maxillary from tip of snout 2.75; dorsal 12; anal 13; branchiostegals 7 or 8; scales 8-71-8; between occiput and dorsal 24; gillrakers 16-29.

Body somewhat over twice as deep as broad, comparatively elongate, more so than in *Leucichthys tullibee*, symmetrically elliptical; dorsal contour of the head straight; snout rounded, tapering; lower jaw slightly longer; maxillary extending to beneath anterior third of the eye, the supplementary bone three times as long as broad; teeth on tongue very minute, none on jaws, vomer, or palatines; width of opercle 4 in head, that of subopercle 7.5, measuring from anterior edge overlapped by opercle; gillrakers 0.87 diameter of eye in length; lateral line straight, ascending a little at the anterior end; scales moderate in size, not deciduous, yet easily removed. Dorsal inserted midway between nares and base of caudal, its height moderate, the longest ray 1.33 in head; adipose fin smaller than in the true tullibee, being

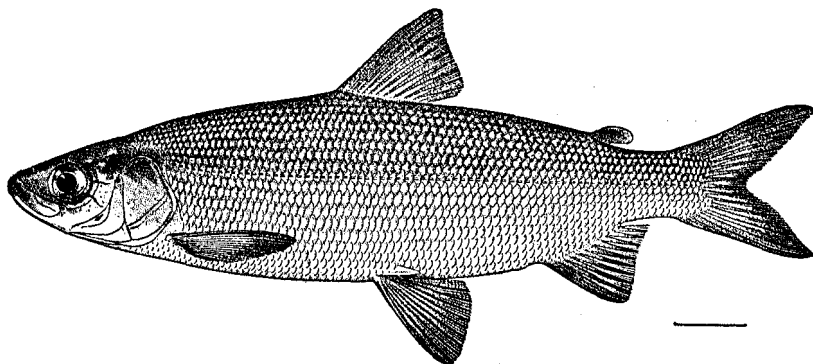


FIG. 16.—*Leucichthys manitoulinus* Jordan & Evermann, new species. Manitoulin tullibee. (Drawn from specimen 11 inches long, collected at Blind River, North Channel of Lake Huron.)

contained 4.25 to 6 in head, measured from insertion to free end; anal base one-half length of head and equal to its longest ray; ventral insertion not much posterior to that of dorsal, its longest ray 1.5 in head, its scale contained 2.75 in its length; length of pectoral 1.33 in head.

Color in spirits, dark on dorsal surface of head and body above lateral line, silvery below, all fins blackish but darker on the border; general hue suffused with smoky, as usual in fishes from waters colored by "muskeeg" or the wash of sphagnum and of peaty substances.

This species is close to *L. tullibee*, from which it may be distinguished by the longer head, longer snout, more slender body, larger eye, and longer and larger maxillary.

This description is based on three specimens, the type and two cotypes, at Stanford University, all taken by Doctor Meek at Blind River on the north side of the North Channel of Lake Huron. Another specimen, smaller and more slender, is in the same collection. It is evidently one of the tullibee group, but it is not identical with the tullibee of the northwestern lakes, differing in the more elongate body and tail and in the smaller adipose fin.

All these characters and every other one shown by the species are approximations toward characters shown by *Leucichthys harengus*, the common lake herring of the same waters. We were told about the Manitoulin Islands that the tullibee was occasionally taken, but we saw no specimens other than these three.

Mr. Charles W. Triggs, a dealer in fish in Chicago, tells us that he recently had a consignment of fish of this species sent from the North Channel to Chicago. There was no sale for them. The flesh was poor and flavorless, almost worthless as food, in comparison with the other fishes of the Great Lakes. This is said to be the only species of the tullibee type, or *Allosomus*, found in the Great Lakes, and it is confined to the northern region of Lake Huron and perhaps of Lake Superior and the smaller lakes of Minnesota.

***Leucichthys tullibee* (Richardson). *Tullibee*; *Tulipi*.**

Salmo (Coregonus) tullibee Richardson, Fauna Boreali-Amer., vol. III, p. 201, 1836, Cumberland House, Pine Island Lake (near Lake Winnipeg).

Coregonus tullibee, Günther, Cat., vol. VI, p. 199, 1866, Albany River. Jordan & Gilbert, Synopsis, p. 301, 1883.

Argyrosomus tullibee, Evermann & Smith, Rept. U. S. Fish Comm. 1894, p. 320, pl. 28, 1896. Jordan & Evermann, Fishes North and Mid. Amer., pt. 1, p. 473, 1898.

Habitat: Winnipeg basin, perhaps entering Lake Superior.

We have critically examined the following specimens of the tullibee type: One 13.75 inches long; from Waubegon Lake at Oxdrift, Ontario; one 12.5 inches long, from Rainy Lake at Rainier, Minn., one 9 inches long, from Lake of the Woods at Warroad, Minn.; a specimen 18 inches long, presumably from Minnesota, figured by Evermann & Smith in their whitefish paper; one 14 inches long, sent to

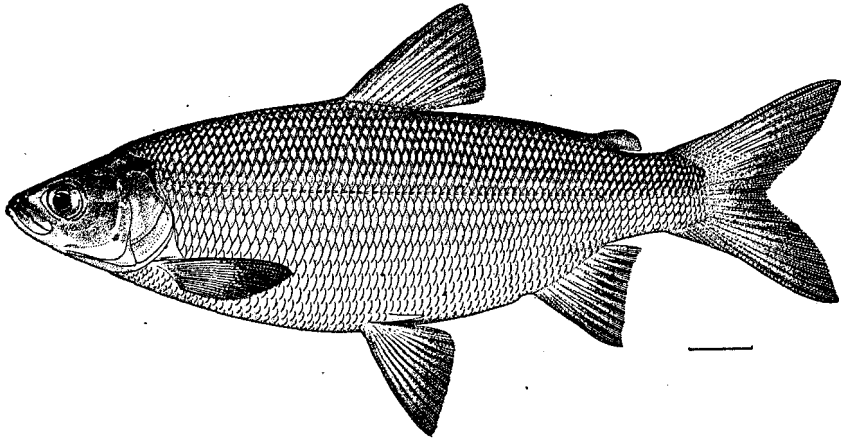


FIG. 17.—*Leucichthys tullibee* (Richardson). Tullibee. (Drawn from specimen 12.5 inches long, collected in Rainy Lake, Rainier, Minn.)

the Bureau of Fisheries by Dr. G. A. MacCallum of Dunnville, Ontario, presumably from Lake Simcoe; one 14 inches long, from Oneida Lake, N. Y.; two specimens 4.62 and 5.5 inches long, from Kettle Falls, Minnesota.

Head 4 in body without caudal; depth 3; depth of caudal peduncle 2.5 in head, its length 3, as measured from last ray of anal to first of caudal; eye 4; snout 4; interorbital space 1.25 in eye, 3.5 in head; length of maxillary from tip of snout 3; dorsal 12; anal 12; scales in lateral line 67 to 72; between dorsal fin and occiput 28; branchiostegals 9; gillrakers 16+34.

Body very deep, elliptical, its width a little less than half the depth; dorsal outline convex, curved strongly upward from the snout; ventral outline nearly as convex as dorsal; head arched slightly dorsally from snout to occiput, premaxillaries continuing the curve of the head; jaws nearly equal in front but the lower contained in the upper; maxillaries extending to below the anterior edge of the pupil, their supplementaries 2.5 times as long as wide and about half their width; scales large, rather firm, lateral line nearly straight.

Dorsal truncate, inserted midway between the occiput and adipose fin, its highest ray 1.33 in head; adipose fin large, its base equal to its height, measured from insertion to free tip, 3.5 in head; longest

anal ray 1.87 in head, anal outline concave; longest ventral and pectoral rays 1.33 in the head; ventral scale 3.5 in ventral length; caudal widely but not deeply forked.

Color in spirits, light olive, silvery laterally, dark above; dorsal, anal, and caudal fins bordered with dark; ventral and pectoral clear, slightly stippled with black.

The specimen from Rainy Lake differs in being much darker in coloration, the lower fins largely black, a few more scales (72) in the lateral line, slightly narrower opercle and subopercle, and slightly larger adipose fin and ventral scale. The specimen from Warroad, Lake of the Woods, differs noticeably in nothing but a darker coloration, more nearly approaching that from Rainy Lake, and the larger eye, correlated with the smaller size.

We have taken as the basis of this description a tullibee from Waubegon Lake at Oxdrift, Ontario, a tributary of Lake Winnipeg, as being nearest the type locality of the species, which is Pine Island Lake, at Cumberland House, a tributary of the Saskatchewan which flows into Lake Winnipeg. We present figures of specimens from Rainy Lake at Rainier and Lake of the Woods at Warroad. In the specimens from the coffee-colored waters of Rainy Lake and Lake of the Woods the coloration is very dark, as is usual with other species in the same locality. The only important differences are

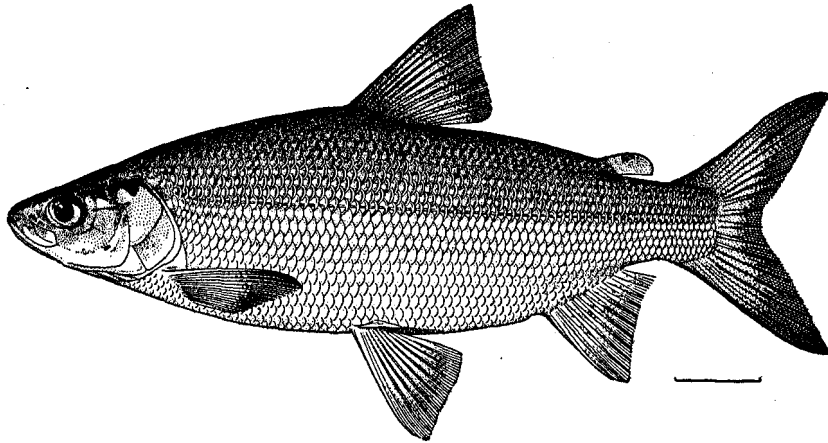


FIG. 18.—*Leucichthys tullibee* (Richardson). Tullibee. (Drawn from a specimen 9 inches long, collected in Lake of the Woods at Warroad, Minn.)

shown in the figures. The caudal peduncle is relatively thickest in the largest examples. The subopercle in the Rainy Lake example is narrower than in the others. These are no doubt individual differences.

Comparative measurements of all of the specimens are given in the following table:

	Waubegon Lake.	Rainy Lake.	Lake of the Woods.	Minnesota.	Kettle Falls.		Simcoe Lake.	Oneida Lake.
Length in inches..	13.75	11.25	9	18	4.625	5.5	14 ♀	14 ♀
Gillrakers.....					14 or 15+28	17+32 L	17+31	17+31 L
					14 or 15+28	17+31 R	17+31	17+29 R
Head.....	4	4.18	4	4.28	3.95	3.65	4.6	4.25
Depth.....	3	2.89	3.25	3.2	4.12	3.65	3.25	2.83
Eye.....	4	4+	5-	5	3.5	3.55	5	5
Snout.....	4	4.25	4.25	4	4	4	5	4+
Maxillary.....	3							

The tullibee or tulipi is the most abundant fish in the lakes tributary to Lake Winnipeg, its young forming a large part of the food of the wall-eyed pike or yellow pike, *Stizostedion vitreum*. It is not highly valued as food, its flesh being rather watery and tasteless. In the summer it is largely infested with worms, which are found in the flesh of the back. In winter it is more esteemed.

The southern distribution of the tullibee is unknown. It occurs in certain small lakes of Minnesota and is reported in those of Wisconsin. Eastward *Leucichthys artedi bisselli* and *Leucichthys eriensis*, species not at all related, have been confounded with it. Doctor Bean records it from Onondaga Lake, in New York. We have seen no specimens of the true tullibee from the Great Lakes, but we are told that it occurs in Lake Superior and the North Channel of Lake Huron. Doubtless these statements refer to *L. manitoulinus*. The "mongrel whitefish" of Lake Erie, once supposed by the present writers to be the true tullibee, proves to be *Leucichthys eriensis*.

Comparison of species of *Allosomus*.

	<i>L. tullibee.</i>			<i>L. manitoulinus</i> , Blind River.	
	Oxdrift.	Lake of the Woods.	Rainy Lake.	5273	5284
Specimen no.	5229	5272	499	5273	5284
Length without caudal mm	330	210	270	245	205
Dorsal rays (fully developed)	12	12	12	12	12
Anal rays	12	12	12	13	13
Scales	8-67-8	9-67-9	9-72-8	8-71-8	8-77-8
Scales between occiput and dorsal fin	30	30	30	24	31
Branchiostegals	9	9	9	8	9
Gillrakers	Evisc.	16+28	16+29	16+29	16+31
Comparative measurements: ^a					
Head	0.24	0.25	0.26	0.25	0.25
Depth . . . . .	.32	.33	.35	.28	.27
Caudal peduncle—					
Length ^b . . . . .	.07	.07	.11	.085	.09
Depth . . . . .	.10	.105	.115	.10	.10
Eye . . . . .	.06	.06	.065	.06	.06
Snout . . . . .	.055	.055	.06	.06	.06
Interorbital space . . . . .	.07	.075	.08	.07	.075
Maxillary length from tip of snout . . . . .	.075	.085	.09	.09	.08
Opercular breadth . . . . .	.07	.07	.065	.065	.065
Subopercular breadth . . . . .	.04	.04	.03	.025	.03
Snout to occiput . . . . .	.17	.17	.17	.17	.18
Ventrals to pectorals . . . . .	.28	.295	.32	.31	.31
Pectorals in pectoral-ventral distance	1.55	1.50	1.60	1.66	1.75
Pectoral length . . . . .	.18	.20	.20	.19	.17
Ventral length . . . . .	.18	.20	.20	.17	.17
Dorsal height . . . . .	.19	.21	.21	.17	.17
Adipose length . . . . .	.08	.08	.08	.04	.055
Anal height . . . . .	.14	.14	.15	.12	.10

^a Measurements in hundredths of body lengths to base of caudal unless otherwise specified.

^b Length from anal to first caudal rays

Genus COREGONUS (Artedi) Linnæus.

Subgenus COREGONUS.

Coregonus clupeaformis (Mitchill). *Labrador Whitefish; Sault Whitefish; Lake Superior Whitefish; Manitoba Whitefish; Musquaw River Whitefish; Whiting of Lake Winnepesaukee; Shad of Lake Champlain.*

Salmo clupeaformis Mitchill, Amer. Monthly Mag., vol. II, 1818, p. 321, Falls of St. Mary, northern extremity of Lake Huron; coll., Col. Samuel Hawkins, who called it "whitefish of the lakes."

Coregonus clupeaformis, Jordan & Evermann, Proc. U. S. Nat. Mus., vol. XXXVI, 1909, p. 171, Sault Ste. Marie; not *Coregonus clupeiformis*, Jordan & Evermann, Fishes North and Mid. Amer., pt. I, p. 466, 1898, which is chiefly based on *Coregonus albus*.

Salmo otsego a Clinton, Account of the *Salmo otsego* or the *Otsego basse*, 1822, p. 1, with plate, Otsego Lake.

Coregonus labradoricus Richardson, Fauna Bor.-Amer., vol. III, p. 206, 1836, Musquaw River, Labrador, and of many subsequent authors.

Salmo (*Coregonus*) *sapidissimus* Agassiz, Lake Superior, p. 344, 1850, Lake Champlain (type), after Zadock Thompson; Lake Superior.

Coregonus lator Agassiz, Lake Superior, p. 348, 1850, Lake Superior.

Coregonus neohantoniensis Prescott, Amer. Journ. Sci. Arts, vol. XI, 1851, p. 343; Lake Winnepesaukee, New Hampshire.

? *Coregonus richardsonii* Günther, Cat. Fish., vol. VI, p. 185, 1866, Arctic North America; locality unknown.

This species is the common whitefish of all the Great Lakes, Lake Erie excepted. It is also found in many of the smaller lakes tributary to these. The Otsego whitefish (*Salmo otsego* Clinton) is apparently identical with this species, as is also the whiting of Lake Winnepesaukee.

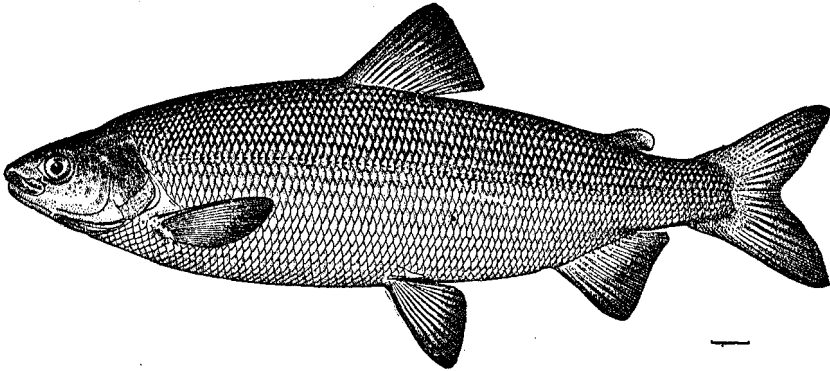


FIG. 19.—*Coregonus clupeaformis* (Mitchill). Labrador whitefish. (Drawn from a specimen 21 inches long, collected at Rainy Lake, Rainier, Minn.)

This whitefish is generally recognizable by the compressed elliptical form, rather pointed snout, the absence of a hump at the nape except in very large examples, and by the presence of a dusky shade on the back, forming more or less distinct streaks along the rows of scales. It varies much in size, being

^aThis description is accredited by authors to the Medical & Philosophical Register, 1844, vol. III, p. 188. The correct title of this publication is "Annals of Medicine, Natural History, Agriculture and Arts, in four volumes, by J. W. Francis & D. Harack, published in 1814". The description and figure appear in a printed "Account of the *Salmo otsego*, or the *Otsego basse* in a letter to John W. Francis, M. D., professor of obstetrics and the diseases of women and children in the University of New York, by De Witt Clinton, LL. D., governor of the state of New York; published by C. T. Winkle, 101 Greenwich street, 1822."

According to Doctor Evermann, who has examined the copy in the Library of Congress, the printed matter is on pages 1, 3, 4, 5, and 6. Preceding the title page, p. 1, is a full-page cut of the fish described. Following the words "Otsego basse" has been written in lead pencil "*Coregonus clupeiformis*". The cut, although crude, plainly shows *Coregonus clupeaformis*. The form is elliptical, and the back shows the dark streaks along the rows of scales usually characteristic of that species.

mature at about 2½ pounds, and growing to the weight of 8 to 12 pounds in Lake Superior. These very large whitefish are known as bowbacks. The species is one of the most valuable of all of our food fishes. It is probably the only large whitefish native to the Great Lakes system, Lake Erie excepted.

In Jordan & Evermann's Fishes of North and Middle America, the upper lakes were supposed to be inhabited also by the Erie whitefish, and on this supposition the name *clupeiformis* was retained for the latter, while the present species was called *Coregonus labradoricus*. There is very little difference between these two species, if species they really are. In general, *Coregonus clupeaformis* can be told at once by its more elongate, more compressed and more symmetrical body, deepest at the dorsal fin, and scarcely elevated at the nape, by its dark and streaked back, and by its longer pectorals, which reach more than halfway to ventrals. The flesh of the Lake Erie fish is fatter and softer.

The whitefishes from the basin of Lake Winnipeg, or Manitoba whitefish, show the general traits of *Coregonus clupeaformis*. In general, however, these are more robust, with larger head, deeper body, and longer fins. The caudal peduncle is deeper than long (the gillrakers are mutilated in all our specimens). Those from the dark or "muskeeg" water are unusually dark, with dark streaks above and black fins. Those from the milky waters of Lake Winnipeg (about the mouth of the Red River of the North) are all very pale, as pale as the whitefish of Lake Erie. As the water of Lake Erie is similarly milky, discolored by muddy, clay-bottomed streams, it is a question whether this feature of coloration is really a specific character. Perhaps *Coregonus albus*, as well as this Manitoba form, may be "ontogenetic species," or forms dependent on the food and the character of the water. Of the Manitoba form of *Coregonus clupeaformis* we have examined hundreds of examples and have preserved examples from Rainy Lake at Rainier, Lake of the Woods at Warroad, Lake Winnipeg at Fort Alexander, Lake Playgreen, and Lake Waubegon at Oxdrift.

We figure the example from Rainy Lake.

The following description of *Coregonus clupeaformis* is taken from numerous specimens, mostly from Lake Superior:

Head, 4.5 to 5 in body length to base of caudal; body depth 3.5 to 4; eye 4.5 to 5.5 in head; snout 3.5 to 4.5; maxillary to tip of snout 3 to 4; interorbital space 3 to 3.8; caudal peduncle length from last rays of anal to first of caudal 1.8 to 2.5 in head, its least depth 2 to 2.5, but usually less than its length; dorsal 10 to 12 (fully developed rays); anal 10 to 14; scales 72 to 86 (usually over 75), between occiput and insertion of dorsal 30 to 34; branchiostegals 9 or 10; gillrakers 9 to 11+16 to 18 (25 to 28 in all) on first gill-arch.

Body moderately elongate, increasing considerably in depth with age, deepest under dorsal; compressed, its width about 2.5 in its depth; dorsal profile sometimes arched from occiput to insertion of dorsal fin, sloping gradually to caudal peduncle, the latter deep, nearly as deep as long, sometimes deeper than long, compressed strongly; head small, conic, square at tip, premaxillaries directed backward so as to place mouth on lower side of projecting snout; lower jaw included, mandible reaching to midway between pupil and hind margin of eye, about 2.6 in head; maxillary broad and short, extending to anterior margin of eye, supplementaries broad, short, not as broad as long; distance from snout to occiput about 2 in distance from occiput to insertion of dorsal; teeth on tongue only, very minute, barely visible, except when dried.

Origin of dorsal about midway between snout and base of caudal; moderate in height, between 0.8 and the whole of the head length, almost always greater than distance from snout to occiput, its base 1.66 in head; adipose moderate or rather large, from insertion to free end contained about 2 to 3 in head; pectorals and ventrals equal to longest dorsal rays in length (former reaching over halfway to vent in forms from Lake of the Woods, Rainy Lake, and Lake Waubegon); anal low, its longest ray 1.66 in head, its base 1.75 or 2. Lateral line straight, scales moderately large.

Color in spirits pale, darker above, always showing more or less distinct streaks along the rows of scales; vertical, pectoral, and ventral fins usually colorless, save for dark margin of dorsal and caudal, although others are sometimes dusky.

Comparison of *Coregonus albus* and *C. clupeaformis*.

Specimen no..	<i>C. albus</i> , Lake Erie.				<i>C. clupeaformis</i> , Lake Ontario.				
	494	5255	5254	5253	4933	4914	4913	4936	4911
Body length.....mm..	340	355	315	290	275	265	350	190	265
Dorsal rays.....	11	10	11	11	11	11	12	11	11
Anal rays.....	12	14	12	11	11	11	10	11	11
Scales.....	9-80-8	9-86-8	10-81-8	10-79-9	10-79-9	9-82-8	10-82-8	10-80-8	10-81-8
Branchiostegals.....	9	9	9	9	9	9	9	9	9
Gillrakers.....	10+16	11+16	9+18	10+18	10+18	10+19	10+18	9+16	10+18
Comparative measurements: ^a									
Head.....	0.20	0.225	0.215	0.215	0.21	0.20	0.22	0.225	0.21
Body depth.....	.30	.325	.29	.30	.27	.26	.29	.205	.29
Caudal peduncle—									
Length.....	.105	.10	.085	.08	.09	.10	.10	.125	.115
Depth.....	.10	.095	.10	.105	.085	.085	.09	.09	.09
Eye.....	.045	.04	.045	.04	.05	.05	.045	.05	.057
Snout.....	.04	.06	.05	.052	.05	.05	.055	.05	.05
Maxillary from tip of snout.....	.055	.065	.06	.06	.06	.06	.065	.065	.07
Distance snout to occiput.....	.14	.15	.15	.16	.15	.15	.15	.16	.15
Pectoral length.....	.18	.19	.18	.18	.163	.17	.19	.165	.18
Ventral length.....	.18	.20	.18	.18	.165	.17	.17	.17	.17
Dorsal height.....	.195	.18	.185	.18	.175	.17	.17	.185	.17
Anal height.....	.12	.13	.13	.13	.12	.11	.12	.115	.115

^a Measurements in hundredths of body lengths unless otherwise specified.

Comparison of specimens of *Coregonus clupeaformis*.

Specimen no..	Lake Superior.	Lake Huron.		Lake Michigan.	Lake of the Woods.	Lake Waubegon.		Rainy Lake.
	5227	4927	13112	528	11918	5231	5259	A
Body length.....mm..	283	370	285	190	420	365	270	445
Dorsal rays.....	12	12	11	11	11	11	12	13
Anal rays.....	12	11	11	11	11	14	11	14
Scales.....	10-84-8	10-79-8	10-78-9	10-79-8	10-70-8	10-74-9	81	86
Branchiostegals.....	9	9	9	9	9	9	9	10
Gillrakers.....	10+18	10+16	8+17	10+16	Evisc.	Evisc.	Evisc.	Evisc.
Comparative measurements: ^a								
Head.....	0.20	0.21	0.21	0.225	0.23	0.225	0.235	0.235
Body depth.....	.25	.26	.26	.25	.37	.37	.29	.32
Caudal peduncle—								
Length.....	.105	.10	.12	.11	.085	.105	.09	.09
Depth.....	.08	.09	.09	.085	.11	.11	.10	.10
Eye.....	.04	.04	.05	.05	.045	.045	.05	.045
Snout.....	.05	.06	.05	.06	.055	.06	.06	.065
Maxillary from tip of snout.....	.055	.06	.05	.065	.075	.065	.07	.068
Distance snout to occiput.....	.15	.155	.15	.17	.16	.167	.165	.16
Pectoral length.....	.16	.18	.15	.17	.21	.21	.20	.20
Ventral length.....	.16	.18	.16	.175	.20	.20	.20	.19
Dorsal height.....	.16	.20	.16	.195	.21	.21	.20	.17
Anal height.....	.11	.13	.11	.13	.16	.14	.15	.12

^a Measurements in hundredths of body lengths unless otherwise specified.

Coregonus albus L.e. Sueur. *Lake Erie Whitefish; Common Whitefish.* (Pl. VI.)

Coregonus albus Le Sueur, Jour. Ac. Nat. Sci. Phila., vol. 1, 1818, p. 232, Lake Erie. Jordan & Evermann, Proc. U. S. Nat. Mus., vol. XXXVI, 1909, p. 171, Lake Erie. And of many other authors.

Habitat: Lake Erie and Lake St. Clair; introduced into other lakes.

This species is the common whitefish of Lake Erie. It is very close to *Coregonus clupeaformis*, the whitefish of the other lakes, differing only in form and color. Compared with the latter, the Erie whitefish has a smaller head, higher nape, more angular form, and the color is almost pure olive-white, without dark shades or dark stripes along the back. The flesh is softer, containing more fat. All these differences may be correlated with the fact that Lake Erie is shallow and its southern shore is fed by warm, shallow, muddy, or milky rivers. The difference shown by the wall-eyed pike of the different lakes is supposed to rest on the same variation in environment. As no difference appears

in technical characters, we regard *Coregonus albus* as a doubtful species, its distinctions being perhaps purely ontogenetic. On the other hand, it is claimed that the fry of the two can be readily separated. Mr. Harry Marks, superintendent of the United States hatchery at Sault Ste. Marie, claims that the eggs of *Coregonus clupeaformis* are larger and darker than those of the Lake Erie whitefish. The fry are also livelier and are marked by two dark lines on the side, while those of *C. albus* are plain silvery.

The Lake Superior whitefish takes the hook readily, large numbers being taken every day in season in the locks at Sault Ste. Marie by local anglers. *Coregonus albus* is not known to take the hook.

The eggs of the Lake Erie whitefish have been planted in all the other lakes, and we have recognized specimens we call *Coregonus albus* from Lake Champlain, Lake Ontario, and Lake Superior among the Apostle Islands. The close resemblance between the whitefish, fat, plump, and pale, from the milky waters of Lake Winnipeg and those of Lake Erie has been noticed by many fish dealers. We doubt if anyone could distinguish individual specimens from these two localities, although on the average they are different. Possibly *Coregonus albus* is merely an "ontogenetic species," its peculiarities being due to the conditions of food and water in Lake Erie.

According to the figures issued by the Bureau of the Census, the total catch of whitefish in United States waters of the Great Lakes for the calendar year 1908 was 7,482,800 pounds, valued at \$507,310. The following table shows the catch by states:

State.	Pounds.	Value.
Pennsylvania	451,200	\$36,290
Ohio	732,200	60,010
Michigan	4,768,500	339,230
Indiana	51,800	4,990
Wisconsin	1,274,500	56,320
Minnesota	204,600	10,470
Total	7,482,800	507,310

Coregonus nelsoni Bean. *Alaska Whitefish.*

Coregonus nelsonii Bean, Proc. U. S. Nat. Mus., vol. VII, 1884, p. 48, Nulato, Alaska; type 29903; collector Edward W. Nelson.

Habitat: Rivers and lakes of Alaska and Mackenzie River region.

This species resembles the Lake Erie whitefish, but has a smaller mouth and the flesh is said to be dry and bony.

Subgenus PROSOPIUM Milner.

Numerous species of river whitefish occur in the United States. These belong to the subgenus *Prosopium*, distinguished by the elongate form, the thick gillrakers, and the moderate or large scales. In some of these the males have pearl organs or tubercles on the scales in spring. In some the adipose fin is enormously developed. In some the snout in the male is much produced, and in one the scales are much enlarged. Each of these types should perhaps stand as a distinct subgenus, the typical species of each being *quadrilateralis* (*Prosopium*), *williamsoni*, *coulteri* and *oregonius*.

Coregonus quadrilateralis (Richardson). *Menominee Whitefish; Pilotfish; Round Whitefish; Shadwainter.* (Pl. VII.)

Coregonus quadrilateralis Richardson, Franklin's Narrative, p. 714, pl. xxv, fig. 2, 1823, Fort Enterprise, British America.

Coregonus nov-anglie Prescott, Am. Jour. Sci. Arts, vol. XI, 1851, p. 342, Lake Winnepesaukee N. H.

Habitat: Alaska and upper Great Lakes to New England, in lakes.

This species is common in Lake Superior and the northern parts of Lake Huron and Lake Michigan. It may be known at once by its short head and elongate, little compressed body. It is not highly valued as food, ranking even inferior to lake herrings in this regard, and agreeing with them in size and form. It is destructive to the spawn of the whitefish.

The species is recorded by Evermann from Lake Bennett, Yukon Territory, where it was taken by the writers in 1903. It is also recorded from various other localities on the Yukon and from Wood River (Bristol Bay). As the species certainly does not occur in the Winnipeg basin, it may

be questioned whether this Yukon fish is not a distinct species of *Prosopium* separate from the ordinary *Coregonus quadrilateralis*. Our specimens are from Mackinac, Cheboygan, Marquette, and Blind River.

Description of a specimen of *Coregonus quadrilateralis* 15.5 inches long from Blind River, North Channel, Lake Huron:

Head 5.5 in body length to base of caudal; depth 4.5; eye 5 in head; snout 3.6; interorbita breadth 3; maxillary from tip of snout somewhat longer than eye diameter; caudal peduncle length 1.28 in head, its depth one-half its length; dorsal 11 (fully developed rays); anal 12; scales 8-90-7, between occiput and origin of dorsal 35; branchiostegals 8; gillrakers 6+10.

Body elongate, little compressed, more terete than in any other species of the genus, its greatest depth and width in anterior portion of body, hence space from snout to insertion of dorsal more strongly arched than remainder; caudal peduncle long, little compressed, half as deep as long; head small, pointed; snout moderately short; post-orbital and sub-orbital bones broad; maxillary very short, broad, not reaching eye; supplementary bone very narrow; mandible short, three in head, not reaching posterior edge of pupil, included within upper jaw; dorsal contour arched somewhat, although not greatly; distance from snout to occiput 2.5 in distance from occiput to dorsal insertion. Dorsal insertion nearer snout than base of caudal, its longest ray equal to distance from snout to occiput, its base about 1.5 in head; adipose small; caudal short; pectorals short, somewhat longer

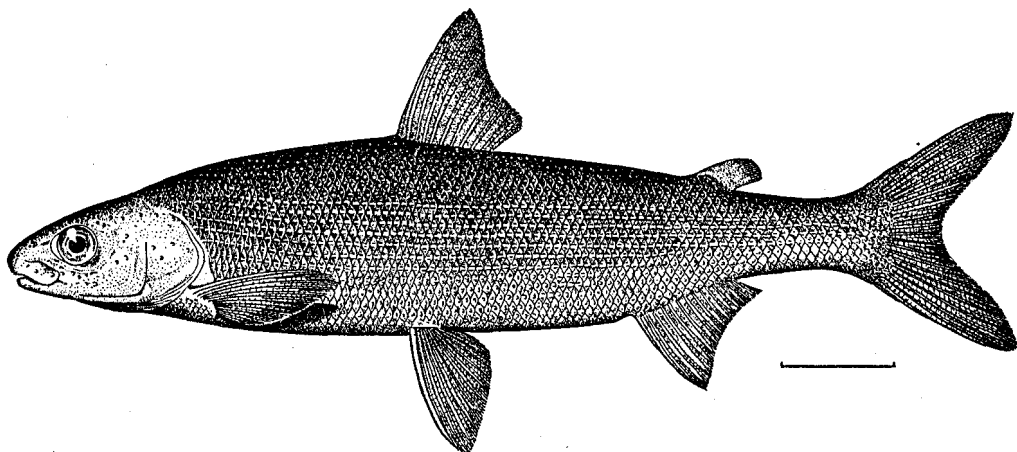


FIG. 20.—*Coregonus stanleyi* Kendall. From the type.

than dorsal rays, inserted low, reaching halfway to ventrals; ventrals very short, considerably more so than pectorals; anal base somewhat more than 0.5 head, its longest ray 1.66 in head. Lateral line straight, scales rather small.

Color in spirits, rather dark on sides and back, colorless ventrally; a line or streak of dark along edges of longitudinal rows of scales, especially just below lateral line; fins pale, except for borders of dorsal and caudal, which are dark

Coregonus kennicotti Milner. *Kennicott's Whitefish.*

Coregonus kennicotti Milner, in Jordan & Gilbert, Synopsis Fishes North Amer., p. 298, 1883, Fort Good Hope, British America.

Habitat: Mackenzie River, Canada, Yukon River, and other streams of the Alaskan region. Recorded by Evermann from Lake Bennett, Alaska, where it is probably common.

Coregonus stanleyi Kendall. *Stanley's Whitefish.*

Coregonus stanleyi Kendall, Bull. U. S. Fish Comm., vol. XXII, 1902 (1904), p. 366, with figure, thoroughfare between Mud and Cross lakes, Aroostook County, Me.

Habitat: Lakes of northern Maine.

This species, provided with pearly bodies on the scales in the breeding season, seems nearest to the Rocky Mountain whitefish, *Coregonus williamsoni*.

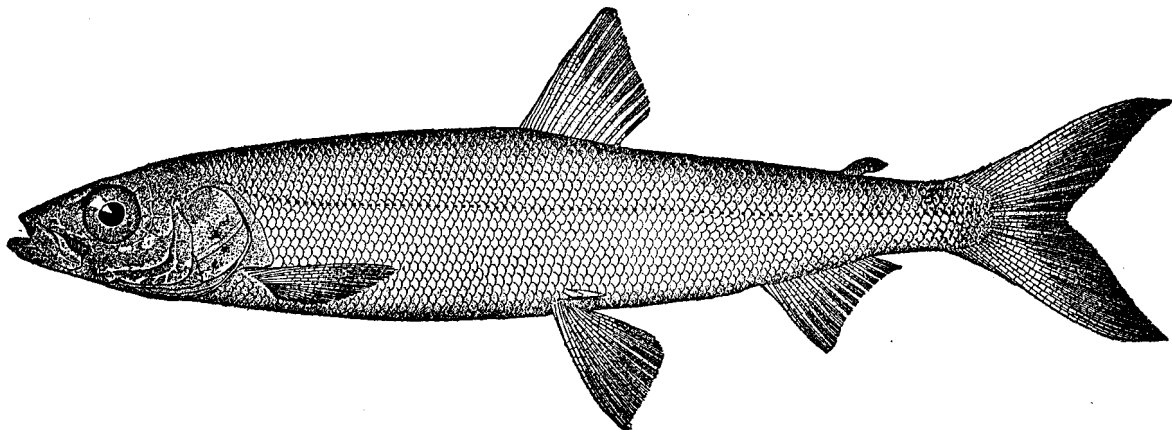


FIG. 21.—*Leucichthys osmeriformis* (H. M. Smith). Smelt. From the type, a specimen 10 inches long, taken in Seneca Lake, New York.

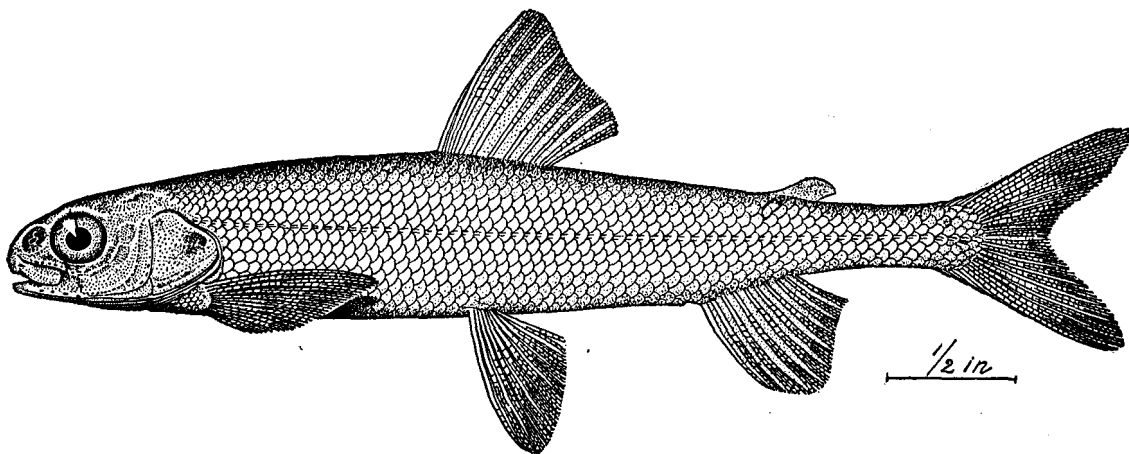


FIG. 22.—*Coregonus coulteri* Eigenmann & Eigenmann. Coulter's Whitefish. From a specimen, $4\frac{1}{2}$ inches long, one of the types, collected in Kicking Horse River, at Field, British Columbia.

Coregonus williamsoni Girard. *Rocky Mountain Whitefish.*

Coregonus williamsoni Girard, Proc. Ac. Nat. Sci. Phila. 1856, p. 136, Des Chutes River, Oregon.

Habitat: Rivers of the Sierra Nevada and west slope of the Rocky Mountains, from the Fraser and the Columbia to the Truckee and other streams of the Lahontan basin of Nevada; abundant especially in lakes of northern Idaho, western Montana, and Washington. One of the most delicious of food fishes, and reaching a weight of 4 pounds.

Coregonus cismontanus Jordan. *Yellowstone Whitefish.*

Coregonus williamsoni cismontanus Jordan, Bull. U. S. Fish Comm., vol. ix, 1889, p. 49, pl. 9, fig. 8, 9, Horsethief Creek, Madison River, Montana; coll., E. R. Lucas.

Habitat: Streams of the Rocky Mountain region tributary to the upper Missouri.

It is very doubtful if this fish differs at all from *Coregonus williamsoni* which replaces it on the west side of the Rocky Mountains.

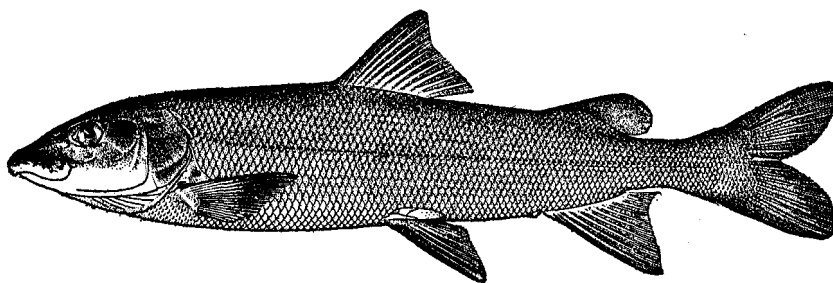


FIG. 23.—*Coregonus oregonius* Jordan & Snyder. Oregon Whitefish. From the type.

Coregonus coulteri Eigenmann & Eigenmann. *Coulter's Whitefish.*

Coregonus coulterii Eigenmann & Eigenmann, Amer. Nat., Nov., 1892, p. 961, Kicking Horse River at Field, British Columbia.

Habitat: Headwaters of the Columbia.

A strongly marked species easily recognized by its large scales (60 to 63).

Coregonus couesi Milner.

Coregonus couesii Milner, Rept. U. S. Fish Comm. for 1872-73 (1874), p. 88, Chief Mountain Lake, Montana; coll., Elliott Coues.

Habitat: Headwaters of Saskatchewan River.

This is a strongly marked species, allied to *Coregonus oregonius*, and very improperly confounded with *Coregonus williamsoni* by Jordan & Evermann.

Coregonus oregonius Jordan & Snyder. *Chisel-mouth Jack; Oregon Whitefish.*

Coregonus oregonius Jordan & Snyder, Proc. U. S. Nat. Mus., vol. xxxvi, 1909, p. 425, with fig., Mackenzie River, Oregon.

Habitat: Lower Columbia River basin.

A well-marked species, agreeing with *C. couesi* in the long snout, and further distinguished by the very high adipose fin.

