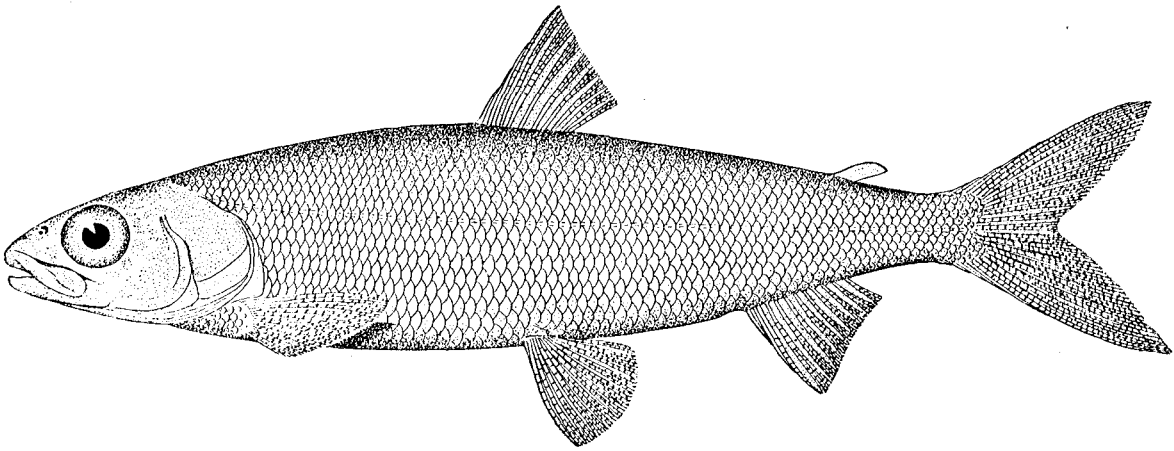
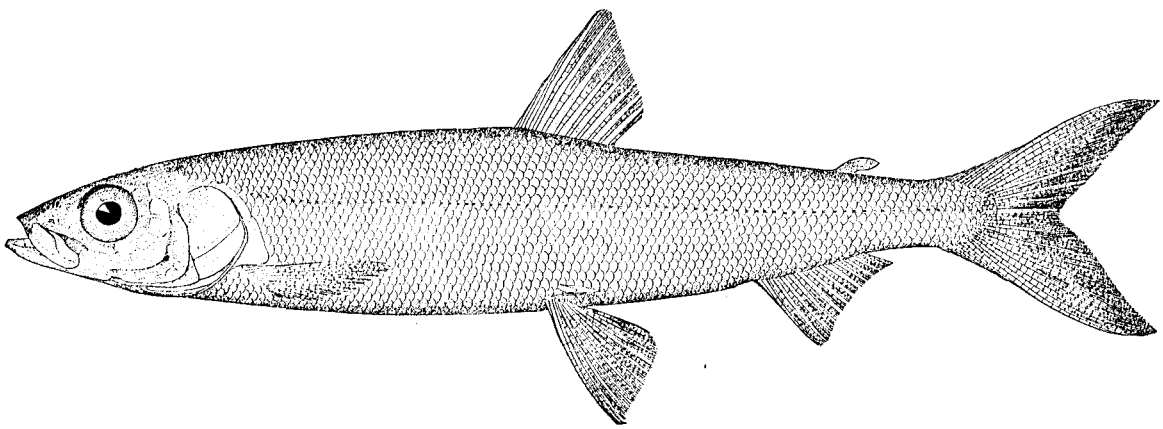
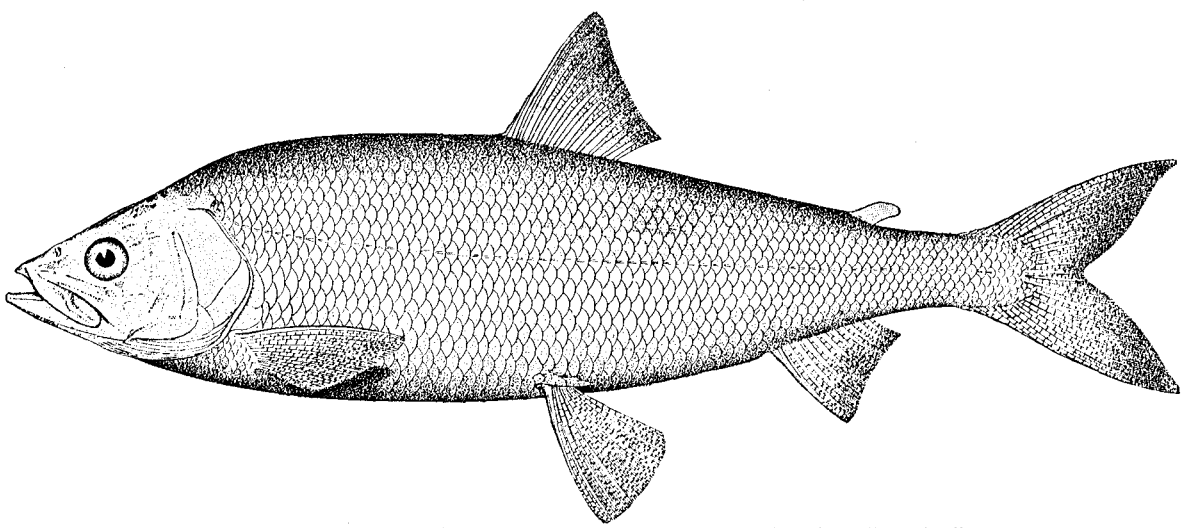


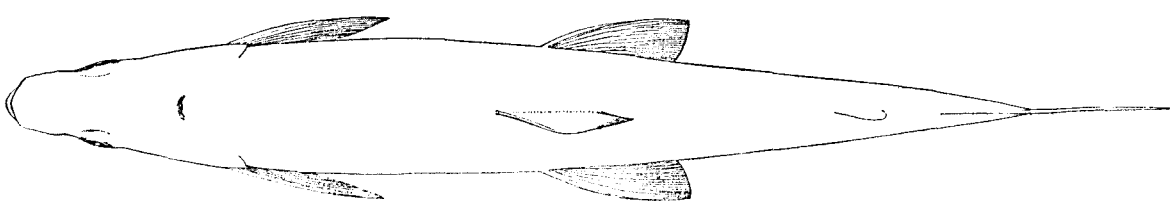
COREGONUS HOYI (Gill). *Hoy's Whitefish; "Cisco;" "Moon-eye."*
From a type specimen, 8 inches long, taken in Lake Michigan, off Racine, Wis., in 1870, at a depth of about 50 fathoms.



COREGONUS OSMERIFORMIS, sp. nov. *"Smelt."*
From a specimen, 10 inches long, taken in Seneca Lake, N. Y.



COREGONUS PROGNATHUS, sp. nov. *Long-jaw Whitefish; Long-jaw; "Bloater."*
From a female specimen, 15 inches long, weighing 17½ ounces, taken in Lake Ontario, off Wilson, N. Y., at a depth of 40 fathoms.



COREGONUS PROGNATHUS. Outline of fish viewed from above.

1.—NOTES ON TWO HITHERTO UNRECOGNIZED SPECIES OF AMERICAN WHITEFISHES.

By HUGH M. SMITH, M. D.

There are seven described species of whitefish whose range embraces the basin of the Great Lakes and which are more or less abundantly represented in the lakes and streams of that region. These are the common whitefish (*Coregonus clupeiformis*), the lake herring or cisco (*C. artedi*), the blackfin or bluefin whitefish (*C. nigripinnis*), the tullibee or mongrel whitefish (*C. tullibee*), the Musquaw River or Labrador whitefish (*C. labradoricus*), the menominee or round whitefish (*C. quadrilateralis*), and Hoy's whitefish or the moon-eye (*C. hoyi*). Concerning the habits, movements, etc., of the first two of these we have a fairly satisfactory knowledge, chiefly because of their economic value, although there is yet much to be learned; but the published information regarding the five remaining species is exceedingly limited and consists largely of such observations as were recorded at the time the fish were first brought to public attention.

This deficiency of information is due to the comparatively slight commercial importance of most of the fishes, to the small size of one, to the relative rarity of several, and to the habit of two or three of frequenting the deepest water of the lakes where they are least accessible to the fisherman and the naturalist; but the deficiency is principally owing to the absence of biological surveys of the lake region and of systematic fieldwork.

In 1891, while visiting the American shore of Lake Ontario in the interests of the U. S. Commission of Fish and Fisheries, my attention was especially called to a whitefish abounding throughout the lake and having considerable commercial value in places, which was well known to fishermen and residents along the lake shore and designated by special names, but which did not appear to have received the notice of ichthyologists and was apparently different from any of the described whitefishes inhabiting this lake. Full notes were taken regarding its abundance, habits, size, and economic importance, but no means were available for preserving specimens, without which a satisfactory determination of the identity of the fish would have been impossible. The following year a good working series of fresh specimens was sent me from two localities in New York and the study of the fish was resumed, with the valuable collections in the U. S. National Museum at hand for comparison. The examination of the whitefishes in that institution has led to the conclusion that the specimens in question from Lake Ontario represent an unrecognized species, and has

disclosed the existence of another related species inhabiting lakes in northern New York that has not heretofore been regarded as distinct.

My studies of these fish have been prompted and much aided by Dr. Tarleton H. Bean, at whose suggestion, and that of Dr. David S. Jordan, president of Leland Stanford Jr. University, whose opinion in the matter was solicited, the writer ventures to call attention to the two fishes in question, to assign to them names, and to note the features that distinguish them from a described species with which they have both been identified, viz, *Coregonus hoyi* (Gill). The opportunity will also be improved to record some original notes on the natural history and commercial importance of one of these.

Figures of the two species regarded as new are presented, and, for purposes of comparison, a figure of *Coregonus hoyi* is given.

Acknowledgment of assistance rendered the writer in the preparation of this paper is respectfully tendered to Prof. Barton W. Evermann, Dr. Theodore Gill, and Mr. Barton A. Bean, in addition to Dr. Bean and Prof. Jordan.

COREGONUS OSMERIFORMIS, sp. nov.

Coregonus hoyi, Bean, Proc. U. S. Nat. Mus. 1882, 658 (Skaneateles and Seneca lakes, N. Y.); Goode, Natural Hist. Aquatic Animals (Seneca Lake, N. Y.), plate only. (Not *Argyrosomus hoyi* Gill).

Body elongate, slender, back not elevated, the greatest depth being considerably less than length of head, and contained 5 times in body length. Head rather large, 4 in body, its width rather more than one-third its length; length of top of head 2 times in distance from occiput to dorsal; profile of head nearly straight. Mouth large, the lower jaw projecting; maxillary contained 3 times in length of head, its posterior edge extending to line drawn vertically through the anterior margin of pupil; mandible one-half the length of head, its angle under the pupil. Eye large, equal to snout, 4 in head. Gill-rakers long and slender, as long as eye, 55 in number, 35 below the angle. Scales small, 83 in lateral line, 9 between dorsal origin and lateral line, 8 between ventral origin and lateral line. Dorsal fin rather high, its height equal to four-fifths depth of body and 1½ times length of base of fin; 9 developed rays; its origin nearer base of caudal than snout; its free margin nearly vertical, straight. Ventrals long, equal to height of dorsal, their length equal to three-fourths of distance from ventral origin to vent; ventral origin midway between base of caudal and pupil; 12 developed rays. Anal with 13 developed rays, the longest four-fifths length of base of fin. Pectorals with 16 rays, longer than ventrals, one-sixth length of body. Teeth present on the tongue. Color above grayish silvery, sides bright silvery, below white; tips of dorsal and caudal dark. Branchiostegals, 7 or 8. Length, 10 inches.

Habitat: Seneca Lake and Skaneateles Lake, New York.

Etymology: *Osmeriformis*, from *Osmerus*, a smelt, and *forma*, form, shape; in allusion to the general shape of the fish. It is known as "smelt" in parts of New York.

The specimens on which this species is based are contained in the collection of the U. S. National Museum; one specimen (No. 32162) is from Seneca Lake, New York, and was collected by Prof. H. L. Smith in June, 1878; the other examples (No. 32165), four in number, are from Skaneateles Lake, New York, and were forwarded by Mr. J. C. Willetts in October, 1882. The foregoing description applies primarily to the specimen from Seneca Lake. The examples from Skaneateles Lake are 5 to 6 inches long; they closely resemble the larger fish but have a somewhat longer head (3¾ or 3⅞

in length), less depth (5½ in length), a rather larger eye (3½ to 3¾ in head), the top of head contained 1⅞ times in distance between occiput and dorsal origin, 2 to 6 fewer scales in the lateral line, and with the dorsal origin rather nearer snout than base of caudal.

This fish more closely resembles *Coregonus artedi* than it does any other known whitefish. The chief points of similarity are the protracted lower jaw and the numerous long gill-rakers. From *C. artedi*, however, it differs in a number of important features, among which the following may be mentioned:

(1) The general form of the two fishes is quite dissimilar, *C. osmeriformis* being much more slender and compressed, with the greatest depth less than length of head, while in *C. artedi* the depth is equal to or greater than head. The ratio of body length to greatest depth is 3¾ or 4 to 1 in *C. artedi* and 5 to 1 in *C. osmeriformis*.

(2) The dorsal fin in *C. osmeriformis* is more posteriorly placed, being nearer base of caudal than snout; in *C. artedi* the dorsal origin is nearer snout than base of caudal, or is situated midway between those points.

(3) In *C. osmeriformis* the mandible is longer than in *C. artedi*, being contained twice in head in former and 2½ to 3 times in latter. The maxillary is also longer in *C. osmeriformis;* its length is contained 3 times in head, while in the other species it is contained 3½ times.

This fish differs from *Coregonus hoyi* as described by Jordan * (not as defined by Milner †) in the following essential particulars:

(1) *Coregonus hoyi*, according to Jordan, belongs in the group of whitefishes characterized by an included lower jaw (subgenus *Coregonus*), of which *Coregonus clupeiformis* is the type; *Coregonus osmeriformis* has a lower jaw which projects considerably beyond the upper even when the mouth is closed (subgenus *Argyrosomus*).

(2) *C. hoyi* has a somewhat elevated back and a relatively deep body (4⅛ in length); in *C. osmeriformis* the back is not elevated and the body is slender (5 in length.) The general form of *C. hoyi* is that of a herring (*Clupea*); that of *C. osmeriformis* superficially resembles a smelt (*Osmerus*).

(3) Numerous minor differences might be noted. In *C. hoyi* the developed anal rays are fewer (10 instead of 13); the scales are somewhat less numerous (8–77–8 instead of 9–83–8); the origin of the dorsal is nearer snout than base of caudal in *C. hoyi* and nearer base of caudal than snout in *C. osmeriformis*; the eye is contained 3⅛ times in head in *C. hoyi*, 4 times in *C. osmeriformis*.

This species was first brought to public notice by Dr. Tarleton H. Bean in an article in the Proceedings of the U. S. National Museum for 1882, entitled "Description of a species of whitefish, *Coregonus hoyi* (Gill) Jordan, called 'smelt' in some parts of New York." The paper is based on the specimens in the National Museum, to which reference has been made. The example collected by Professor Smith is described in detail, a table of careful measurements being appended. Regarding this fish Dr. Bean remarks:

> The species is most closely related to *C. artedi*, but differs from it and all other species known to me in many important characters, which have been only vaguely indicated in most of the published descriptions.

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* Manual of the Vertebrates.—American Naturalist, 1875, p. 136.—Also, Jordan & Gilbert, Synopsis of the Fishes of North America.

†Report U. S. Fish Commission 1872–73, p. 86.

Dr. Bean now regards this fish as distinct; he was never fully satisfied with the identification of these specimens with *C. hoyi*, and so expressed himself some years ago. The paucity of material, however, and the somewhat indefinite or confused published descriptions, to which he alludes in the paragraph quoted, deterred him from attempting a final settlement of the question.

COREGONUS PROGNATHUS, sp. nov.

Argyrosomus hoyi, Milner, Rept. U. S. Fish Comm., 1872–73, 86. Outer Island, Lake Superior. (Not *Argyrosomus hoyi* Gill.)

Body oblong, much compressed, back elevated, tapering rather abruptly toward the narrow caudal peduncle, the adult fish having a slight nuchal hump as in *C. clupeiformis*; greatest depth 3½ to 4 in body length. Head rather short and deep, pointed, 4 to 4⅓ in length; greatest width half the length; cranial ridges prominent. Snout straight, its tip on level with lower edge of pupil. Top of head 2 in distance from occiput to front of dorsal. Mouth large and strong; maxillary reaching to opposite middle of pupil, 2½ in head, length 3 times its width; mandible long, projecting beyond upper jaw when mouth is closed, reaching to or beyond posterior edge of eye, 1¾ to 1⅞ in head. Eye small, 5 in head, 1½ in snout, 1⅓ in interorbital space, 1½ in suborbital space. Gill-rakers slender, about length of eye, 13 above and 25 below angle. Adipose fin the length of eye, its width half its length. Narrowest part of caudal peduncle contained nearly four times in greatest body depth. Dorsal rather high, with 9 or 10 developed rays, the longest one-half longer than base of fin and contained 1¾ times in greatest body depth, 3¼ times in distance between dorsal and snout, and 1½ times in head; free margin slightly concave; origin midway between end of snout and base of caudal; dorsal base opposite 9 scales. Anal with 10 to 12 developed rays; the longest ray equal to base of fin and two-thirds height of dorsal. Ventrals as long as dorsal is high; their origin midway between anterior edge of orbit and base of caudal. Ventral appendage short, covering about 3 scales. Pectorals as long as ventrals. Scales rather large, about 75 in lateral line, 7 or 8 above the lateral line, 7 or 8 below the lateral line. Lateral line straight except at origin, where it presents a rather marked curve. Sides of body uniformly bright silvery, with pronounced bluish reflection in life; the back dusky, the under parts pure white without silvery color. Above lateral line, light longitudinal stripes involving central part of scales extend whole length of body. Fins flesh color or pinkish in life, the dorsal and caudal usually showing dusky edges. Postorbital area with a bright golden reflection. Iris golden, pupil black. Branchiostegals, 8. Average length, 15 inches.

Habitat: Lake Ontario, Lake Michigan, Lake Superior, and doubtless the entire Great Lake basin, in deep water.

Etymology: *Prognathus*, from πρό, before, and γνάθος, jaw; in allusion to the projecting mandible. The fish is called "long-jaw" in lakes Michigan and Ontario.

This species is based on 8 specimens from lakes Superior and Michigan in the collection of the U. S. National Museum and 17 specimens from Lake Ontario in the collection of the U. S. Fish Commission. The examples in the museum are as follows: Seven from Outer Island, Wis., Lake Superior, collected by J. W. Milner (catalogue numbers 10576 and 35344), and one from Petosky, Mich., Lake Michigan, collected by McCormick and Connable (catalogue number 23540). The fish in the possession of the Fish Commission were received in the flesh in 1892. One lot, consisting of 11

examples, was forwarded by Mr. John S. Wilson, of Wilson, N. Y., on April 20; the other, containing 6 specimens, came to hand on June 12, and was sent by Mr. George M. Schwartz, of Rochester, N. Y., at the solicitation of Mr. Frank J. Amsden, of the same place. I also to refer to three examples now in the collection of the Fish Commission obtained by Dr. R. R. Gurley at Nine-Mile Point, New York, in June 1893.

This species is quite different from any other whitefish inhabiting the Great Lake basin. It may be at once distinguished from all the whitefishes known to occur in the United States by the general form of body combined with the very long lower jaw, which is contained less than twice in the length of head and extends backward to or beyond the posterior edge of orbit. It most closely resembles *Coregonus laurettæ* Bean, inhabiting northern Alaska, but is easily distinguished from that species by its more elevated back, greater depth ($3\frac{1}{2}$ instead of $4\frac{1}{5}$), larger head (4 to $4\frac{1}{3}$ instead of 5 in body length), larger mouth, longer maxillary ($2\frac{1}{2}$ instead of $3\frac{1}{2}$ in head), longer mandible ($1\frac{3}{4}$ to $1\frac{7}{8}$ instead of $2\frac{1}{2}$ in head), larger scales, and a number of other features.

From the lake herring (*Coregonus artedi*), with which the fish has some affinities, it differs in general form, greater depth, smaller eye, longer mandible and maxillary, shape of head, rather larger scales, more contracted caudal peduncle, longer ventrals, etc.

Dr. Bean has drawn my attention to the resemblance existing between this fish and the *Coregonus lucidus* of Richardson,* described from Great Bear Lake, Canada, in 1836, and not again detected by ichthyologists until 1893.† The similarity consists chiefly in the long lower jaw, the slender caudal peduncle, and the slight nuchal enlargement. These features appear in the figure of *C. lucidus* in the work cited. The plate is so faulty, however, and so often at variance with the text, that much reliance can not be placed on it. The differences in the two fish, as determined by Richardson's not wholly lucid description, are, in Dr. Bean's opinion, sufficiently marked to establish their specific distinctness. *Coregonus lucidus* is described as having 88 scales in the lateral line, with the thirty-third scale in the lateral series equidistant between end of snout and base of caudal. The scales are thus more numerous than in *C. prognathus*, and the position of the particular scale is widely different in the two fish. *C. lucidus* has the ventrals longer than dorsal, and a ventral appendage eleven-twelfths of an inch long in a fish 18 inches long. The ventrals in *C. prognathus* are equal to dorsal, and the appendage is very short, being less than half an inch long in a fish 15 inches in length. Both the maxillary and mandible are smaller in *C. lucidus* than in the other species.

Notice of this fish was first published by the late Prof. J. W. Milner, by whom it was identified with *Coregonus hoyi* (Gill). In the foregoing remarks on *Coregonus osmeriformis* attention was drawn to some of the characters of *C. hoyi* as understood by Jordan. In order to clearly discuss the various points involved in the description of the fish now under consideration and to show the error into which Milner fell, it is necessary to make a further detailed reference to *C. hoyi*.

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* Fauna Boreali-Americana, part 3.

† See Article 3 in the present Bulletin, by Professor Gilbert, who writes under date of February 21, 1894: "My specimens of *lucidus* are from the type locality, and agree in most points with Richardson's description and figure. The lower jaw does not, however, project, and many other points—to some of which you call attention—show abundant difference from *prognathus*."

In 1870 the late Dr. P. R. Hoy, of Racine, Wis., brought to public notice two apparently new species of whitefish, specimens of which were obtained while experimentally dredging in Lake Michigan, about 16 or 20 miles off Racine, in water from 50 to 70 fathoms deep. The fish were sent to the Smithsonian Institution and were named *Argyrosomus hoyi* and *Argyrosomus nigripinnis* by Dr. Theodore Gill, who, however, published no descriptions of them. In an important paper, entitled "Deep-water fauna of Lake Michigan," read before the Wisconsin Academy of Sciences and printed in the Transactions of the Academy for 1870–72, Dr. Hoy recorded the results of his researches and referred to the former fish as follows:

The *Argyrosomus hoyi* Gill is the smallest of the whitefish so far found in any of the Great Lakes, it being only about 8 inches in length and weighing one-fourth of a pound. The moon-eye, as called by the fishermen, is an excellent panfish, but its small size renders it unsuitable for market. Trout devour large numbers of these little beauties, as they constitute a large share of their food. The moon-eye is only found in water over 40 fathoms.

In a paper by Prof. Milner, entitled "New Species of *Argyrosomus* and *Coregonus*," printed in the Report of the U. S. Commission of Fish and Fisheries for 1872–73, Dr. Gill's manuscript names, *Argyrosomus hoyi* and *A. nigripinnis*, are used. Referring to the former, Milner remarks:

The cisco of Lake Michigan, not to be confounded with the cisco of Lake Ontario, is a fish frequenting the deep waters. It is taken in considerable quantities, at depths of from 30 fathoms to 70, and is the principal food of the salmon or mackinaw trout. Specimens were sent to the Smithsonian Institution, in 1870, by Dr. P. R. Hoy, of Racine, Wis., obtained in that vicinity, from which Dr. Gill made diagnostic notes, and adopted the name *Argyrosomus hoyi*. In a list of species of Lake Michigan, published in the Transactions of the Wisconsin Academy of Sciences, Dr. Hoy included Dr. Gill's manuscript name.

Milner further states that in 1871, while engaged in work for the U. S. Fish Commission, he collected numerous specimens of this species (locality not given, but presumably Lake Michigan), which were lost in the Chicago fire. In 1872 he obtained specimens in Lake Superior, one of which, now in the U. S. National Museum (No. 10576), from Outer Island, Wisconsin, he describes in detail; the fish, which is 11½ inches long, agrees perfectly with examples from Lake Ontario, a figure of one of which accompanies this paper. There is no doubt that the fish collected by Dr. Hoy, for which Dr. Gill proposed the name *Argyrosomus hoyi*, are very different from those which Milner had in hand when he prepared the article mentioned. It seems strange that in what purported to be the first published description of the fish Milner should not have consulted the specimens on which the species was based.

In a letter dated December 26, 1893, Prof. Jordan writes as follows regarding the true *hoyi* and the fish described as such by Milner:

It is evident that the *hoyi* of Gill is a very different fish from the other, having no particular relation to it. The description of *hoyi*, in the Synopsis, was taken from the specimen sent by Dr. Hoy. I do not know whether any part of Milner's account was mixed with it or not; I think not. The fish Hoy sent has the lower jaw included, the snout decurved, rather short gill-rakers, and is, I think, a typical *Coregonus* rather than an *Argyrosomus*. The other fish bears more or less resemblance to *laurettæ*, but is probably a new species.

It will thus be seen that an interesting question of nomenclature, involving the two species, is raised, and its settlement becomes necessary. It would seem that if Milner's use of the name *hoyi* in the report referred to was the first appearance of the name in print, it must be retained for the fish described by him, notwithstanding the misapplication of Dr. Gill's name.

The first printed reference to the name *hoyi* was in the paper of Dr. Hoy, previously quoted, in the Transactions of the Wisconsin Academy of Sciences for 1870–72, published in 1872. No description of the fish was given. The first use of the name *hoyi*, accompanied by a description of the fish so named, appeared in an article by Prof. Jordan, on the sisco of Lake Tippecanoe, in the American Naturalist for March, 1875. While the description consists, for the most part, of a comparison between *hoyi* and *sisco*, it is, in the opinion of Prof. Jordan, sufficient to retain the name for that species, provided the principle of priority is not infringed. The question is whether the use of the name *hoyi* by Milner, applying, as it did, to a different fish from that to which the name was attached by Dr. Gill, antedated the article by Prof. Jordan, in which the name was correctly employed. As bearing on this matter, the following extract from an interesting letter from Prof. Jordan, dated December 23, 1893, may appropriately be quoted:

The name *hoyi* was given by Gill without description to the two little fishes from Racine. At the same time I was at work on the *sisco* of Lake Tippecanoe and I wrote to Dr. Hoy to get me specimens of *sisco* from Lake Geneva. In sending these to me, in 1874, Dr. Hoy also sent me a specimen like those he sent to Gill of the little lake moon-eye to which Gill gave the name of *hoyi*. Of my specimens I published a short account in connection with *sisco* in the American Naturalist for March, 1875, p. 136. This description was reprinted with other matter in the report of the fish commissioner of Indiana for 1875. My little account, which is, however, long enough to hold the name of *hoyi* for the species to which it refers, was the first printed reference to the species, so far as I know at this time. In the U. S. Fish Commissioner's report for 1872–73, ostensibly issued in 1874, but not coming into my hands, as I find from my records, until some time after my paper was printed in 1875, Milner described his fish from Outer Island. I noticed sometime ago that his description did not agree with mine very well, but I presumed that he knew the fish of which he wrote and referred to the same one. So far as I can see, if my description was really first, as I suppose, the name *hoyi* must go with type. If, however, Milner's paper comes first, then the question arises whether *hoyi* should go with Milner's fish or the fish Milner thought he had.*

Prof. Jordan's surmise as to the date of issuance of the Fish Commission report in question is borne out by all the information obtainable at this time. The report was certainly not issued in 1874. The copy for some of the illustrations was not submitted to the Public Printer until January 28, 1875, and the indications are that the report was not printed before May or June, 1875. We are, therefore, justified in continuing to associate with the name *hoyi* the fish for which Prof. Gill proposed that designation.

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* The type specimens of *C. hoyi* in the U. S. National Museum (No. 8902), two in number, are in a poor state of preservation, and it is impossible, at this time, to determine the exact morphology of their heads and fins. The accompanying figure of the species, based on these specimens, is therefore possibly subject to slight corrections, although it agrees with Prof. Jordan's description in the American Naturalist (1875) of an example of this fish then before him, sent by Dr. Hoy: Depth 4¼, head 4, eye 3½. Lower jaw much shorter than in *Argyrosomus sisco*, almost *Coregonus*-like in this respect. Maxillaries stronger than in *sisco*, 2¾ in head. Mandible 2 in head. Distance from occiput to tip of snout contained 1⅞ times in distance from occiput to dorsal origin. Scales in lateral line, 75. Depth of body at vent 6¾ times in body length. Distance between vent and rudimentary caudal rays 4½ times in length of fish. Head thickly punctate with small black dots. Scales with a peculiar rich silvery color. Length rarely exceeding 7 inches.

Professors Jordan and Gilbert, in the "Synopsis," give the following additional features of *hoyi*, based on the example previously referred to: Body rather elongate, compressed, the back somewhat elevated. Head rather long, intermediate in form between *Coregonus* and *Argyrosomus*. Mouth rather large, terminal, the lower jaw evidently shorter than upper, even when mouth is open; tip of muzzle rather bluntly truncate; maxillary reaching to opposite middle of pupil; mandible extending to posterior margin of pupil. Dorsal 10, anal 10.

NOTES ON THE NATURAL HISTORY AND ECONOMIC VALUE OF COREGONUS PROGNATHUS, WITH SPECIAL REFERENCE TO LAKE ONTARIO.

A few notes based on original observations and inquiries can be submitted regarding the habits and importance of this fish; they relate chiefly to Lake Ontario, where the fish is of considerable commercial value. The writer is indebted to the following gentlemen for interesting information concerning the fish, based on their personal experience: Mr. John S. Wilson, Wilson, N. Y.; Mr. Charles H. Strowger, Nine-Mile Point, N. Y.; and Mr. B. E. Ingersoll, Oswego, N. Y.

In a paper* on the fisheries of Lake Ontario, issued in 1892, the writer drew attention to this fish, but erroneously, although dubiously, referred to it under the name *Coregonus hoyi.* In an earlier report,† relating to the fisheries of the Great Lakes in 1885, the fish under discussion was also mentioned by its common names, without any attempt to identify it scientifically.

COMMON NAMES.

There are at least ten common names given to this fish in Lake Ontario and Lake Michigan. Some of these are of local application; others are quite generally employed.

In Lake Michigan, the most common name in present use is "long-jaw," which is heard along both sides of the lake, but most frequently in localities having steamers employed in the deep-water gill-net fishery. In places in this lake it shares with *C. artedi* the name "herring."

In Lake Ontario this fish, whenever taken, is distinguished by the fishermen from the other *Coregoni,* and has received numerous names in different parts of the lake. In the eastern end, in Jefferson County, the name "bloater" is in general use. At Oswego and along the adjacent shores the name "long-jaw," "bloater," "bloater whitefish," "silver whitefish," and "Ontario whitefish" are employed. Mr. Ingersoll, of Oswego, states that in the New York market the fish is called "siscowet" or "ciscoette," a designation which has been transferred to a few places on Lake Ontario. In Niagara County the names "long-jaw" and "cross whitefish" are in common use, the latter expressing the current opinion among some fishermen that the "long-jaw" is a hybrid between the common whitefish and the cisco, or lake herring. Owing to the relative scarcity of the latter and the abundance of the other whitefish at Wilson, in Niagara County, some of the fishermen call the latter the "cisco," although they do not fail to distinguish it from the regular lake herring. Mr. Wilson states that "long-jaw" is the name generally employed in that locality. This, it would seem, is perhaps the most appropriate common name given to the fish.

The origin of the name "bloater" or "bloater whitefish" can no doubt be traced to the swollen appearance of the abdomen when the fish are brought up from deep water, owing to the expansion of the air bladder under the diminished pressure near or at the surface. All of the fresh specimens examined by me have had the appearance of being greatly enlarged with ripe spawn, and the swimming-bladders were found to be distended. Mr. Strowger states that in the few instances in which he has noticed fish caught in comparatively shallow water there were no signs of bloating.

* Report on an Investigation of the Fisheries of Lake Ontario. Bulletin U. S. Fish Commission, 1890, p. 207.

† Review of the Fisheries of the Great Lakes. Report U. S. Commissioner of Fish and Fisheries for 1887, p. 316

SIZE, HABITS, ABUNDANCE, ETC.

The average length of the fish seems to be about 15 inches, although it reaches a much larger size. In the series of specimens at hand the females have a somewhat greater length than the males, the averages being 14·96 inches and 14·40 inches, respectively. The largest female is 15·25 inches long and the smallest male is 13·37 inches long. The extremes of weight are 443 and 602 grams for females, and 402 and 473 grams for males, the averages being 508 and 447 grams, respectively.

The average weight of the fish caught in Lake Ontario at the present time is about 1¼ pounds. The smallest taken by the fishermen are under a quarter of a pound. The largest of which a definite record has been obtained weighed 5¼ pounds and was caught off Wilson, N. Y., as I am informed by Mr. Wilson, of that place. Mr. Strowger, of Nine-Mile Point, has seen long-jaws that weighed upwards of 4 pounds and has heard of some weighing as much as 6 pounds. In recent years the use of small-meshed gill nets has reduced the size of the fish taken. The range in weight of marketable fish is now ½ of a pound to 2 or 3 pounds.

The information at hand concerning the movements of the long-jaw whitefish in Lake Ontario goes to show the existence of a definite bathymetrical migration, which depends chiefly on the seasons and is well recognized by most of the fishermen. In winter the fish are found in the deepest water of the lake, at a depth of 400 to 700 feet. Towards spring they begin to approach the shores, being taken at a gradually decreasing depth until August, when they occur in water about 20 fathoms deep. After this time they begin to work out toward the middle of the lake, and by the end of November or the beginning of December they have reached a depth of 45 or 50 fathoms. In the opinion and experience of Mr. Wilson and other fishermen of the western end of the lake, the process of spawning then supervenes, after which the fish retire to the deepest water, where the winter is spent. During the period of spawning the fishermen of Niagara County find that the fish are apparently more plentiful than at other times, the largest catches being then made; this is because the fish scattered over large areas are drawn together by the reproductive instinct and resort to special grounds, where they are found in more compact bodies.

There is a gravelly area off Wilson on which the fish congregate for the purposes of spawning.

Concerning the specimens which Mr. Wilson forwarded, he states that they were taken April 18 in water 50 fathoms deep. At that time of the year the schools are usually more scattered than at other seasons and fewer fish are caught in a given time in a given amount of netting. This dispersion seems to be due to the fact that the fish are quite voracious after their sojourn in the deep water and are obliged to distribute themselves over a wider area in order to secure the necessary supply of food.

Under date of May 17, 1892, Mr. Strowger writes that the first fishing boat to come from the lake that season arrived on that day and had two bloaters, taken about 2 miles from the shore, inside the main schools, which are usually found in 80 to 100 fathoms of water off that place. One of the bloaters had ripe spawn, the other very immature spawn-sacks. In the opinion of Mr. Strowger, this species probably has a prolonged spawning period, extending over the entire year, a view which is plausible enough and in harmony with the known habits of certain other salmonoid fishes inhab-

iting deep water. At the same time, it is no doubt possible, and even probable, that most of the fish spawn in the early winter, like the common whitefish, as observed by Mr. Wilson. The condition of the ovaries in the specimens sent in April by Mr. Wilson indicates the completion of spawning some months before. The ova in the 7 examples examined were uniformly hard, white, and immature, and about one-fortieth of an inch in diameter. In one specimen, 14½ inches long and weighing 531 grams, the ovaries were 5 inches in length and had a combined weight of 17 grams, the left organ being considerably fuller and weighing 9½ grams.

Several of the specimens forwarded by Mr. Schwartz on June 13, 1892, which had probably been caught about two days before, had fully matured spawn, which was running when the fish were unpacked. One of these, 12 inches long, contained 2 ounces of ripe eggs and also many undeveloped ova of very small size, together with a number of larger eggs that were apparently approaching maturity. The ripe eggs were of a pale-yellow color, transparent, and one-sixteenth of an inch in diameter. A careful computation indicated that this fish contained about 15,000 more or less mature ova.

Off the entire shore between Stony Point and the Niagara River, wherever the fishermen set their nets in deep water, the presence of an abundant supply of this whitefish is disclosed. Taking the entire lake into consideration, the fish do not show any marked fluctuations in abundance from year to year, and are now probably as numerous as when the fishery began. Mr. Wilson remarks that appearances would indicate that the fish are less numerous than formerly, but the fishermen think this is not the case, as the fish now go in more scattered schools than in earlier years, probably as a result of the scarcity of food on the regular feeding-grounds.

The largest single lift of which a record has been obtained was made by a crew of Wilson fishermen in 1885; 2 men setting 9 pounds of netting (equivalent to about 140 rods) took 1,600 pounds of these fish in one day. The usual daily catch to a boat is from 200 to 800 pounds.

Comparing the abundance of this whitefish with that of the lake herring, it is interesting to observe that in some places at least, and probably generally, the former is much more numerous. The most pointed information available relates to the experience of the fishermen of Wilson; they often find the ciscoes on the same grounds as the long-jaws, but they are very scarce now and appear to have been affected, like the whitefish, by the advent of the long-jaws. Of the total quantity of long-jaws and ciscoes annually taken there, the former represent no less than 90 per cent.

Very little definite information bearing on the subject of the food of this whitefish can be given. It may be safely surmised, however, that it has substantially the same food as the common whitefish, although its deep-water habits would no doubt afford a different series of animal and vegetable food organisms; and its larger mouth and more powerful jaws indicate a somewhat wider range of food than is possessed by the common whitefish, in which respect it resembles *Coregonus artedi*. The digestive tracts of the specimens at hand contain nothing, but this proves little, as an examination of fish stomachs, unless undertaken soon after the fish are caught, usually fails to be satisfactory, as the intestinal and gastric juices continue their action after the death of the fish and the stomach contents are often completely digested in a short time. Mr. Wilson states, as a result of his personal observation, that the food

of the long-jaws examined by him has consisted mostly of a small crustacean, resembling a crab, with a soft shell. This is probably a *Mysis*.

One of the most interesting and important questions suggested by the presence of this whitefish in Lake Ontario in large numbers is the relation which it may have to the present scarcity of the regular whitefish. It is no doubt possible that the uninterrupted increase of this prolific fish during a long period of years might finally have resulted in the depletion of the natural-food supply of the whitefish to such an extent that the common whitefish, being numerically and physically weaker, were forced to seek other feeding-grounds, which may have been much restricted and in such situations that it was taken by man more easily than formerly, and so more rapidly caught up. The exhaustion of the food would also affect unfavorably the growth and survival of young whitefish. Mr. Wilson's observations confirm this theory; he states that the first year after the appearance of the long-jaws the regular whitefish, which had been abundant, became very scarce, and at the present time are so rarely taken as to be almost a curiosity, the explanation assigned by him and others being that both fish fed on the same food, on the same grounds, and at the same time.

In some of the specimens of this whitefish at hand parasites have been found, to which reference may appropriately be made, although the unfamiliarity of the writer with the subject precludes an entirely satisfactory discussion of the animals in question. In the gill cavities of a number of the fishes received from Wilson, N. Y., in April, small crustaceans about one-half of an inch long, belonging to the order of copepods, were discovered fastened to the gill arches and the under surface of the opercle. Some of the parasites were sent to Prof. R. Ramsay Wright, of the biological department of the University of Toronto, who has contributed extensively to the literature of the parasites affecting fresh-water fishes; he courteously examined the specimens and reported as follows:

> I should regard it as identical with the form described and figured by Kellicott (Proc. Amer. Soc. Microscopists, 1878) as the gill herring-sucker, and named *Achtheres corpulentus*. He also figured a *Lernæopoda* from the whitefish, but this agrees with *Achtheres* in the curved egg sacks, stalked sucker, and form. It appears also to have some indications of segmentation in the abdomen, which *Lernæopoda* ought not to have.

Among the matured ova expressed from specimens received in June a considerable number of trematode worms of the genus *Echinorhynchus* were found. As the usual habitat in fishes of the numerous members of this genus is the intestinal tract, it is not probable that these parasites came from the ovary, although found among the eggs.

COMMERCIAL IMPORTANCE AND FOOD VALUE OF THE LONG-JAW WHITEFISH.

Information is lacking to show that this whitefish has ever been a special object of fishery or at present has any commercial importance, except in lakes Michigan and Ontario, although it is probable that additional inquiries will disclose the fact that in the other lakes the fish is caught in greater or less quantities, but is perhaps not generally distinguished from the closely related lake herring.

In Lake Ontario this is now one of the most important commercial fishes. At some fishing centers it is more valuable than all other fish combined. It never approaches near enough to the American shores to be caught in seines or with any of the fixed forms of apparatus, and is taken only in gill nets set at the bottom in deep water.

Owing to the fact that the fishermen and dealers rarely keep records of the quantities of different species caught or handled, only approximate figures can be given, showing the annual catch of this species in Lake Ontario. In the inquiry, during which most of the accompanying notes were obtained, it was impossible to separate the catch of this whitefish from that of the lake herring and other minor whitefishes, about which less is known than regarding the "long-jaw." It may be stated, however, that the approximate yield of this species in 1891 was 250,000 pounds, with a value to the fishermen of $8,100. The catch of regular whitefish in the same year was only 150,000 pounds, worth $7,000. These figures of course apply only to American fisheries.

Mr. Ingersoll, of Oswego, employs the steamer *George H. Haselton* in his business, and, although the vessel is chiefly used to transport fish from the Canadian fisheries of the Bay of Quinte and the Duck Islands, it is sometimes employed for short periods in fishing with gill nets. In 1890 the aggregate catch of whitefish by this vessel was as follows:

Species.	Pounds.	Value.
Common whitefish	2,000	$80
Long-jaw whitefish	17,500	700
Total	19,500	780

These figures illustrate the great relative abundance of the long-jaw, and are no doubt typical of results to be obtained by deep-water gill-net fishing at the present time.

The habit of the fish of frequenting cold, deep water gives the flesh a firmness and flavor which have made it a very highly esteemed food. Many people assert that the superiority of the common whitefish is only slight, and there seems no reason why the difference in the food value of the two species should be marked. As in the case of the common whitefish, the flesh of the long-jaw will soon become soft unless proper measures are taken to preserve it.

Mr. Strowger gives his personal estimate of the edible qualities of this species in the following words:

> When properly cared for on being caught this is a delicious fish. When salted it keeps well and does not lose its freshness when cooked. A great deal of prejudice against the long-jaw is entertained because of the soft and damaged condition in which the fish is usually sold to the consumers. It is a fish that ought to be iced as soon as it is taken from the water and kept cold until used, as it easily softens and on cooking becomes too greasy for ordinary human palates to enjoy. When fresh-caught it is equal in my judgment to any fish for delicacy of flavor. It is a superior fish for baking when of full size, but small-sized fish are always of less value and should not be caught.

In New York City the long-jaw is used quite extensively for smoking and is very popular, as I am informed by Mr. Ingersoll, who has at times shipped one or two tons weekly to smokers. Personal knowledge of the value of this fish in a lightly smoked condition leads me to attest its excellence.

Perhaps no better criterion of the edible qualities can be adduced than the market prices. The wholesale value of this whitefish is as a rule a little less than that of the common species, but in some localities and at certain times the two fish bring the same price.

Inquiries as to the circumstances of the origin of this fishery in Lake Ontario have elicited the information that it was only at a comparatively recent date that the fish assumed commercial importance, and in most fishing centers it has been known only a few years. When the common whitefish was sufficiently abundant in the more accessible portions of the lake, there was little occasion for the fishermen to undergo the additional labor and time required to set their nets in the deeper water, and consequently the species under discussion was very rarely caught; but the continued scarcity of *Coregonus clupeiformis* brought *Coregonus prognathus* into gradually increasing prominence, and at the present time it is an important food-fish at almost every fishing center on the lake, and in 1891 the catch was probably the largest ever made.

Mr. Strowger, who has been familiar with the lake fishes for a great many years, says that long-jaws were not fished for in the vicinity of Nine-mile Point until some time after the civil war. An old fisherman, however, informed him that prior to that time he occasionally took a specimen while fishing for regular whitefish.

The following local newspaper account of the discovery of "a new kind of fish" reflects the current opinion of the fishermen in the western end of the lake, and is additionally interesting because of the information conveyed:

> Gill nets were recently set in 40 fathoms of water 10 miles out from Charlotte in Lake Ontario, with the expectation of taking trout. When they were taken up they were filled with whitefish; not a trout was found in them. This was a great surprise, especially as the whitefish were of a variety called "long-jaws," which had never before been caught in considerable numbers in Lake Ontario. Those which had been taken in this lake before were small, not larger than herring, and nobody seems to have suspected that "long-jaws," like these, weighing from 2 to 5 pounds each, were to be found in these waters. Seth Green thinks that none of these fish have ever been planted in Lake Ontario. There are two kinds of deep-water whitefish, the "long-jaws" and the "black fins," but only the former has been found thus far. Of these, great numbers are caught, an average "lift" being about 800 pounds. The fish are packed and shipped to New York, Buffalo, and other cities besides Rochester, and readily find sale, the demand for them being so great that difficulty is found in supplying the dealers.—(Journal, Lockport, N. Y., November 22, 1887.)

At Wilson, the principal fishing center west of the Genesee River, the fish have been known only ten years. In the fall of 1882 they made their appearance, and some were then taken by Wilson fishermen. Shortly afterward the fishery became regularly established and is now quite extensive and important.

It would seem that the principal factor in the inauguration of the fishery for long-jaw whitefish was the pronounced diminution in the supply of common whitefish, which made it necessary for the fishermen to resort to new grounds in hope of finding that fish. The more or less experimental setting of gill nets in the deeper water resulted in making the existence of the long-jaw more generally known.

In Lake Michigan this fish is found in the deeper water of the southern two-thirds of the lake, and is taken in considerable numbers in gill nets, in conjunction with lake trout, chiefly by the steam tugs operating long lines of netting in deep water. It is usually distinguished by the fishermen from the lake herring or cisco.