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THE FISHES OF LAKE NIPIGON

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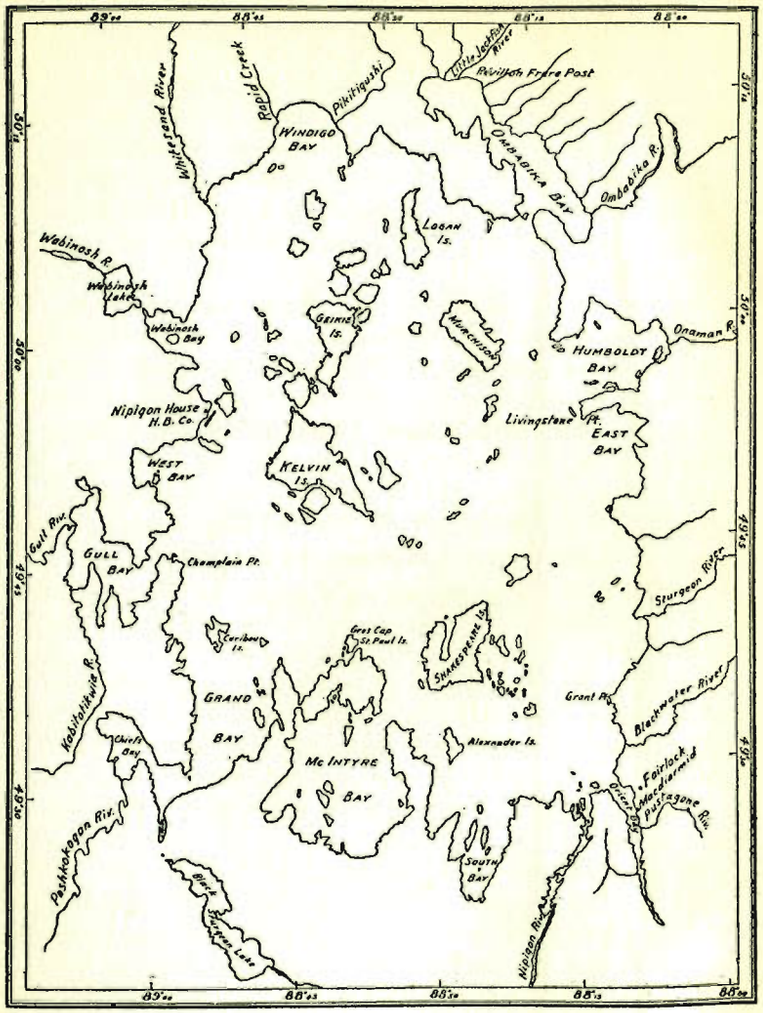

Map of Lake Nipigon.

THE FISHES OF LAKE NIPIGON

Lake Nipigon has been made the subject of a very thorough limnobiological survey during the past four summers (1921-24), and reports on various phases of the work have already appeared in previous publications of the present series. As part of this investigation it fell to the writer's lot to make a study of the fishes from a systematic and ecological point of view.

At the time this study was commenced in June, 1921, Lake Nipigon was still little changed from its natural and primitive condition and represented, more closely than any other body of water to-day, the conditions originally existing in some of the Great Lakes. In fact, Lake Nipigon may quite properly be regarded as the first in the chain of the Great Lakes, at one time forming a northern bay of Lake Algonquin, the precursor of the present Lakes Superior, Huron, and Michigan (Coleman, 1922, p. 20).

Previous to the opening of the lake to commercial fishing in 1917, the only disturbance of natural conditions, so far as the fish life of the lake is concerned, was that due to the fish taken by a few hundred Indians who live around the lake, and in connection with the construction of two lines of railroad, one at the north and the other at the south end of the lake. The amounts so removed must have been so small as to cause no appreciable disturbance to the natural balance in the waters.

As most of the drainage basin of the lake is comprised within the Nipigon Forest Reserve, which has been practically untouched by fire or lumbering operations, original conditions in the lake had not been disturbed through changes within its cachment-basin. Since 1923, however, logging operations have been carried on both on Gull and on Sturgeon rivers. On the former, railroad ties have been made during each of the past two years at two points, respectively four and eight miles

TABLE 1.—Quantities in pounds and value of Lake Nipigon fish, 1917-1922.

	Whitefish	Trout	Pickerel (Pike Perch)	Sturgeon	Caviar	Pike	Mixed and Coarse Fish	Value
1917*	39,103	40,123	5,002				30,225	$ 9,934.05
1918	850,041	401,109	16,394	4,215		365	24,624	128,647.05
1919	1,620,970	617,900	30,035	17,595	140	1,080		229,219.90
1920	1,399,390	369,675	35,525	20,995	145	3,605		183,303.65
1921	1,168,200	427,825	91,765	20,775	140	7,810		171,802.50
1922	897,500	389,035	62,440	13,086		8,265		163,967.08

*The initial shipment of Lake Nipigon fish reached Toronto on Sept. 26, 1917.

TABLE 2.—Temperatures in centigrade at different depths at various times during the summers of 1921, 1922, 1923 and 1924.

Depth in feet	1921			1922			1923			1924		
	June 17	July 9	Aug. 29	June 27	July 29	Aug. 17	July 11	Aug. 15	Sept. 14*	June 23	July 25	Aug. 15
Surface	12.5	22.0	17.1	10.3	18.2	17.6	15.3	14.5	11.3	7.8	14.8	14.9
15	8.5	16.6	16.8	9.0	15.2	16.4?	12.0		11.2	7.0	14.2	14.8
30	7.7	9.3	15.9	8.8	12.9	16.6	11.0	13.6	11.1	6.0	13.0	14.7
60	6.0	6.2	8.0	7.4	8.2	7.8	6.1	12.1	11.1	5.0	8.4	10.3
75	5.2		6.7	7.0	7.2	6.7	5.6	10.3	11.0	4.9	6.8	7.75
120	4.8	4.3	5.7	5.3	5.6				10.7	4.4		6.1
150				4.7	5.1					4.25	5.4	5.6
159	4.0											
276							4.0					
285												4.5
300				4.0	4.1	4.6?			5.8	3.9?	4.2	
345								4.4				
375						4.1						

*During the end of August and the beginning of September, 1923, a number of rather violent storms mixed the waters of the lake so thoroughly as to raise the temperatures of the lower depths to an unusual extent.

from the mouth of the river. The logs brought down the Sturgeon river have been sawn at a mill near Macdiarmid, erected during the winter of 1923-24. Since 1920, plantings of whitefish and lake trout fry have been made each year, and in that year a number of parent small-mouthed black bass were introduced into the lake near the foot of Orient bay.

The quantities of the different varieties of fishes taken from Lake Nipigon for the first six years after it was open to commercial fishing are given in Table 1, together with the total value of the catch for each year. These figures are taken from the Reports of the Fish and Game Department, Ontario.

The lake has been described, and its limnological features discussed by Clemens in a number of papers in the present series (1923, 1924A, 1924B), so that here it is necessary to refer to only a few of its most outstanding characteristics as a fish habitat. In general it may be said that Lake Nipigon is a large, deep, cold-water lake of high oxygen, low free carbon dioxide, and high bicarbonate contents, with a hydrogen-ion concentration around 8.0 to 8.3. Table 2 gives the temperatures at various intervals during the four summers spent on the lake.

The coast line is characterized by a succession of rocky headlands (Fig. 1, Plate IX), alternating with large bays. Most of these bays are not well protected, and their shore lines are usually rocky, stretches of sandy beach (Fig. 2, Plate IX) or areas of marsh being uncommon. There are, however, a number of well-protected bays which, on account of the contrast between conditions in them and those obtaining in the main body of the lake, deserve special mention.

BAYS

Orient Bay (Pijitawabic Bay). This deep narrow bay at the south-eastern extremity of the lake received a great deal of attention because our headquarters were situated at Macdiarmid, a fishing village just inside the mouth of the

bay and also because near its extremity there are a number of smaller bays with considerable aquatic vegetation (Fig. 1, Plate X). Some of these little bays are so well protected from the effects of disturbances in the lake that we find in them conditions quite different from those found in similar small bays more directly influenced by the waters of the open lake. Except for that portion of the bay near its extremity, and the little offshoots mentioned above, conditions in the body of the bay itself differ less from those in the lake than do conditions in a number of other bays to be described later. This is brought about by the wide mouth of the bay facing the longest stretch of open water to be found in the lake. This long stretch of open water extending in a north and south direction exposes Orient bay to the influence of storms which sweep the lake. Its water becomes mixed with water from the open lake, and approximates more closely in temperature and chemical content to the lake water than does the water of more protected bays.

The most interesting of the little inlets near the foot of Orient bay is Aviators' bay, which is so well protected that silting and the development of aquatic vegetation have gone farther than in any other situation studied in the southern end of the lake. Here, in addition to the fishes characteristic of shore marshes elsewhere, we found *Etheostoma iowae* and *Eucalia inconstans* quite common and at the very extremity, far removed from the influence of the lake, we found *Notropis heterolepis*. This species was not found anywhere else in the lake, but was taken in two small lakes, one about twenty miles up Gull river and the other on Shakespeare island. In association with this species we found a number of perch larger than those taken elsewhere in the southern end of the lake.

Humboldt Bay. This large bay, situated at the north-eastern part of the lake, consists of an outer, deep-water, more or less exposed portion and an inner, very shallow, protected portion. The former does not differ in its fish fauna from that of the open lake, while the latter contains

Acipenser fulvescens, Moxostoma lesueurii, M. anisurum, Stizostedion canadense and large specimens of *Perca flavescens*.

Windigo Bay. This is in the north-western corner of the lake. It contains a considerable area of shallow water, the depth increasing gradually from shore to twenty-four feet about three miles out. Although open to the south, it is protected to some extent by the numerous islands lying in this part of the lake. Its waters, of course, are protected from the east, north, and west. We found it to contain great numbers of saugers, 122 specimens having been taken in one hundred yards of two-inch net in one night, whereas, in the southern half of the lake, only one specimen has been taken during the four summers. We also found the round whitefish much more common and of a larger size here than farther south. The cisco, *L. artedi*, occurs too in large numbers.

Wabinosh Bay. This small bay on the western shore of the lake contains an area of shallow, protected water and a considerable development of aquatic vegetation near shore. Here again we found the sauger and round whitefish in comparatively large numbers.

Gull Bay. This large, shallow bay is connected with the lake by a narrow channel and hence the water of the lake does not mix with its water to any considerable extent. The greatest depth we found was 68 feet. It contains few whitefish and no lake trout, but considerable numbers of sturgeon, pike perch, pike as well as sauger, red horse, and the shallow water cisco, *L. artedi*.

Ombabika Bay. This is perhaps the most interesting of all the bays of Lake Nipigon from an ecological point of view. It is a long narrow body of water about 18 miles in length and about 3 miles in average width, connected with the lake by a very narrow channel. It contains a great deal of shallow water, much of it being less than ten feet deep. There is a deeper channel off the west shore, reaching a depth of 84 feet towards the northern end of the bay.

At this end of the lake the granite, which farther south has been covered by a flow of diabase, comes to the surface and forms a more gently rolling surface in contrast to the

rough, almost mountainous topography of the country about the southern end of the lake. No chemical analyses have been made of the water, but the following temperature records have been secured.

TABLE 3.—Temperatures (centigrade) at various depths in Ombabika bay and in the open lake at intervals during the summer of 1924.

	Ombabika bay, 1924				Open lake (Station 4) 1924		
Depth in yards	June 18	June 27	July 22	Aug. 8	June 23	July 25	Aug. 3
Surface	10.7	12.2	15.8	17.6	7.8	14.3	13.9
5	10.2	12.2	15.6	17.4	7.0	14.2	13.9
10	9.6	11.8	15.2	17.2	6.0	13.0	13.9
15	7.5	8.9	12.6	15.9	5.2	10.6	13.6
20	6.4	7.8			5.0		
22	6.1	7.8					

The colour as determined on June 18, 1924, was 21, and transparency 2.5 yards. The corresponding values for the waters of the open lake are 7 to 10 and 11.7 to 17.0. (See Clemens, 1923.)

The fish taken in Ombabika bay include *Acipenser fulvescens, Catostomus catostomus, C. commersonii, Notropis hudsonius, N. atherinoides, N. deliciosus stramineus, Couesius plumbeus, Rhinichthys cataractae, Prosopium quadrilaterale, C. clupeaformis, Leucichthys nipigon, L. nigripinnis, L. artedi, L. zenithicus, L. reighardi, Esox lucius, Pungitius pungitius, Percopsis omisco-maycus, Stizostedion canadense, S. vitreum, Perca flavescens, Boleosoma nigrum, Percina caprodes zebra, Cottus cognatus, C. bairdii, C. ricei, Lota maculosa.*

The interesting points about the fish fauna of this bay are as follows:

(1) Species rare or absent throughout the greater part of the lake are here common, and species which, although found commonly elsewhere, do not reach a large size, here grow much larger. The perch is the most striking example of the latter. In Orient bay and throughout most other parts of the lake, perch are numerous, but it is rare to find one over six inches in length: in Ombabika bay specimens of nine and ten inches are fairly common. Saugers, very rare or entirely absent throughout the greater part of the lake, are here common. This species, however, is perhaps still more numerous in Windigo bay, and occurs in numbers in other shallow bays in this part of the lake, such as Humboldt and Wabinosh, and also in Gull bay. The round whitefish is unusually common here and reaches a larger size than elsewhere except for Windigo bay specimens. The tullibee (*L. nipigon*), rare elsewhere, is quite common in Ombabika bay. The log perch and straw-coloured minnow are both not uncommon here, while elsewhere in the lake they have been taken but rarely, and *Cottus bairdii* has been taken only in Ombabika bay. It is interesting to note, too, that crayfish (*Cambarus virilis*) occur in considerable numbers among the rocks along the shore, whereas not a single specimen has been taken south of Humboldt bay. Other species which reach a larger size or occur in larger numbers include spot-tailed minnow, lake shiner, and trout perch.

(2) The coloration of Ombabika bay specimens is usually much lighter than that of specimens of the same species taken elsewhere. For example, Lake Nipigon specimens of lake chub and trout perch are usually quite brilliantly coloured (see descriptions), whereas here they are of a monotonous creamy gray colour throughout. The same applies more or less to all the species found in the bay, the black fin cisco (*L. nigripinnis*), for instance, scarcely differing in coloration from *L. zenithicus*. This is no doubt related to the slightly turbid coloration of the water.

(3) The eyes of all species of ciscoes found in the bay average larger than for the same species taken in the rest of the lake.

LAKES

As elsewhere throughout the Archaean area of Canada, the country surrounding Lake Nipigon contains numerous lakes, ranging in size from mere ponds to lakes of many square miles in extent. Most of these are above the level of Lake Nipigon and afford a variety of habitats, most of which contrast strongly with those of the lake itself. A number of these have been visited and their fish fauna determined. Chemical tests of the water have been made in very few of them and, apart from temperature records and their general physical characters, little indication can be given of their characteristics as fish habitats.

Black Sturgeon Lake. The largest of the lakes in the Nipigon region is Black Sturgeon lake, which is about 12 miles long and 2 or 3 miles wide. An early outlet of Lake Nipigon is believed to have been by way of the basin occupied by this lake. Its shores are not so high or so rocky as is so much of the shore of Lake Nipigon. There are more gravelly or sandy beaches, although in the more exposed situations stones and rocks of considerable size form the shore line. Near the northern end of the lake there is a considerable area of shallow water with muddy bottom that supports in some places a good deal of aquatic vegetation.

The greatest depth we found was 80 feet, but we do not know whether this is the maximum depth or not, though it is probable that there is not much water of a greater depth. The water is of a very dark brown colour. The following temperature records were obtained on July 20, 1922: surface, 20.5° C.; 8 yards, 14.9° C.; 22 yards, 5.8° C.

The following species were taken during a stay of two days which we made on the lake in July, 1922: *Catostomus commersonii, Notropis hudsonius, N. atherinoides, Coregonus clupeaformis, Leucichthys nipigon, L. artedi, Esox lucius, Pungitius pungitius, Percopsis omisco-maycus, Micropterus dolomieu, Stizostedion vitreum, Perca flavescens, Boleosoma nigrum, Percina caprodes zebra, Lota maculosa.* We have also seen a number of sturgeon (*Acipenser fulvescens*) that were

taken from the lake during the summer of 1924. The fish are all very dark, even the whitefish being black above and quite dark below.

Lake on Shakespeare Island. Two visits were made during the summer of 1924 to a lake near the south-eastern corner of the main island of the Shakespeare group. It is situated inland about 100 yards, and its water level is practically, if not exactly, the same as that of the main lake, with which its waters were undoubtedly at one time continuous. The lake, which is very irregular in outline, averages perhaps three-quarters of a mile long and slightly less than half a mile wide. It is almost completely surrounded by low, well-wooded hills, so that ordinary winds cause very little disturbance. On one occasion, when we were there, a considerable gale was blowing on Lake Nipigon, whereas on this little lake the effect of the wind was scarcely noticeable. On this account it is probable that the heat is not driven down to the same extent as would occur if it were more exposed to the action of wind.* This is indicated by the following temperature records:

TABLE 4.—Temperatures in Shakespeare Island lake, 1924

Depth in yards	July 8	Aug. 4
Surface	22.1° C.	22.5° C.
3	17.9	18.2
5	10.1	11.8
8	6.6	7.7
11		6.6
12	6.2	

In most places alders grow along the water's edge, while large spruces grow only a few feet back. In one bay there is a clean sand beach, but others are more muddy with some aquatic vegetation. There is very little exposed rock any-

*On the effect of wind in distributing heat to lower depths, see Clemens (1923, p. 8).

where along the shore. The greatest depth found was 36 feet. Following are the results of some analyses made on August 5, 1924:

TABLE 5.—Chemical Analyses of Water of Shakespeare Island lake.

Depth in yards	Oxygen	CO_2	Bicarb.	Total acidity	pH.
Surface	5.75	trace	165	1.0	8.2
5	5.7	2.1	180	3.5	7.2
11	2.3	6.5	160	8.0	7.0

The species of fish found in this lake were as follows: *Notropis hudsonius*, *N. heterolepis*, *Coregonus clupeaformis*, *Esox lucius*, *Perca flavescens*, *Etheostoma iowae*. The remarkable feature of the fish population was the large number and large size of the whitefish. From 450 yards of gill net of various sizes from 1½" to 5" stretched mesh, we got, after 43½ hours, 90 whitefish and 2 pike. The whitefish averaged larger than whitefish taken in Lake Nipigon, quite a number being over 19 inches in length.

Lone Island Lake. This lake is situated beside Gull river at a distance of 8 or 10 miles in a straight line west from Gull bay, but following the windings of the river it is perhaps 20 miles from the bay. It is situated quite close to the river, but has no connection with it except possibly at high water when it may drain into the river, but it is doubtful if at any time there is a well-defined stream leaving the lake. The lower (eastern) side of the lake is at a considerable elevation above Gull river, but owing to a series of rapids and falls in the river above this point the upper (southern) end of the lake is scarcely higher than the river above the falls. The lake is about 1½ miles long by three-quarters of a mile wide. Its shores are for the most part rocky or sandy, but in a few small bays the shore and bottom for some distance out is composed of finely divided decaying vegetable matter. In places aquatic vegetation has become established. The water is quite clear, not noticeably dark as in so many of the small

lakes of the region. The greatest depth found was 53 feet. The only temperature records obtained were on June 3, 1924, at 3.30 p.m., when the water at the shore was 24° C., and near a small rocky island in the centre of the lake, 14° C. The fishes taken in the lake were *Notropis hudsonius*, *N. heterolepis*, *Coregonus clupeaformis*, *Esox lucius*, *Perca flavescens*, *Boleosoma nigrum*. This list is identical with that for Shakespeare lake, except for the tessellated darter, which is replaced in the latter by the Iowa darter.

Wabinosh Lake empties into Wabinosh bay on the western side of Lake Nipigon. This lake has received very little attention, but is of interest because in it we took specimens of *Margariscus margarita nachtriebi*, which was taken in only two other localities, namely, in Station lake and in Aviators' bay, Lake Nipigon. It is a lake of considerable size, being three or four miles long and two or three miles wide. Its shores, so far as we examined them, are wooded with alders growing at the water's edge. The bottom for several yards out, at least for a mile along the south-eastern shore, is of fine sand. Large boulders are found at intervals, usually some little distance from shore. Very few fishes were taken, although several seine hauls were made in likely looking places. The only fishes taken in the seine were two perch. A number of Nachtrieb's minnows were taken in the dip net among large rocks near the outlet of the lake, where the water was fairly swift.

Station Lake. This is a small lake about one-half mile long and 150 yards wide, occupying a trough-like depression between two ridges, about a mile north east of Macdiarmid. At each end of the lake a sphagnum bog has developed, but the more or less steeply sloping sides are timbered nearly to the water's edge with alders lining the shore in most places. At one point the foot of a talus slope forms the shoreline for perhaps one hundred yards. In most places the bottom is very soft, being composed of finely divided vegetable detritus, several feet in thickness. In places, however, the bottom is composed of hard sand for a distance of ten or twelve feet from shore. The lake is everywhere shallow, in very few

places exceeding six feet in depth. The water has a decidedly brownish tinge, but is not nearly so dark as in the more boggy lakes next described. It is drained by a small stream which flows through the western edge of the village of Macdiarmid. This tiny stream flows among large boulders. Its descent is quite rapid, and at one point there is a fall of two or three feet. It seems impossible that fish ascend it even at high water. Analyses of the water on July 6, 1922, gave the following results:

TABLE 6.—Temperature and Chemical Analyses of Water of Station lake.

Depth	Temperature	Oxygen	CO_2	Bicarb.	Total acidity
Surface	17.7° C.	5.8	1.5	96	5
5 feet	16.4	5.7	2.0	37	5

On July 5, 1924, the surface temperature of the water was 18° C. and its pH. 6.9, using bromthymol blue and cresol purple as indicators.

The fish taken in the lake include *Catostomus commersonii*, *Pfrille neogaeus*, *Margariscus margarita nachtriebi*, *Pimephales promelas*, and *Eucalia inconstans*. Nachtrieb's minnow and the fathead are the dominant forms. The suckers are all small, most of them less than six inches in length. The largest one taken measured eleven inches.

Lake near Fairlock. At the foot of the hill on which is situated the firerangers' lookout tower at Fairlock (3 miles from Macdiarmid), is a small lake which differs in character from any other examined. It is somewhat larger than Station lake, and its shores are solid and are tree-and-alder-lined, except for a short distance at one end where bog conditions prevail. The bottom at least for ten or twelve yards from shore is covered with large boulders. The water at this distance out is about 5 feet deep, but it is not known what the maximum depth is. The water has a turbid appearance, but we have no temperature records or other data to indicate its character. The only fishes taken as a result of several

seine hauls along shore were *Pimephales promelas* and *Eucalia inconstans*.

BOGGY LAKES

Many small boggy lakes are found in the depressions among the elevations characteristic of the region. A number of these have been examined for fishes, and such data as we were able to obtain is presented herewith.

Crescent Lake. This small lake is situated at the head of Cedar creek which flows into Orient bay about a mile north of Macdiarmid. The lake is crescent-shaped, about 200 yards long, and 75 yards wide. Its western side is formed of solid earth and supports a stand of fairly large trees, but the opposite side and the ends, *i.e.*, the outside of the crescent, are low and boggy. The bottom of the lake and the shores near the outlet are of muck, but the greater part of the shoreline is formed by a sphagnum bog. The water nowhere appears to be more than two or three feet deep and is dark brown in colour. *Pfrille neogaeus* occurs in very large numbers in this lake, but a few specimens of *Chrosomus erythrogaster* and *Eucalia inconstans* were also taken.

Centre Lake occupies part of the same depression as Crescent lake. The two were undoubtedly at one time connected, as the area between them is marshy, and at high water fish could no doubt still pass from one lake to the other. As in the case of Crescent lake, the western shore is of higher, solid ground supporting a good stand of timber. The other three sides are bog-margined. This lake is deeper than the former, and is not so nearly filled with muck. It contains a higher proportion of *Chrosomus erythrogaster*, although *Pfrille neogaeus* is also abundant. A few *Eucalia inconstans* also occur. The pH. of the water was found to be about 7.

Two other small bog-margined lakes were examined fairly thoroughly for fish, but no specimens could be found. In both cases quaking sphagnum bogs completely encircled the lakes, and the waters were of a very dark brown. It is of

interest to note that in both of these lakes ambystoma larvae were taken and that in none of the lakes described above in which fish were found were such larvae found. Another lake, but of an entirely different character, was found to contain ambystoma larvae but no fish. At times it contained large numbers of newts. The latter lake is situated on a plateau at a considerable elevation above Lake Nipigon on the opposite side of Orient bay from Macdiarmid. It is about the size of Station lake. Its shores, except at the western end where they are quite muddy, are firm and well timbered.

RIVERS

We have given very little attention to the rivers entering Lake Nipigon. Trap and gill nets have been set in a few of them, and Mr. W. J. K. Harkness has spent considerable time on the Gull river in connection with his sturgeon studies, but beyond this no studies of the rivers or their fishes have been made. These tributary streams are similar to the rivers of other parts of the Archaean area, being characterized by numerous falls and rapids. The water in most of them is of a dark brown colour, more pronounced in some than in others. The more important streams are the Blackwater, Sturgeon, and Onaman to the east, Ombabika, Little Jackfish, Pikitigushi (Mud), and Whitesand on the north, and Wabinosh, Gull, and Poshkokagan in the west. Two smaller streams, Pustagone river and Trout Creek, because of their proximity to Macdiarmid, our headquarters, received a good deal of attention, brook trap-nets being maintained at intervals in the Pustagone during each of the four summers.

So far as our observations are concerned, the rivers of the region do not appear to possess any large permanent population of fishes. They are resorted to by several species at spawning time, but seem to have few permanent inhabitants. The speckled trout is perhaps the most characteristic of the larger stream fishes, but it is not found in all of the rivers and is not confined to streams, being found in considerable numbers in the lake. Numbers of pike perch

remain in the streams after spawning until the middle of July, when they pass into the lake, gradually moving into deeper water as the season advances. A few pike are to be found in suitable localities in the rivers and some of the smaller fishes, such as the Miller's Thumb (*Cottus cognatus*) and the long-nosed dace (*Rhinichthys cataractae*), are perhaps always to be found in the streams, but towards midsummer the fishes are surprisingly scarce in the rivers.

Table 7 gives the results of the trap net catches in various streams for the four summers.

In addition to the brook trap-net for which the results are given in Table 7, the fyke net was set a few times, the most interesting catch being made by this net in the Pustagone river on June 13, 1924, when 201 northern suckers, 2 common suckers, and 1 pike were taken. Of the northern suckers 32 were females and the remainder males. Most of the females had recently spawned, but a few contained ripe eggs, while milt could be stripped from all of the males.

The Pustagone River. Some distance above its outlet this river is divided into branches, which, however, reunite just before it enters Orient bay. Our trap net was placed in the smaller branch about four hundred yards from the bay. The water here is usually from a foot to a foot and a half in depth, and the current, though not swift, is quite rapid.

The fish taken here were practically all small, the pike being from 2 to 4 inches in length and none of the suckers over 5 inches. The largest fish taken were the speckled trout taken on June 5 and 7, 1922, and June 22, 1924. These specimens were 15½, 10, and 6¼ inches long respectively.

Trout Creek. This is about the size of the branch of the Pustagone in which our trap net was maintained, but it is a much colder stream, the temperature of its water on July 16, 1923, being 13¼° C. as compared with 22° C. in the Pustagone on the next day. The difference, it is believed, would represent the average difference in temperature between the two streams during the summer.

The net was placed about one hundred yards from the mouth of the stream. Comparison of the list of fishes taken

TABLE 7.—Trap-net catches.

		Percopsis omisco-maycus	*Rhinichthys cataractae*	*Couesius plumbeus*	*Notropis hudsonius*	*Coltus cognatus*	*Boleosoma nigrum*	*Esox lucius*	*Salvelinus fontinalis*	*Catostomus commersonii*
Pustagone river										
1921										
June	11	2	15	5						
	12		6	4						
	13[1]	3	15	10		1				
	14		8	8		2				
	16		6	6		11				
	18[2]					2				
July	20	970								
	21	864								
	22	412								
	23	82								1
Aug.	26									
	27									
1922									1	
June	5		19	21	1					3
	6		23	14					1	
	7		4	9						
	8		36	6						
	15	4	30	28	2					
	17	13	22	20			1			1
July	2	25	22	1						
	4	736	7	4	2	1	1	1		
	5	85	5	5	1	1				
	7	22	20	6	3	2	2			1
	8	26	2	2	2	1				
	10	45	11	2		2				
	13	44	17	2	1	3		1		1
	17	43	11	3		1		1		
	28[3]	116	1	1			1			
	29[3]	24	4					1		1
	30[3]	13	1							
Aug.	8		1	2						

[1]Mouth of net open upstream June 13-16.
[2]On June 16 the net was set in deeper water farther down stream.
[3]During these days the net was set about 100 yards farther upstream than usual.

		Percopsis omisco-maycus	*Rhinichthys cataractae*	*Couesius plumbeus*	*Notropis hudsonius*	*Coltus cognatus*	*Boleosoma nigrum*	*Esox lucius*	*Salvelinus fontinalis*	*Catostomus commersonii*
Pustagone river										
1923										
July	5	20	11	4						
	7	16	21	6				3		
	9	9	17	8		1	1	2		
	10	6	2		1	1				
	12	148	5	3						
	14	89	3	4						2
	16	39		2		1	1	2		
	17[1]	17								
	19	28	3	4				1		
	21	65	1	3		2				2
1924										
June	6			4		1				
	7					1				
	9									
	10					1				
	13			3						
	14									
	16			2		1				
	19	3		3						
	21									
	22								1	
	25									1

[1]Temperature of water 22° C. as determined July 17.

		Percopsis omisco-maycus	*Rhinichthys cataractae*	*Couesius plumbeus*	*Notropis hudsonius*	*Coitus cognatus*	*Boleosoma nigrum*	*Salvelinus fontinalis*	*Catostomus commersonii*	*Catostomus catostomus*	*Perca flavescens*	
Stream through Macdiarmid 1922												
June	18 a.m.	23	4	25	1				182		22	
	p.m.			7	2		1	1	722			1 *P. pungitius*
	19 a.m.	35	2	21					14		4	
	p.m.			5	2		1		146		11	
	20 a.m.	1		9	1		1	1	189		49	
	p.m.	1		14				1	673		45	1 *P. pungitius*
	21 a.m.		1	3					3	2	36	
	p.m.			11	4		1		218		19	1 *P. pungitius;* 1 tadpole
	22 a.m.			2				1	20		3	
	p.m.			8					565		10	
	23 a.m.	9	1	39			1		11		2	
	p.m.			7			1		299		7	
	24 a.m.	5	1	33					20			
	p.m.[1]			3					6		4	1 *Pfrille neogaeus*
	25 a.m.[2]								10	5		
	p.m.			1		1	1		87		2	
	26 a.m.			4					181	6	1	
	p.m.			2					13			
	27 a.m.		1		1				12			
	p.m.	1						1	180	4		
	28 a.m.	1							19		3	
	p.m.			1					58			
	29 a.m.			2					29	3		
	p.m.	2		5					64	1	11	
	30 a.m.	2	1	3					20			
	p.m.			4					60	4		
July	1 a.m.	13							15			
	p.m.	1							56		4	
	2 a.m.	2		1					1			1 muskrat
	3 a.m.	2			1				5			
	p.m.	2		6					7			

[1]High wind and waves during the day.
[2]There was frost during the night of June 24.

		Percopsis omisco-maycus	*Rhinichthys cataractae*	*Couesius plumbeus*	*Notropis hudsonius*	*Coitus cognatus*	*Boleosoma nigrum*	*Esox lucius*	*Salvelinus fontinalis*	*Catostomus commersonii*	*Catostomus catostomus*	
Trout Creek *1923*												
July	*8*	*36*			3				3	7	2	
	9	*73*								6	1	
	14[1]	*356*	1		2				3	3	1	
	16[2]	*45*							9			
	18	*148*				2			9	2	2	
	19	*89*	1							2		
	20	*703*	3	3			1			3		
	21[3]	*834*	9	2			1					
	22[3]	*564*	33			2		1	2		1	
Sept.	1								1			
	2								2		1	
	3								1			1 *Lota maculosa*
	4			2		1						
	5			1								1 *Lota maculosa*
	6					1			2			
	7								3			
	8								4			
	10								6			
	13											
Stream entering South Bay 1921												
Aug.	4	33					1			18		
	5	30						1		3		
Rapid Creek (Windigo bay) 1923												
July	26[4]		3				1				5	3 *Percina caprodes*
	26[5]		1							1	1	

[1]On July 9 the net was taken from the water and not reset until July 13.
[2]Temperature of water 13¼° C. on July 16.
[3]For the catches on July 21 and 22 the net was reversed so that the mouth opened upstream.
[4]Mouth open upstream. [5]Mouth open downstream.

in this stream with that taken in the Pustagone indicates that speckled trout are very much more common in Trout creek. The specimens taken averaged about 12 inches in length, ranging from 6 to 16½ inches, specimens larger than the latter length being unable to enter the net. The northern sucker was also frequently taken in Trout Creek, the specimens ranging in size from 6 to 10 inches. The ling taken in this net were 22 and 9½ inches in length respectively.

In connection with the catches made in 1922 in the stream flowing through Macdiarmid, it should be explained that this stream is quite small, and that the net was set just a few yards from the point where the stream entered Orient bay. The mouth opened towards the bay so that the fishes taken in the net came chiefly from the bay and entered the stream either to seek spawning grounds or to feed. It will be noticed that large numbers of common suckers were taken in this stream. These were all small specimens, most of them under 7 inches in length. The net was lifted in the morning between 7 and 8 o'clock, and the suckers taken at this time were larger than those entering during the day and found in the trap when it was lifted about 8 o'clock in the evening. The specimens of this species found in the trap in the morning were mostly from 5 to 7 inches in length, while those found in it in the evening were from 2 to 5 inches in length.

SPAWNING NOTES

One of the commonest fishes in all three of the streams where trap-nets were commonly set was the trout perch (*Percopsis omisco-maycus*). This species resorts to these streams to spawn, the height of the run occurring in July, the exact time depending evidently on the season and on the stream in which spawning occurs.

Many ripe specimens of long-nosed dace (*Rhinichthys cataractae*) and lake chub (*Couesius plumbeus*) were also taken in the trap-nets, but it is believed that these species do not

enter the streams so much for spawning purposes as to feed on the spawn of the trout perch.

In the case of the trout perch, records have been kept of the proportions of the sexes taken in the trap-net. From these records it appears that males predominate among the fish entering the stream as spawning time approaches, but that later, at the height of the spawning season, females are the more numerous. There is a good deal of fluctuation both in the proportion of the sexes taken and in the total number of individuals taken from day to day. Some of this variation is no doubt due to natural causes, such as variation in temperature and other weather conditions, and some of it is certainly due to variations in the efficiency of the net from time to time. After a rain quantities of débris are carried down the stream, partially clogging the net and interfering with the entrance of the fish into it. It was not possible to visit the net every day, and sometimes the net had to be removed at critical periods of the spawning season because other problems necessitated expeditions to distant parts of the lake. This trap-net work was carried out only incidentally in connection with the fish survey of the lake, but the data in connection with the spawning of the trout perch, incomplete as it is, may be of some value and is accordingly given in Table 8.

In connection with the problem of the proportion of males and females on the spawning beds, the catch of northern suckers in the Pustagone river on June 13, 1924, should be noted (see p. 17). This catch was made towards the close of the spawning season in this river. In this catch the males were found to make up 84 per cent. of the fish taken. Whether this is the usual condition in this species is not known, as this is the only observation we have bearing on the subject. It should be noted, too, that the female northern suckers were larger than the males, whereas in the trout perch the sexes were found to be of the same average size.

TABLE 8.—Male and female trout perch (*Percopsis omisco-maycus*) in trap-net catches.

Pustagone river	Total number	Males	Females	Undetermined
1922				
July 2	25	14	8	3
4	736	473	261	2
5	85	64	21	
7	22	16	6	
8	26	16	10	
10	45	28	17	
13	44	28	16	
17	43	35	8	
28	116	38	78	
29	24	3	21	
30	13	4	9	
1923				
July 5	19	15	4	
7	13	12	1	
9	9	7	2	
10	6	6	0	
12	138	108	30	
14	89	45	44	
16	39	21	18	
17	17	6	11	
19	28	14	14	
21	65	45	20	
Stream through Macdiarmid				
1922				
June 18	23	21	2	
19	35	32	3	
23	9	2	7	
24	5	2	3	
July 1	13	4	9	
Trout Creek				
1923				
July 8	36	16	15	5
9	73	58	15	
14	356	210	128	18
16	45	17	28	
18	148	55	93	
19	89	60	28	
20	703	380	323	
21	834	325	509	
22	564	209	355	

FISH HABITATS

The general ecological relations of the individual species of fish are discussed in connection with the accounts of the various species. No two species perhaps have the same ecological requirements, and for very few have the definite factors which limit their distribution been worked out. In Lake Nipigon the principal fish habitats appear to be as follows: The deep water of the open lake, the shallow water, especially of the larger bays, shore marshes and stony beaches. Another habitat which might be included is that of the sandy beaches, but such situations appear to be practically barren so far as fish life is concerned. Occasional specimens are taken in such places, but they appear to be stragglers rather than permanent inhabitants. The streams and smaller lakes of the region offer a variety of habitats, many of which differ widely from those of the lake.

Deep water of the open lake. In the deeper waters of the open lake, that is, in water over 100 feet deep, are found, in the summer, ciscoes, especially *L. nigripinnis*, *L. hoyi*, and *L. zenithicus;* whitefish; lake trout; northern sucker; ling; and *Triglopsis thompsoni*. This water is always cold. The temperatures at 120 feet in the open lake (see Clemens, *loc. cit.*) on various dates during the four summers were as follows: 1921, June 17, 4.8°; July 9, 4.3°; Aug. 29, 5.7°; 1922, June 27, 5.3°; July 29, 5.6°; Aug. 17, 5.7°*; 1923, Aug. 15, 7°*; Sept. 14, 10.7°; 1924, June 23, 4.4°; July 7, 4.5°; Aug. 15, 6.1°.

Shallow water of protected bays. In more or less protected situations in shallow bays, down to a depth of sixty feet, are found the common sucker, pike perch, lake herring (*L. artedi*), sturgeon, and in certain localities speckled trout, sauger, round whitefish, and red horse. The pike is usually confined to the very shallow water, especially where there is some aquatic vegetation, but in the late summer and early fall, in common with the pike perch, it moves out into

*Approximate.

deeper water, occasionally being taken below one hundred feet.

Shore marshes. There are comparatively few places in the lake where there is any considerable extent of very shallow water sufficiently well protected to permit of the development of extensive growths of aquatic plants (Fig. 1, Plate X). In these protected localities in water 2 to 3 feet deep, with more or less development of aquatic plants, are found spot-tailed minnows, perch, small suckers, tessellated darters, pike, and in some localities trout perch, lake chub, Iowa darters, and straw-coloured minnows.

Stony beaches. On exposed beaches covered with stones of smaller size than boulders, but larger than gravel, the miller's thumb (*C. cognatus*) is the most typical inhabitant. The long-nosed dace and in some places, chiefly northward, the log perch are also found, but are not so closely confined to this type of environment. A few other species are found in such places rather commonly, the most frequent being the tessellated darter and the nine-spined stickleback, but they do not show a preference for such localities, being taken just as frequently in protected bays with a mud bottom.

Small lakes. No attempt was made to study the smaller lakes of the region at all thoroughly. Their number is so vast and habitat conditions in them so varied that their investigation would be an extended piece of work in itself.

For a list of the fishes characteristic of the principal types of habitat presented by the lakes visited, reference should be made to the account of these lakes on pages 10-16.

Streams. As is pointed out elsewhere (p. 16), the rivers and smaller streams of the region were given comparatively little attention, but from the observations made it is believed that there are few, if any, species confined to the streams, at least in their lower reaches.

COMMERCIAL POSSIBILITIES

As may be seen by reference to Table 1, the Lake Nipigon fisheries are of considerable commercial importance. The

species produced include most of the more valuable commercial species of the Great Lakes. The whitefish are of excellent quality and stand first in point of quantity produced and monetary value. Lake trout are considered by the fishermen to be improving in quality since the lake has been fished commercially. On account of the distance from market, the shipment of ciscoes (lake herrings) is not profitable. This works to the advantage of lake trout, since ciscoes constitute their principal food material. As compared with the area of open, deep water, the areas of shallow water suitable for pickerel (pike perch) and sturgeon are limited, and hence these species will never bulk large as compared with whitefish and lake trout. However, some of the larger bays, *e.g.*, Humboldt, Ombabika, Windigo and Gull, appear to be especially favourable for these shallow water forms, and we may expect the pickerel to hold its own as compared with whitefish and trout. On account of the slow rate of growth of sturgeon, as demonstrated by Harkness (1924), this species will no doubt become rapidly depleted unless some means of artificial propagation can be worked out.

Under present conditions the suckers (common and northern) and the ling constitute an economic loss. The former consume enormous quantities of the staple food materials of whitefish and sturgeon, besides materially increasing the labour of clearing and caring for the nets, since they are taken in such large numbers and tangle the nets so badly. Ling are competitors of lake trout for the ciscoes, and since they occur in such enormous numbers they must seriously reduce the productivity of trout. Our studies have not suggested any means of controlling the ling except the killing of every one taken in the nets. In the case of suckers, their removal by means of trap-nets placed in streams at spawning time could be accomplished without a great deal of difficulty. It is possible, too, that the suckers removed at that time could be marketed at a profit as they are of a better quality and sell more readily in the spring.

On the whole, Lake Nipigon should continue to produce good quantities of whitefish, lake trout, and pickerel, although

the yield for the first few years of commercial fishing may not be maintained indefinitely. One factor which limits productivity is the low temperature which decreases the rate of growth of the fish as compared with that in lakes farther south.

METHODS

Three principal types of nets were employed for obtaining specimens and securing data on the distribution, numbers, and ecology of the different species, viz., gill-nets, trap-nets, and seines. Dip-nets and set-lines were used, but very infrequently, while all of our specimens of *Triglopsis thompsoni* and many of *Cottus ricei* were obtained from the stomachs of predaceous fishes, chiefly from ling.

During the summer of 1924, gill-nets of eight different sizes of mesh were used as follows: 1½, 2, 2½, 3, 3½, 4, 4½ and 5 inch stretched mesh. Previous to this we depended on 1½, 2, 3, and 4½ inch nets. During the summer of 1922 Dr. W. Koelz of the United States Bureau of Fisheries spent two weeks on the lake and used, in addition to sizes already mentioned, nets of 2¾ inch stretched mesh.

In all, over one hundred gill-net "settings" were made. In some cases the nets were set a number of times in the same place, but as a result of the four summers' work, fish were taken in gill-nets from a wide variety of depths in the open lake and in most of the larger bays, as well as from many different sorts of ecological conditions nearer shore.

A brook funnel trap-net, 5 feet wide and 1⅞ feet high at the mouth (Fig. 1, Plate XI), was operated in a number of the streams near Macdiarmid, while a large fyke or hoop net was set a few times in larger streams.

Minnow seines of two different lengths, thirty feet and fifty feet, were used to secure the smaller fishes from shallow water near shore (Fig. 2, Plate XI). In many places seining operations could not be carried out very successfully because of large rocks strewn about the bottom, but seine "hauls" were made in all possible types of shallow-water habitats in many parts of the lake.

PROPORTIONATE MEASUREMENTS AND DESCRIPTIONS

Most of the measurements on which the descriptions included in this paper are based were made of fresh specimens, that is, before preservation in formalin or alcohol. Only in the case of some of the smaller species was preserved material used. All of the whitefish, ciscoes, lake and speckled trout, pike, pike perch, saugers, suckers, ling, and sturgeon were measured before preservation. This explanation is made because it has been found by the subsequent measurement of a number of preserved specimens, previously measured when fresh, that the body length was about 5 or 6 per cent. less in the preserved material. All parts of the body, however, had not contracted to the same extent, the head, for instance, shrinking very little in length as a result of preservation. Except in a few cases, the descriptions are based on the measurement of at least ten specimens. In most cases, however, considerably more than ten have been measured. Where the length is given in inches, it is the length in a straight line from the tip of the snout to the end of the tail fin (middle point or fork of the tail); when given in centimeters, it is the length from the tip of the snout to the end of the vertebral column. The usual method of indicating the proportionate lengths of the various parts of the body has been followed—the measurement indicated for the head being the number of times the actual length of the head (not including the opercular membrane) is contained in the body length (snout to end of vertebral column) and the measurements given for parts of the head, *e.g.*, eye, snout, interorbital (bony width), maxillary, etc., being the number of times the measurement of these parts is contained in the head length. Scales along the lateral line were counted only to the end of the vertebral column. Scale rows above the lateral line were counted from the insertion of the dorsal fin obliquely backward to, but not including the lateral line; below the lateral line the count was made from the insertion of the ventral fin in the case of soft-rayed fishes and from the anal in spiny-rayed forms, upwards and for-

wards to, but not including the lateral line. Soft rays at the front of fins are not included in the count unless at least two-thirds as long as the longest ray of the fin. The last ray was counted as one even though divided to the base. All spiny rays, no matter how short, were counted. The meaning of the proportionate measurements of other structures is given in the text in each case.

Because of the wide range of values found for some of the proportionate measurements, it has been thought best to give the average value for all the specimens measured, indicating in parentheses the usual range of variation in each case. Measurements varying widely from those usually found are given outside the parentheses, but within brackets.

Colour descriptions have been omitted in the case of species in which the colour does not differ from that already described for the species in such works as Jordan and Evermann (1896) and Forbes and Richardson (1908). Detailed colour descriptions have been included for some species of typical northern distribution, in the case of groups such as the ciscoes, where colour is of value for comparative purposes, and whenever the colour or pattern varies from published descriptions or is of special interest for other reasons.

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It is impossible to mention the names of all those from whom assistance has been received during the course of the studies recorded herein. Without the sympathetic interest and active support received from numerous residents of the district, both permanent and transient, the report would have been far more incomplete than it is. In this connection the commercial fishermen of the lake have extended every courtesy and, by bringing in specimens from their nets, by reporting occurrences which would otherwise have escaped notice, and by supplying information, have contributed materially to the data obtained.

From the other members of the field parties from the Department of Biology, University of Toronto, and the Royal Ontario Museum of Zoology, who were engaged in related studies on the lake, I received every possible co-operation. Especially to Dr. W. A. Clemens, under whose direction the work was undertaken, I am indebted for placing at my disposal such assistance and facilities as to permit of the work being carried on under the most advantageous conditions.

Many thanks are also due to the following for the identification of specimens and advice on matters connected therewith: Carl L. Hubbs, Museum of Zoology, University of Michigan; Dr. Walter Koelz, U.S. Bureau of Fisheries, Dr. W. C. Kendall, Roosevelt Wild Life Forest Experiment Station, Syracuse, N.Y.; Prof. P. Cox, University of New Brunswick, Fredericton, N.B.; and Prof. R. C. Osburn, Ohio State University, Columbus, Ohio; and to Dr. Chas. C. Adams, Director of the Roosevelt Wild Life Forest Experiment Station, for allowing Dr. Kendall the time necessary for a study of the specimens submitted.

The drawings reproduced in Plates I-VIII are by E. B. S. Logier, of the Royal Ontario Museum of Zoology.

GENERAL STATEMENT AS TO RELATIONSHIP OF THE NIPIGON FISH FAUNA

The fishes described in this paper include not only those found in Lake Nipigon, but also the species collected from a number of small lakes in the immediate vicinity.

Of the 41 species listed all but two (*C. erythrogaster* and *P. promelas*) have been taken in Lake Nipigon; although, in the case of one or two species, their occurrence in the waters of the lake appears to be more or less accidental. One species (*Micropterus dolomieu*) has been planted in Lake Nipigon, although it occurs naturally in the region, notably in Black Sturgeon lake. These 41 species belong to 28 genera and 12 families. They are practically all characteristic of the Great Lakes, all but one (*Leucichthys nipigon*) having been taken in the Great Lakes basin. As was to be expected, the Nipigon fish fauna resembles that of Lake Superior more

closely than it does that of the other lakes. The absence of species commonly found in the lower Great Lakes is believed to be due mainly to ecological factors, although some species undoubtedly reached these lakes after Lake Nipigon, by the falling of the water level of glacial Lake Algonquin, had become inaccessible on account of the height of some of the falls in its outlet stream. Forbes and Richardson (1920), in their account of the general distribution of Illinois fishes, divide the area over which they are distributed into 12 districts. Only 26 of the fishes found in Lake Nipigon are listed as occurring in Illinois. The number of these 26 species occurring in each of the districts mentioned by Forbes and Richardson is as follows: Great Lakes region, 25; Quebec and New England, 23; Upper Mississippi Valley, including Missouri and its tributaries, 21; the far North, extending northward from the headwaters of the Mississippi, east to the Lake Superior drainage and west to the Rocky Mountains, 19; lower Mississippi Valley, including the Ohio and its tributaries, 19; the north Atlantic drainage from New England to the Chesapeake Bay, 11; the south Atlantic from the Chesapeake Bay to Florida, 9; the Hudson River district, 6; the far northwest, separated from the far north district as described above, by the Rocky Mountains range, 4; the west Gulf district, bounded by the Mississippi drainage on the east and extending west and south to include the Rio Grande and its tributaries, 4; the east Gulf district, bounded by the Mississippi drainage on the west, 3; the peninsula of Florida, 0.

The species common to Lake Nipigon and Illinois which Forbes and Richardson do not include in the Great Lakes region is the Iowa darter (*E. iowae*), but Bensley (1914) found this darter in Georgian bay and it has perhaps been overlooked elsewhere in the Great Lakes drainage.

While it is not intended to enter into a discussion of the relative effects of geology and ecology in determining the fish fauna of Lake Nipigon, it is suggested that the similarity of its fauna to that of the Great Lakes is due primarily to geological factors, whereas its similarity to the fish fauna of

Quebec and New England depends more on similar ecological conditions.

KEY TO THE FAMILIES OF FISHES OF LAKE NIPIGON

A. Ventral fins abdominal.
  B. Tail heterocercal.....**Acipenseridae**
  BB. Tail not heterocercal.
    C. Scales if present cycloid, their free edges smooth.
      D. Body with scales.
        E. Head without scales.
          F. No adipose fin present.
            G. Mouth with thick fleshy lips with plicae or papillae; pharyngeal teeth in a single row, more than 10.....**Catostomidae**
            GG. Mouth with thin lips without plicae or papillae; pharyngeal teeth in one or two rows, fewer than 9.....**Cyprinidae**
          FF. Adipose fin present
            H. Scales larger, fewer than 100 in lateral line.....**Coregonidae**
            HH. Scales very small, more than 100 in lateral line.....**Salmonidae**
        EE. Head more or less covered by scales.....**Esocidae**
      DD. Body without scales; ventral fins each of one spine and one soft ray; dorsal fin with 2 or more spines not connected by a membrane.....**Gasterosteidae**
    CC. Scales ctenoid, their free edges rough; dorsal fins 2, the posterior adipose.....**Percopsidae**
AA. Ventral fins thoracic or subjugular.
  I. Chin without a barbel.
    J. Body covered with true scales.
      K. Spinous and soft dorsal fins united into one fin.....**Centrarchidae**
      KK. Dorsal fins separate or very slightly joined.....**Percidae**
    JJ. Body without true scales.....**Cottidae**
  II. Chin with a barbel.....**Gadidae**

FAMILY ACIPENSERIDAE

ACIPENSER FULVESCENS Rafinesque

LAKE STURGEON

Body elongate, almost cylindrical, tapering towards snout and tail; width 8.3 (7.5-9.1); depth 8.8 [7.2 (8.0-9.0) 10.2]; head, not including flap 5.0 (4.7-

5.3); eye, small 15.5 (12.5-19.4); snout 2.8 (2.6-3.1); interorbital 2.9 (2.7-3.1); length of barbels 4.3 (3.8-4.9) in head. These proportions refer to specimens 50 to 63 inches in length; specimens of 24 to 36 inches in length have slightly longer heads (4.7); considerably longer and slimmer snouts (2.3 in head); larger eye (12.6); and are slimmer in body with depth and width about equal (9.3 or 9.4). Dorsal fin with 34 [26 (32-38)] rays, its base 2.6 [2.1 (2.4-2.8) 3.1] in head and approximately equal to its own height; anal with 22 (18-25) rays, its base 4.6 (4.1-5.4) in head and 1.8 (1.5-2.1) in its own height; pectoral length 1.8 (1.6-2.1) and ventral 2.8 [(2.5-3.1) 3.4] in head.

Body in young armed with large rough shields or scutes, each bearing a strong, median, backward-pointing spine; these shields arranged in five longitudinal rows, two lateral, two ventro-lateral and one dorsal; between the shields the skin is rough with many minute spinules; shields becoming smooth with age, specimens over three feet in length usually having body quite smooth; dorsal scutes 13 (11-15), lateral 34 [29 (32-38)], ventral 9 (8-10); gill rakers 29 (24-33).*

The sturgeon is fairly common in Lake Nipigon, 76,666 pounds having been taken from 1918 to 1922 inclusive. It is found chiefly in the shallower bays, such as Humboldt, Ombabika, Windigo, and Gull, although considerable numbers have been taken in shallow water in other parts of the lake. Conditions are not as favourable for it here as in some other lakes, notably Lake Nipissing; and it does not reach a very large size, seldom attaining a weight of one hundred pounds. Harkness (1924) found that its food in Lake Nipigon consists of a wide variety of materials, chironomid larvae, molluscs, and ephemerid nymphs being taken most commonly. Crayfish, fish, amphipods, caddis worms, and other organisms are occasionally eaten in considerable quantities.

As shown by Hubbs (1917) the sturgeon of the Great Lakes must be known by the name *fulvescens* instead of *rubicundus*. The change has been accepted by Jordan (1917) and others. The species occurs in the Mississippi valley, the Great Lakes, and in the larger inland lakes and rivers northward.

FAMILY CATOSTOMIDAE

A. Scales in lateral line less than 50 ..... Moxostoma
AA. Scales in lateral line more than 50 ..... Catostomus

*Description based on measurements and notes by W. J. K. Harkness.

GENUS **MOXOSTOMA** RAFINESQUE

A. Head 3½-4⅓ in body, halves of lower lip meeting at an angle, mouth large, developed dorsal rays 15 or 16 ..... **anisurum**
AA. Head short 4½-5½ in body, lower lip with a straight posterior margin (forming an obtuse angle when the mouth is shut very tightly), mouth small, developed dorsal rays 12-14 ..... **lesueurii**

MOXOSTOMA ANISURUM (Rafinesque)

WHITE-NOSED SUCKER

Body stout and rather deep, somewhat compressed, the back elevated, depth 3.5; width 5.7-5.8; head 3.7; eye 5.3-5.9; snout 1.9-2.0; interorbital 2.5; length of caudal peduncle 1.9-2.6 in head, its depth 1.0-1.3 in its own length; dorsal fin with 15 or 16 rays, its base 1.1 in head and 0.6-0.8 in its own height; anal with 7 rays, its base 2.5-2.6 in head and 1.7-2.3 in its own height; pectoral length 1.3-1.4 and ventral 1.7-1.8 in head; scales 6-41-5. This description is based on the measurement of only two individuals as these were the only fresh specimens secured. Two other preserved specimens are in our collection, but the measurements of these are not included. Largest specimen 21½ inches.

Of the four specimens secured, one was taken in the Gull river at spawning time and the other three in Humboldt bay (inner bay) later in the season. Commercial fishermen have never taken it, so far as we were able to learn, except in Humboldt bay. It may therefore be considered as quite rare in Lake Nipigon. The species is found from the St. Lawrence, through the Great Lakes region, west to Lake Winnipeg and the Assiniboine river. In the United States it occurs in the Ohio valley and in streams of the Atlantic coast as far south as North Carolina.

MOXOSTOMA LESUEURII (Richardson)

SHORT-HEADED RED-HORSE

Body somewhat more compressed than in preceding species, width 6.2 (5.4-6.5); depth 3.6 (3.3-3.9); dorsal outline arched, sloping gradually from snout to dorsal fin; greatest depth in front of dorsal; head very short 4.6 (4.5-4.8), broad behind, interorbital space noticeably convex, flattened above and tapering into the pointed snout which projects beyond the mouth, the mouth is inferior, lips plicate; eye 5.3 (4.6-6.1); snout 2.2 (2.0-2.3); interorbital 2.2 (2.1-2.3); length of caudal peduncle 1.7 (1.5-1.9) in head; its depth 1.2 (1.1-1.4) in its own length; dorsal fin usually inserted over 14th or 15th scale of lateral

line, of 12 or 13, rarely 14 rays; its base 1.2 (1.0-1.3) in head and height usually slightly less than its base; anal with 7 rays, its base 2.4 (2.0-2.6) in head and 2.1 (1.8-2.3) in its own height; pectoral length 1.1 (1.0-1.2) and ventral 1.3 (1.2-1.4) in head; scales 6 or 7-44 (43-46)-5 or 6. Largest specimen 19½ inches.

The short-headed red-horse of Lake Nipigon agrees with Richardson's (1836) description of *Cyprinus sueurii* (*Catostomus lesueurii* Richardson 1823) and has been identified as that species. Carl L. Hubbs, who examined my specimens, says they are hardly separable from *Ptychostomus breviceps* Cope 1870. The latter may, therefore, be regarded as a synonym of *lesueurii*. This species appears to be more common in Lake Nipigon than the preceding, but, like it, is restricted to a few localities, all our specimens having been taken in Humboldt bay (inner bay) and in Gull river at spawning time. It therefore appears to be restricted so far as this lake is concerned to very shallow, well-protected localities.

Ripe males taken June 2 and June 11, 1922, in Gull river bore pearl organs on the anal and caudal fins similar to those borne by the males of *C. catostomus* in the spawning season. As no females were taken at the time these ripe males were secured, it is assumed that spawning occurs earlier, perhaps towards the end of May. Richardson found the species to spawn in Pine Island lake in June.

This species occurs in the Ohio and Mississippi valleys through the Great Lakes region, north and west at least to Pine Island lake, Saskatchewan.

GENUS **CATOSTOMUS** LE SUEUR

A. Scales in lateral line 95 to 115 ..... **catostomus**
AA. Scales in lateral line 60 to 72 ..... **commersonii**

CATOSTOMUS CATOSTOMUS (Forster)

NORTHERN SUCKER; LONG-NOSED SUCKER

Body elongate, rounded; width 5.5 (5.0-6.1); depth 4.6 (4.0-5.2); head long 4.0 (3.9-4.3), rather broad behind, tapering into a long conical snout overhanging the mouth; snout 1.8 (1.7-1.9); eye small 7.6 (6.8-8.6); mouth fairly large, inferior, with thick, coarsely papillose lips; interorbital 2.5 (2.3-2.7); length of caudal peduncle 1.7 (1.5-1.8) in head, its depth 1.6 (1.3-1.7) in its own length; dorsal fin with 10 or 11 rays, its base 1.8 (1.7-2.1) in head, its height usually somewhat greater than its base; anal with 7 rays, its base 2.9 (2.7-3.2) in head and 1.9 (1.6-2.2) in its own height; pectoral length 1.2-1.3 and ventral 1.7 (1.5-1.8) in head. Scales small, 19 (17-21)-104 (97-112)-15 (12-16). Largest specimen 22½ inches.

The northern sucker is very abundant in Lake Nipigon. During the summer it occurs at almost all depths down to 30 fathoms and is one of the species taken commonly in nets set for whitefish. The average catch of northern suckers in our 4½ inch nets at all depths was nearly one-third the whitefish catch. On account of the cost of transportation it has not been found profitable to ship this species to market. As it consumes much of the stock foodstuffs of the whitefish, its presence in such enormous numbers probably interferes to a considerable extent with the whitefish productivity of the lake. In this connection it is interesting to note the large numbers of very fine whitefish found in a small lake on Shakespeare Island from which suckers are absent.

Two-thirds of the food of northern suckers of over ten inches in length has been shown to consist of *Pontoporeia*, while molluscs and chironomid larvae make up more than half of the remainder of the food materials found in their stomachs.

Spawning occurs in streams, usually at the end of May or early in June. The time of spawning, of course, varies with the season, and also, no doubt, with the temperature of the water in the stream where spawning occurs. We have never been on the lake earlier than May 24, and so do not know how early spawning begins, but we have taken a spent female as early as May 26, 1922, and a ripe female as late as June 15, 1922. On July 25, 1923, five specimens ranging in length from 15 to 18 inches were taken in the brook-trap near the mouth of Rapid Creek, a swift, cold stream flowing into Windigo bay. Three of these were males from which a little milt could be pressed, and each had tubercles on its anal and caudal fins. The pearl organs borne by spawning males of this species are smaller than those of the common

sucker but are similarly arranged, that is, the largest tubercles are found on the anal and lower half of the caudal fins and smaller ones on the upper lobe of the caudal, as well as on the dorsal and pectoral fins and still smaller ones on the scales and upper part of the head. As in the case of the common sucker, these tubercles are assumed again early in the autumn.

On June 13, 1924, 201 specimens of this species were taken in a hoop fyke net set in one branch of the Pustagone river near its mouth. Of these, 84 per cent. were males and 16 per cent. females. The latter had nearly all spawned, but considerable milt could still be pressed from most of the males. The average length of the females was 17.1 inches and of the males 16.2 inches. At spawning time the fins of the males are longer than those of the female, the difference being most marked in the case of the anal.

The following table indicates the relative lengths of the fins of five females and six males taken on the spawning grounds.

TABLE 9.—COMPARATIVE MEASUREMENTS OF THE FINS OF MALE AND FEMALE NORTHERN SUCKERS AT SPAWNING TIME.

Sex	Total length	Lengths of fins in thousandths of the body length			
		Dorsal	Anal	Pectoral	Ventral
Female	410	154	146	183	132
"	410	159	146	180	137
"	400	145	145	190	125
"	372	156	157	202	144
"	370	162	161	195	147
Male	395	159	180	203	144
"	365	159	189	186	145
"	365	164	184	192	148
"	360	164	200	203	153
"	350	163	191	220	160
"	348	154	184	207	172
Average					
6 males		160½	188	201⅝	153⅞
5 females		155⅛	151	190	137
Percentage of difference = (M—F): F		3.4	24.5	6.2	12.2

These differences are similar to, though somewhat smaller than, those found in the case of spawning common suckers by Reighard (1920).

This is a species of typical northern distribution, ranging from New Brunswick, Maine, and New York through the Great Lakes and northward to Alaska and Siberia.

CATOSTOMUS COMMERSONII (Lacépède)

COMMON SUCKER

Body stout forwards, tapering towards the tail; width 5.8 (5.3-6.1); depth 4.3 [3.5 (3.9-4.7)]; head rather large, conical 4.0 (3.6-4.4) flattish above; eye small 6.4 [5.5 (6.0-6.9) 7.3]; snout short 1.9 (1.7-2.0) scarcely overpassing the mouth; mouth inferior with strongly papillose lips; interorbital 2.4 (2.2-2.7); length of caudal peduncle 1.8 (1.6-2.3) in head; its depth 1.4 (1.2-1.6) in its length; dorsal fin with 11 to 13, usually 12 rays, inserted over 27th (25-30) scale of lateral line; its base 1.5 (1.3-1.7) in head; its height usually somewhat less than its base; anal with 7, rarely 8, rays; its base 2.7 (2.4-3.2) in head, and 2.0 (1.8-2.3) in its own height; pectoral length 1.3 (1.2-1.4) and ventral 1.7 (1.5-1.9) in head; ventral usually inserted opposite 6th or 7th ray of dorsal (occasionally 5th or 8th); scales crowded anteriorly and below, 10 or 11 (rarely 9)-64 (60-71)-8 or 9. Largest specimen 20½ inches.

The common sucker occurs in large numbers, but is confined to shallow water (less than 50 feet) and so does not enter into competition with the whitefish to the same extent as does the northern sucker. However, it cannot be profitably marketed under present conditions, and as it is not eaten to any extent by other species, it appears to be of little or no economic value so far as Lake Nipigon is concerned. Its food consists of molluscs, mayfly nymphs, chironomid larvae, caddis larvae, *Pontoporeia hoyi*, diatoms and a considerable variety of bottom-living plankton organisms. As many of these are important items in the food of more valuable species, especially of the sturgeon, a considerable reduction in the numbers of suckers in the lake would appear to be desirable.

The sucker enters streams in spring to spawn. On June 1, 1922, a number were seen spawning near the edge of a rapids about four miles from the mouth of Gull river. Several were

observed in swift water flowing between rocks near shore; none was seen in the quieter water nearer shore, or in the swifter water farther out. The depth at this point was from 8 to 24 inches. Three was the largest number seen at one time. They were all headed up stream in the narrow channel between two rocks. During most of the time they were under observation, they were several inches apart, but from time to time the smaller one in the middle which was believed to have been a male, approached first one and then the other of the females on either side of him. Whether eggs were actually extruded or not was not determined, but milt ran freely from the male when he was dipped from the water. He was seen to pass close against the side of the female as described by Reighard (1920), but the spreading of the fins and the colour changes were not noticed. The tremour of the fishes when in contact was quite marked, especially posteriorly, where it seemed to be a very rapid movement from side to side. All of the fins of the male bore pearl organs (hard, rough, white, conical tubercles). The pearl organs on the anal were the largest, those on the lower half of the caudal were larger than those on the upper half but smaller than those on the anal. The organs of the other fins were comparatively small, and on the pectorals and ventrals were confined to the outer half of the upper and lower surfaces of the fin. They were larger and more numerous on the pectorals and those on the lower surface of the pectorals were larger than those on the upper surface. The tubercles on the outer half of the dorsal were larger than those below. Pearl organs also occurred on the posterior margin of the scales and became gradually larger on the scales behind the dorsal. They were also found on the top and sides of the head. These tubercles are assumed again in the autumn. Specimens taken in Humboldt bay on September 3, 1923, and in Orient bay a week later, had tubercles showing prominently on the anal and lower half of the caudal fins. As Reighard (1920) has shown, the fins of males exceed in length those of the females in the spawning season. The following table indicates the relative lengths of the fins of

five specimens of spawning common suckers taken in Gull river on June 1, 1922.

TABLE 10.—COMPARATIVE MEASUREMENTS OF THE FINS OF MALE AND FEMALE COMMON SUCKERS AT SPAWNING TIME

Sex	Total length	Lengths of fins in thousandths of the body length			
		Dorsal	Anal	Pectoral	Ventral
Female	455	152	168	197	137
"	401	150	175	182	140
"	390	155	190	197	138
Male	357	162	224	210	155
"	347	156	205	193	147
Average					
2 males		159	214½	201½	151
3 females		152⅓	177⅔	192	138⅓
Percentage of difference = (M-F): F		4.4	20.7	5.0	9.1

These percentages are all somewhat smaller than those obtained by Reighard (1920) for Michigan specimens, although the results agree in that the greatest difference occurs in the case of the anals, the next greatest in the pectorals and is least in the case of the dorsals.

The young up to two or three inches in length are common in muddy bays supporting some aquatic vegetation, as many as 904 having been taken in one short haul with our minnow seine in a small bay near the foot of Orient bay in August, 1921. Their most common associates are the young of the perch, the spot-tailed minnow, and the tessellated darter. Considerable numbers were taken in a brook funnel net set in a small brook within a few yards of where it entered the lake. This net was lifted every morning and every evening for some time, and it was noticed that the suckers taken in it during the day were invariably small, usually from two to four inches in length, whereas those taken during the night were larger, averaging about six inches in length (see Table 7). Bigelow (1924), who investigated the food of young suckers in Lake Nipigon, found that up to a length of

1.9 cm. they feed largely on plankton forms, chiefly rotifers. From this size up to 5 cm. in length they take more and more bottom organisms, cladocera forming the chief food organisms.

The common sucker ranges from the Maritime provinces, through Quebec and Ontario, north and west at least as far as Lake Athabaska (Kendall, 1924). In the United States it is found southward to Missouri and Georgia and west to Montana and Colorado.

FAMILY CYPRINIDAE

A. Alimentary canal long, usually more than twice the length of the body; inside coat of the abdominal wall usually black; pharyngeal teeth one rowed.
  B. Scales small, about 80 ..... **Chrosomus**
  BB. Scales larger, 45-50 ..... **Pimephales**
AA. Alimentary canal short, less than twice the length of the body; inside coat of the abdominal wall generally of pale coloration.
  C. Scales small, 55-85.
    D. Premaxillaries not protractile ..... **Rhinichthys**
    DD. Premaxillaries protractile.
      E. Scales 58-65 ..... **Couesius**
      EE. Scales 67-72 ..... **Margariscus**
      EEE. Scales 75-83 ..... **Pfrille**
  CC. Scales larger, 30-40 ..... **Notropis**

CHROSOMUS ERYTHROGASTER Rafinesque

RED-BELLIED DACE

Body fusiform, moderately elongate, little compressed, width 5.7 (5.4-6.0); depth 4.9 (4.5-5.4); head 4.1 (4.0-4.4); eye 3.6 (3.4-3.9); snout 3.5 (3.2-3.9); mouth terminal oblique, the maxillary not reaching a vertical through front of eye; interorbital broad 2.7 (2.5-2.8); length of caudal peduncle 1.1 (1.0-1.2) in head, its depth 2.1 (1.9-2.2) in its length; dorsal fin with 8 rays, its base 2.6 (2.5-2.9) in head and 1.7 (1.5-1.8) in its own height; anal with 7 or 8 rays, its base 2.7 (2.4-2.9) in head and 1.6 (1.5-1.7) in its own height; pectoral length 1.5 (1.4-1.6) and ventral 2.0 (1.9-2.2) in head; lateral line short, usually not reaching the ventrals; scales 17 or 18-80 (79-82)-10 or 11; teeth 5-5. Largest specimen 2⅝ inches.

The red-bellied dace has been taken in the Nipigon region only in small boggy lakes always in association with *P. neogaeus*. Elsewhere it has usually been recorded from clear water, but all of the lakes in which we have found it have been characterized by dark, brown water. Smith (1908) found it breeding in a small pebbly or sandy-bottomed brook in Illinois about the middle of May. In the Nipigon region the breeding season appears to be about a month later, for females with abdomens distended with ripe or nearly ripe eggs and males with bright scarlet abdomens were taken on June 24, 1924. On July 17, 1923, none of the specimens taken were in breeding dress, but one was marked with bright greenish yellow in place of the scarlet of the breeding male.

The species has been recorded from New Brunswick to North Carolina on the east, and westward to Colorado.

PIMEPHALES PROMELAS Rafinesque

FATHEAD MINNOW

Body short and stout, much heavier forward; width 5.8 (4.8-7.1); depth 4.3 (3.8-4.5); head 3.7 (3.4-3.8); eye 4.5 (3.8-5.2); snout very obtuse, longer than diameter of the eye, 3.3 (2.8-3.8); mouth small, subterminal slightly oblique; interorbital broad, 2.5 (2.2-2.8); caudal peduncle stout, its length 1.35 (1.2-1.4) in head, its depth 1.7 (1.6-2.0) in its own length.

Dark olive green above; sides, except for a dark lateral streak, lighter with coppery or golden reflections; belly white. Males in breeding dress considerably darker than females, the head black; area between the head and dorsal fin, pad-like, wider in front and narrowed to a point at the insertion of the dorsal fin, and dark grey or steel blue in colour; two dark saddle-shaped areas extending to the lower sides, the first midway between the head and the dorsal fin, the other beneath the dorsal, sides between these dark areas buffy with brassy reflections; a dark longitudinal band across the middle of the dorsal fin; tubercles on the snout, lower jaw and along side to dorsal fin.

Dorsal fin inserted over 21st (20 to 23) scale of the lateral line, of one rudimentary and 8 (rarely 9) developed rays, the rudimentary ray club-shaped, but separated from the first developed ray by a distinct membrane; dorsal base 2.1 (2.0-2.2) in head, and 1.1 (1.0-1.2) in its own height; anal with 7 rays, its base 3.6 (3.3-4.0) in head and 1.8 (1.5-2.0) in its own height; pectoral length 1.5 (1.3-1.9) and ventral 1.9 (1.6-2.2) in head; scales 8 or 9-48 (44-52)-5; lateral line incomplete, usually ending beneath the dorsal fin. In one specimen examined, having 52 scales in a longitudinal series, there were pores on 32 scales, the next 3 scales lacked pores, they were present on the following 4, then lacking on 3, present on the next one and lacking on the remainder. The lateral line begins

high up, descends more or less abruptly and continues horizontally, but its course is often irregular; teeth 4-4; alimentary tract from 2 to 3 times combined length of head and body. Largest specimen 2⅜ inches.

The fathead minnow has been taken in only two of the small lakes investigated, namely, Station lake and the lake near Fairloch. In the latter its only associate appears to be *Eucalia inconstans*, but in Station lake it is associated with *Margariscus margarita nachtriebi*, *Pfrille neogaeus*, *Eucalia inconstans*, and *Catostomus commersonii*. Ripe or nearly ripe females and males in breeding dress were taken in Station lake on June 17, 1924.

This minnow ranges from Lake Champlain, through the Great Lakes region westward to the Saskatchewan (Medicine Hat).

PFRILLE NEOGAEUS (Cope)

COPE'S MINNOW

FIG. 1, PLATE I.

Body short and stout, heavy forward, deepest just back of the head, width 5.9 (5.3-6.2); depth 4.7 (4.5-4.8); head 3.6 (3.4-3.8); eye 4 (3.8-4.3); snout 3.5 (3.2-3.7) blunt; mouth very oblique, small; maxillary protractile, scarcely reaching a vertical through front of eye; head broad, interorbital 2.7 (2.5-2.8); length of caudal peduncle 1.3 (1.2-1.4) in head, its depth one-half its own length (1.8-2.1).

Back and upper sides dark brownish olive, with a very dark vertebral streak and a narrow dark lateral band, continued forward as a faint streak through eye to end of snout: this band more pronounced in males in breeding dress; a small black caudal spot; between the dark upper side and the dark lateral band, a lighter area; lower sides and belly pearly white; males in breeding dress with crimson band below the dark lateral band and greenish-yellow below; fins, lower cheeks and lower opercles greenish-yellow.

Dorsal fin with 8 rays, inserted well behind a vertical through the insertion of the ventral; its base 3 (2.6-3.2) in head and 1.8 (1.6-1.9) in its own height; anal with 8 rays, its base approximately equal dorsal base and 1.5 (1.4-1.7) in its own height; pectoral length 2 (1.7-2.3) and ventral 2.4 (2.1-2.6) in head; lateral line, short, beginning at upper, posterior edge of opercle, but quickly bending downward to a median position, usually ending in front of a vertical through the insertion of the ventrals, but occasionally extending past the dorsal insertion; scales so small as to make the fish appear scaleless when fresh from the water, 17-78-10 (16-19, 75-83, 9-10). Largest specimen 3 inches.

This minnow is common in some of the small boggy lakes in the vicinity of Lake Nipigon and at least two specimens have been taken in our trap-nets set in brooks draining such lakes, so that occasional specimens undoubtedly find their way into Lake Nipigon, but we have never taken it in any of our seining there. The lakes in which we have found it, Station lake, Crescent lake, and Centre lake, all have more or less sphagnum bog margins and dark brown water. The pH. of the water in two of these lakes was determined, and it was found to be about neutral or very slightly acid (6.9-7.0). Its most characteristic associate in these lakes was *Chrosomus erythrogaster*, although *Margariscus m. nachtriebi* and *Eucalia inconstans* were also commonly taken with it. On June 24, 1924, females with nearly ripe eggs and males in breeding dress were taken.

This species is known to occur in New Brunswick, Maine, New Hampshire, Michigan, and Wisconsin. In Ontario it has previously been recorded by Wright and Simpson (1920) from Otter lake, in the Lake of Bays district of the Muskoka region.

MARGARISCUS MARGARITA NACHTRIEBI (U. O. Cox)

NACHTRIEB'S MINNOW

FIG. 2, PLATE I

Body rather stout, but not so heavy forwards as in **P. neogaeus**, deepest at a point from one-third to one-half the distance from the occiput to dorsal insertion; not much compressed, width 5.9 (5.2-6.6); depth 4.8 (4.2-5.3); head 3.6 (3.5-3.8); eye 4.1 (3.8-4.5); snout 3.3 (2.9-3.5); mouth slightly less oblique than in **P. neogaeus** and head not so broad as in that species; premaxillaries protractile; interorbital 3.2 (2.8-3.5); length of caudal peduncle 1.4 (1.3-1.5) in head; its depth 1.9 (1.4-2.1) in its own length.

Back and upper sides much as in **P. neogaeus**, a very dark olive brown; sides with a dark lateral band continued forward on the opercle but not on the snout except in the young; lateral band less pronounced in large specimens which, however, have small irregular dark blotches scattered along the sides; between the lateral band and the dark upper sides is a lighter band, much narrower than the similarly placed band in **P. neogaeus**; belly white.

Dorsal fin with 8 rays, inserted behind a vertical through the insertion of

the ventral; its base 2.9 (2.7-3.1) in head and 1.6 (1.4-1.8) in its own height; anal with 8 rays; its base 3.0 (2.6-3.3) in head and 1.5 (1.3-1.7) in its own height; pectoral length 1.7 (1.3-1.9) and ventral 2.4 (1.9-2.9) in head; lateral line usually complete, or nearly so in larger specimens, those up to 1½ inches in length have lateral line incomplete posterior to the ventrals; it begins at upper edge of opercle but bends downward abruptly to a median position; scales small 13-69-9 (12-14, 67-72, 9-10); teeth 2, 5, -4, 2. Largest specimen 3⅞ inches.

Nachtrieb's minnow, although sometimes found associated with *P. neogaeus*, seems to prefer larger lakes, with less boggy borders and firmer bottoms. It is not, however, found in those lakes such as Lone Island lake and Shakespeare lake where the water is comparatively clear, the bottom firm and the shores largely solid and wooded to the water's edge. An approach to boggy conditions seems essential, and the water in lakes where we have taken it has been quite dark. One specimen was taken at the mouth of a very sluggish creek entering Aviators' bay, a small offshoot of Orient bay near its foot.

Its breeding season in this locality has not been determined, although we suspect that it breeds later than *P. neogaeus*. Males with faint suggestions of red on their sides were taken in Station lake on July 4, 1924.

This species was described by U. O. Cox (1896) from Mille Lacs Lake, Minnesota. The same or closely related species have been recorded from New Brunswick and Gaspé (*Leuciscus rubrilateralis*, P. Cox 1921), Maine (*L. carletoni*, Kendall, 1904), and Michigan (*L. carletoni*, Hankinson, 1917).

GENUS **NOTROPIS** RAFINESQUE

A. Anal rays typically 8.
  B. A prominent black spot at base of caudal fin. . . . . **hudsonius**
  BB. A dark band along sides through eye to end of snout. . . . **heterolepis**
  BBB. A dark band along sides but not continued forward to end of snout. . . . . **deliciosus stramineus**
AA. Anal rays more than 8, usually 10 or 11. . . . . **atherinoides**

NOTROPIS HUDSONIUS (DeWitt Clinton)

SPOT-TAILED MINNOW

Body moderately robust, somewhat compressed, width 6.6 [5.6 (6.3-7.0) 7.7]; depth 4.4 (4.0-4.8); head short 4.2 (4.0-4.4); eye 3.1 (2.7-3.5); snout blunt, decurved, 3.2 [2.8 (3.0-3.5)]; mouth sub-inferior, rather small, maxillary scarcely reaching a vertical through anterior edge of orbit; interorbital 2.5 (2.3-2.8); length of caudal peduncle 1.2 (1.1-1.3) in head; its depth about one-half its own length; dorsal fin with 8 rays, inserted directly over or slightly in front of a vertical through the insertion of the ventral, its base 1.9 (1.7-2.1) in head and 1.6 (1.5-1.8) in its own height; anal with 8 rays, its base 2.3 (2.0-2.5) in head and 1.5 (1.4-1.6) in its own height; pectoral length 1.4 (1.2-1.5) and ventral 1.6 (1.4-1.8) in head; lateral line with anterior half bowed downward; scales 5 or 6-38 (36-40)-4 or 5; teeth 2, 4-4, 2; 2, 4-4, 1; 1, 4-4, 1; 1, 4-4, 0 or 0, 4-4, 0. Largest specimen 3¾ inches.

The spot-tailed minnow is abundant and found almost everywhere in shallow water, except on wave-swept sandy beaches. Quite a number have been taken in our trap-nets near the mouths of the Pustagone river and Trout creek and some in the quieter water of larger rivers, but it prefers sheltered bays with mud bottom supporting considerable aquatic vegetation. This species is more of a plankton feeder than the other common minnows of the lake—lake shiner (*N. atherinoides*), long-nosed dace (*Rhinichthys cataractae*), and lake chub (*Couesius plumbeus*). *Daphnia* forms about forty per cent. of its food, while *Bosmina*, *Sida* and *Leptodora* are taken in considerable quantities. Larval insects (Diptera, Chironomidae and Ephemerida), however, are eaten in large numbers, nearly forty per cent. of the food on the average consisting of these forms. Spawning occurs in late June or early July.

This species is essentially a northern minnow, ranging from New England throughout the Great Lakes region, north and west to Hayes river (fifteen miles above York factory) (Evermann and Goldsborough, 1907) and Lake Athabaska (Kendall, 1924). Northward the spot-tailed minnow has been considered to be of a different subspecies (*Notropis hudsonius selene*) from that occurring farther south, the chief points of distinction being the very short head (4⅛ as compared with 4⅜), the more oblique mouth and the

TABLE 11.—BODY PROPORTIONS OF *Notropis hudsonius* FROM VARIOUS LOCALITIES, CHIEFLY NORTHWARD

Authority	Locality	Head	Depth	Eye	Snout	Scales	Size
		22.72% (4.4)	23.37% (4.3)	34.28% (2.9)	28.57% (3.5)	7-40-4	92 mm. 4"
Kendall 1924	Lake Athabaska	22.05% (4.5)	25.00% (4.0)	33.33% (3.0)	30.00% (3.3)		84 mm. 3¼"
		4.1-4.5	3.9-4.3	3-3.25	3-3.5		
Fowler 1910	Lake of the Woods	4.2 (4.0-4.4)	4.4 (4.0-4.8)	3.1 (2.7-3.5)	3.2 (3.0-3.5)	5 or 6, 38 (36-40), 4 or 5	3¾"
Dymond	Lake Nipigon					6-38 to 41-4	2⅛"
		3.8-4.5	4.2-4.7	2.3-3.6			
Bensley 1915	Georgian Bay					37 or 38-5	3 1/16"-4⅜"
Fowler 1910	Sparrow lake, Simcoe Co.	3¼-4.2	3.8-4⅛	3.1-3.75	3.4-3.75		
						5 or 6, 36-39, 4	4"-6"
Forbes & Richardson 1908	Illinois	4.1-4.7	4-4.5	2.8-3.6	3.2-3.5		
Fowler	Seventy examples from Mass., Va., O., Mich., Ind., Ia.	3⅜-4¼	3¾-5	2⅓-3⅔	3⅓-3⅞	37 (34-38)	1¼"-3½"

very distinct black caudal spot (J. and E., 1894). The type of the subspecies was taken in Lake Superior at Bayfield, Wisconsin (Jordan, 1877), but the only large specimen which Hankinson (1916) took in Lake Superior answered more closely to the description of typical *N. hudsonius*. Fowler (1910) quotes Evermann in regard to Lake of the Woods specimens as follows: "The only tangible difference so far as these measurements show [from the typical *hudsonius*] is the length of the head, the *selene* type having a considerably shorter head than the others. There is no difference in the fins or scales."

For purposes of comparison, the principal body proportions of spot-tailed minnows from various localities, chiefly northward, are presented in Table 11.

From an examination of this table it is apparent that there is a tendency towards a shorter-headed form northward, but the difference does not appear to be sufficiently marked to necessitate its recognition as a distinct subspecies.

NOTROPIS HETEROLEPIS Eigenmann and Eigenmann

BLACK-NOSED SHINER

Body only moderately elongate, little compressed, its width 6.5 (6.0-6.9); depth 4.6 (4.2-4.9); head 3.7 (3.4-3.9); eye 3.7 (3.5-4.0); snout 3.2 (3.0-3.4) somewhat pointed; mouth subterminal, small, maxillary not nearly reaching a vertical through front of eye; interorbital 3.2 (3.0-3.4); length of caudal peduncle 1.1 (1.0-1.3) in head, its depth 2.4 (2.2-2.7) in its own length; dorsal fin with 8 rays, inserted distinctly behind a vertical through ventral insertion; its base 2.6 (2.4-2.8) in head and 1.9 (1.8-2.0) in its own height; anal with 8 rays, its base 3.2 (2.8-3.6) in head and 1.7 (1.6-1.8) in its own height; pectoral length 1.6 (1.4-1.7) and ventral 2.0 (1.7-2.3) in head length; lateral line varies from very short to nearly complete; scales 5 or 6-36 (34-37)-4; teeth 4-4. Largest specimen 2⅜ inches.

This species has been taken only once in Lake Nipigon—at the mouth of a small sluggish stream entering Aviators' bay, a well-protected little bay near the foot of Orient bay. It was found to be quite common in a small lake on Shakespeare island, and was also secured in Lone Island lake. It

appears to be a minnow of small lakes having rather sandy bottoms. Spawning occurs in July.

This is the minnow described by Meek (1899) as *N. muskoka*, and regarded by Bensley (1915), who took it in the Georgian bay region, as a variety of *N. cayuga*. Hubbs, in his forthcoming check list of Great Lakes fishes, shows that the minnow described by Meek (1889) as *N. cayuga* cannot be distinguished from *N. bifrenatus* and that therefore Eigenmann and Eigenmann's name (1893), *heterolepis*, must be applied to the species of which we took representatives in Lake Nipigon. It, no doubt, occurs in suitable situations throughout most of Ontario. Dr. W. A. Clemens and the writer took it in McKewan lake, about thirty miles north east of Toronto.

NOTROPIS DELICIOSUS STRAMINEUS (Cope)

STRAW-COLOURED MINNOW

Body moderately stout, little compressed, width 6.8 (6.5-7.3); depth 4.8 (4.6-5.1); head 4.1 (3.9-4.3); eye large 3.1 (2.9-3.3); snout blunt, usually slightly shorter than eye 3.4 (3.0-3.8); mouth sub-inferior, small, maxillary scarcely reaching a vertical through front of eye; head rather broad, interorbital 3.5 (3.1-3.8); length of caudal peduncle 1.2 (1.1-1.3) in head length, its depth 2.3 (2.1-2.6) in its own length; dorsal fin with 8 rays, inserted a little behind a vertical through ventral insertion; its base 2.1 (1.9-2.2) in head and 1.7 (1.4-2.0) in its own height; anal with 8 rays, its base a little shorter than base of dorsal and 1.7 (1.6-1.9) in its own height; scales 4 or 5-36 (34-37)-3; teeth 4-4. Largest specimen 2⅛ inches.

This is one of the most insignificant of the minnows, both in size and appearance. It is not common in Lake Nipigon, having been taken in only six localities. It appears to prefer a sand bottom, with little vegetation, and most of the situations in which we have found it have been so well protected that the water in which it lives must at most times be quite quiet.

This is the minnow which Jordan and Evermann (1896) identified with Girard's *blennius*, but Fowler (1910) has shown that the minnow so named is something entirely different. Hubbs in his forthcoming check list therefore

recognizes Girard's name *deliciosus* for the present species. The subspecies *stramineus* replaces typical *deliciosus* in the Great Lakes drainage.

NOTROPIS ATHERINOIDES Rafinesque

LAKE SHINER

Body long and thin, profile scarcely arched, dorsal surface much more nearly parallel with ventral than in **N. hudsonius**; width 7.6 (6.4-8.6); depth 4.7 (4.2-5.4); head 4.4 (4.2-4.7); eye 3.6 (3.1-4.0), not placed so high as in **N. hudsonius**; snout 3.4 (2.9-3.7); mouth terminal, oblique; maxillary nearly reaching a vertical through front of eye; interorbital 3.0 (2.8-3.2); length of caudal peduncle 1.2 (1.0-1.4) in head, its depth about one-half its own length; dorsal fin with 8 rays, inserted over 15th to 17th scale of lateral line and well behind a vertical through the insertion of the ventral, its base 2.2 (2.1-2.3) in head, and 1.7 (1.5-1.9) in its own height; anal usually with 11 rays, sometimes 10, its base 1.7 (1.6-1.9) in head and 1.1 (0.9-1.3) in its own height; pectoral length 1.3 (1.2-1.3) and ventral 1.7 (1.6-1.8) in head; lateral line begins near upper edge of opercle, bends downward to a point opposite the outer edge of the pectoral fin, and then runs straight or with a slight upward curve to the caudal; scales 5 or 6-38 to 40-3; teeth 2, 4-4, 2, hooked. Largest specimen 4 inches.

This species is evidently much less common in the lake than *N. hudsonius*, and has been taken in our seine on comparatively few occasions. This, however, is undoubtedly due, in part at least, to its being a more active species and moving about more freely. Any sheltered bay with a muddy bottom and containing aquatic vegetation may be counted on to yield numbers of spot-tailed minnows if seined, but it is apparently only by chance that this species is taken, and then it is taken almost invariably in the more exposed locations, in deeper water and over a cleaner bottom. Forbes and Richardson (1908) say that it "moves and feeds in large schools, thousands being frequently seen together near the surface." It has been taken on two occasions in the Gull river, near shore at the side of a considerable rapid which would indicate that it is fond of a rather swift current. It has also been taken in the Sturgeon river, but never in any of the smaller streams. Females distended with nearly ripe eggs were taken in the Sturgeon river on July 12, 1922.

The lake shiner is found from Lake Champlain through

the Great Lakes region west to Medicine Hat and north to Lake Athabaska (Kendall, 1924). In the United States it ranges as far south as Tennessee and Kansas.

RHINICHTHYS CATARACTAE (Cuvier and Valenciennes)

LONG-NOSED DACE

Body spindle-shaped, little compressed; width 5.7 (5.3-6.2); depth 4.8 (4.4-5.3); head long 3.8 (3.7-4.0); eye small, 5.9 (5.3-6.6); the snout long and somewhat pointed, 2.4 (2.2-2.6), projecting considerably beyond the tip of the upper jaw; mouth wholly inferior, horizontal; premaxillaries not protractile; a small barbel present; interorbital 3.4 (3.2-3.6); dorsal fin with 8 rays, inserted well behind a vertical through insertion of ventral; its base 2.4 (2.2-2.5) in head and 1.4 (1.3-1.6) in its own height; anal with 7 rays, its base 2.7 (2.5-3.0) in head and 1.6 (1.4-1.7) in its own height; pectoral length 1.4 (1.2-1.6) and ventral 1.9 (1.8-2.2) in head; scales small, 11 to 13-66 (60-72)-10 or 11; lateral line nearly straight, slightly bent upward on the first six or seven scales. Largest specimen 4 inches.

Most of our specimens of the long-nosed dace were taken in the trap-net in creeks and small streams, but it was also taken on a number of occasions in the lake, especially over a stony or rocky bottom. Chironomid larvae formed the bulk of the food of those examined. One specimen was found to have eaten fish eggs, and it is suspected that they eat the spawn of the trout perch and other brook-spawning species with which they are found associated in the streams. Spawning occurs during June and July.

The long-nosed dace has an extensive range being found from the Atlantic westward to the Columbia river and south in the United States as far as the Rio Grande.

COUESIUS PLUMBEUS (Agassiz)

LAKE CHUB

FIG. 3, PLATE I

Body rather elongate, little compressed, width 6.4 [5.0 (5.9-7.0)]; depth 4.8 [3.9 (4.7-5.3)]; head 4.1 (3.9-4.3) rather flat above; eye large 4.3 (4.0-5.0) placed high; snout 3.0 (2.7-3.4); mouth oblique, maxillary not reaching a vertical through front of eye; barbel evident, attached above, near posterior end of maxillary; interorbital 2.8 (2.6-3.1); length of caudal peduncle 1.1 [(1.0-1.2) 1.4] in head, its depth 2.2 [1.8 (2.0-2.4)] in its own length.

Upper parts very dark olive green,* bounded below by a thin gilt stripe; between the gilt stripe and the lateral line is a broad purplish band which posteriorly passes slightly below the lateral line; belly pearly white; head dark above; an ill-defined dark band from snout through eye to posterior margin of opercle, more distinct in the young in which it appears as an anterior extension of the lateral purplish band which is also more prominent in young specimens. In the breeding season the bases of pectoral and ventral fins and contiguous areas of the body, reddish; reddish areas also on the snout between the eye and the maxillary and just below the upper posterior margin of the opercle at the point of origin of the lateral line.

Dorsal fin with 8 rays, preceded by a rudimentary ray closely attached to the first undivided ray, inserted over the last ray of the ventral; its base 2.1, rarely 2.0 or 1.9 in head and 1.4 (1.3-1.6) in its own height; anal with 7 or 8, occasionally 9 rays, its base 2.4 (2.1-2.6) in head and 1.4 (1.3-1.6) in height of anal; pectoral length 1.4 (1.3-1.5) and ventral 1.7 (1.6-1.9) in head; caudal deeply forked; lateral line begins at upper posterior margin of opercle but quickly bends downward to a median position, sometimes sharply bent upwards below the dorsal; scales 11 or 12-62 (58-65)-7 or 8, smaller anteriorly, 22 to 27 before the dorsal; teeth 2, 4-4, 2, flattened and hooked; stomach and intestine .9 to 1.2 in total length. Largest specimen 5¼ inches.

The lake chub frequents the lower stretches of creeks and small streams, especially during the early summer as may be seen by reference to the records of trap-net catches (p. 18). In the lake it has been taken on comparatively few occasions, usually over a sand bottom in medium-sized bays with little vegetation. Apart from its occurrence in streams it appears to choose about the same habitat as the straw-coloured minnow, *Notropis deliciosus stramineus*. The latter has been taken in only six localities in Lake Nipigon, and in all but one of these it was found associated with the lake chub. Spawning occurs in June.

This species appears to be of rather wide distribution in northern Canada. It was described by Agassiz (1850) from Lake Superior. Preble (1908) took it in Lake St. Croix between Great Slave and Great Bear lakes. Cox (1900) has

*This colour description is based on specimens taken from a small river about 400 yards from where it enters Orient bay. Specimens from Ombabika bay were much lighter, pale olive to straw colour above, with lateral band very indistinct.

taken it commonly in New Brunswick and also in the Gaspé peninsula, and it is probably found in all suitable localities in the intervening territory. Kendall (1918) says it is common throughout northern New England, occurring in almost every lake, pond, river, and brook in Maine.

FAMILY COREGONIDAE

A. Premaxillaries broad, with the cutting edge nearly vertical or directed backward, the lower jaw short and more or less included; cleft of mouth short.
  B. Body long and slender, gill rakers 8 to 11 on lower limb of first arch..... **Prosopium**
  BB. Body compressed, gill rakers 15 to 18 on lower limb of first gill arch..... **Coregonus**
AA. Premaxillaries with the cutting edge nearly horizontal and directed forward; lower jaw long; cleft of mouth rather long.. **Leucichthys**

PROSOPIUM QUADRILATERALE (Richardson)

ROUND WHITEFISH; FROSTFISH

Body long, slender and rounded; width 7.2 [6.2 (6.6-7.8) 8.2]; depth 4.8 [4.3 (4.6-5.1) 5.3]; head 5.0 (4.8-5.3); eye 4.3 [3.5 (4.1-4.8)]; snout narrow 3.6 (3.3-4.0); mouth very small, maxillary 4.2 [(3.9-4.5) 4.7], not reaching a vertical through front of eye; interorbital 3.4 (3.1-3.6); length of caudal peduncle 1.5 (1.3-1.8) in head, its depth 1.9 (1.6-2.1) in its own length; dorsal fin usually with 12, sometimes 11 rays, inserted over 25th to 28th scale of lateral line, its base 1.7 (1.6-1.9) in head and 1.2 (1.1-1.4) in its own height; anal with 10 or 11 rays, its base 2.2 (2.0-2.5) in head and 1.2 (1.0-1.3) in its own height; pectoral length 1.3 (1.2-1.4) and ventral 1.5 (1.4-1.7) in head; scales 9-86 (80-92)-8, rarely 7; branchiostegals 6 to 8, gill rakers17 (6+8 to 7+11), quite short.

The young (Fig. 1, Plate VIII), at least up to 95 mm. in length, have three rows of dark spots on each side—a row along the lateral line consisting of ten or eleven rounded dark spots at approximately equal intervals along the whole length, another row about midway between the lateral line and the mid-dorsal line, of smaller spots, thirteen in number and ending posteriorly at a point midway between the dorsal and adipose fins, and a third row just below the mid-dorsal line, consisting of ten or twelve spots, often fused or joined by dark bars to those of the opposite side, especially anteriorly.

The round whitefish is rather uncommon in Lake Nipigon. It is found only in comparatively shallow water, being seldom taken below forty feet and usually in much shallower water. In common with a number of other species (sauger, perch, straw-coloured minnow, log perch) it seems to find conditions in some of the shallow northern bays, especially Ombabika, Windigo, and Wabinosh, more suitable and there occurs in larger numbers and reaches a larger size. In the main body of the lake it has been taken off the mouths of rivers more frequently than elsewhere. It shows a strong preference for caddis larvae, but mayfly nymphs, chironomid larvae and smaller molluscs are also eaten freely.

The largest specimen taken measured 14¼ inches and weighed slightly more than one pound. On account of its slender body, it does not gill in the nets now in use in commercial fishing here. In any case it does not occur in sufficient numbers in Lake Nipigon to make it of commercial importance.

It has a very wide range, being found from New England, throughout the Great Lakes and northwestward to Alaska.

COREGONUS CLUPEAFORMIS (Mitchill)

COMMON WHITEFISH

The whitefish of Lake Nipigon present quite a range in general shape, coloration, and body proporotins. In shape they vary from a long slender form with little or no elevation at the nape to a very deep form with a distinct nuchal hump and strongly arched back and belly. Extreme examples of the latter type are not characteristic, although specimens showing this tendency are not uncommon. The more elongate, slender form is the more typical. In colour they range from very light to very dark, depending apparently on the nature of the water which they frequent. In Black Sturgeon lake, whose water is very dark in colour, the whitefish are nearly black except below. The average proportionate measurements of 25 specimens, all over 30 cm. in length, are as follows: Average length 39.4 cm.; width 7.1 (6.0-8.0); body depth 3.5 (3.1-4.0); head 4.7 (4.4-5.0); eye 4.66 (4.0-5.1); snout 3.3 (2.9-3.7); interorbital 3.6 (3.1-4.0); maxillary 3.2 (2.9-3.4); length of caudal peduncle 2.0 (1.6-2.2) in head, its depth 1.8 (1.1-1.5) in its own length; dorsal fin with 11 or 12, rarely 10 rays, its base 1.8 (1.6-2.1) in head and 1.4 (1.2-1.6) in its own height; anal with 11 to 13 rays, its base 1.8 (1.6-2.2) in head approximately equal to its own height (0.85-1.2); pectoral length 1.2 (1.1-1.3) and ventral 1.3 (1.2-1.4) in head; scales 10 or 11, rarely 9—81 (74-87)—8 or 9, rarely 10; gill rakers 10+18 (9+15—11+18).

The whitefish is the most important commercial species of Lake Nipigon, the catch for the years 1917 to 1922 inclusive

aggregating 5,975,204 pounds. It is taken in both gill-nets and pound-nets and ranges through a wider variety of depth than any other species found in the lake. We have taken it at every depth at which nets have been used from 2 feet to over 300 feet. At the former depth, a specimen 17 inches in length was taken in the seine on July 21, 1922. Another, 18¼ inches long, was seined in Ombabika bay on June 26, 1924, from water about 4 feet deep. The optimum depth during the summer appears to be from 15 to 25 fathoms. A few frequent rivers, a specimen having been taken by W. J. K. Harkness in Gull river twenty miles from its mouth. They are also common in the swift water at the foot of Virgin Falls in the Nipigon river, and are not infrequently taken there on a fly by trout fishermen. Lake specimens will also take the hook, Prof. E. M. Walker having taken one in this way off the dock at Macdiarmid.

The food of the whitefish consists of a great variety of organisms, as is to be expected of a species which ranges through such a wide variety of depths. The average percentage of the principal food materials found in the alimentary tracts of 124 specimens ranging in length from 8 to 21¼ inches was as follows: *Pontoporeia hoyi* 31%, chironomid larvae 27%, molluscs 11% (chiefly *Valvata sincera, V. tricarinata, Amnicola pallida, A. limosa, A. limosa porata* and various species of Sphaeriidae), terrestrial insects 7%, Ephemeridae 5%, miscellaneous 19% (Clemens, 1924). Its chief competitors in the matter of food are the suckers (*C. catostomus* and *C. commersonii*), and it is believed that the abundance of these species curtails to some extent the whitefish productivity of the lake.

Fishermen state that the whitefish now move about more freely than when the lake was first fished commercially. At that time, it is said, nets set in a certain locality would yield at the first lift perhaps three tons of fish; reset in the same locality, about two tons; and on the third lift, one ton. If settings were continued in the same place continuously decreasing quantities were taken. Now, it is said, there are

localities where nets may be reset more or less continuously for weeks without showing any marked decrease in yield. These differences are, no doubt, due in part to the fishermen's increased knowledge of the fishing grounds of the lake, but it is also believed that with the thinning out of the whitefish population the fish are moving about more freely. This may be partly due to the depletion of their food supplies caused by an increase in the number of suckers, following the removal of so many of the whitefish which feed on much the same organisms as the suckers. We have no data as to whether the suckers have increased since commercial fishing was commenced, but the relation of the suckers to the whitefish is a problem of considerable economic importance.

In the early days the whitefish were an important item in the food of the Indians, being preferred apparently to all other species. At spawning time they were netted and put up to freeze as winter feed for their dog teams. According to Mr. A. E. Fraser, District Warden of the Ontario Department of Game and Fisheries at Fort William, the Nipigon Indians used to take from one thousand to five thousand fish for each family owning a dog team. The fish were put up by tens. A pointed alder stick long enough to hold this number and to leave six inches free at each end was run through the fish near the tail end. These "strings" were supported between poles fastened to trees. When fish were plentiful two were fed to each dog per day. Mr. Fraser adds: "In the days of construction (1908-1912) we used to pay twenty-five cents a string for these fish, but the Hudson's Bay Company got them for ten cents a string."

The average weight of the whitefish taken in the fishermen's nets is very little more than 2 pounds and few specimens exceed 5 pounds, although 12 pounds is said to be occasionally attained. Spawning occurs in November, usually towards the middle of the month.

GENUS **LEUCICHTHYS** DYBOWSKY

LAKE HERRINGS; CISCOES

Six species of ciscoes are recognized in Lake Nipigon by Dr. Koelz, to whom all my specimens have been submitted, and to whom I am greatly indebted for much other assistance in connection with the systematic study of this group.

The ciscoes of the lake are of economic importance at present chiefly as food for lake trout, for which they form the staple food supply. The tullibees, of which only a few are taken, are shipped with the whitefish, as are also some large black-fins. Occasionally the latter species is taken in sufficient numbers to be shipped separately, but the quantity so disposed of is insignificant. If nets of smaller mesh were used, larger quantities of ciscoes, principally *L. nigripinnis*, *L. zenithicus*, and *L. reighardi*, could be taken, but they do not occur in sufficient numbers to make them of any considerable economic importance; and as they form the main food supply of the lake trout, it is probably wiser not to interfere with this natural arrangement.

As a group the ciscoes are remarkable for the degree of fluctuation shown by the different body proportions by which species may usually be distinguished. In common, too, with most salmonoids they appear to be unusually plastic, the same species from different habitats exhibiting differences which may or may not be related to the environment. On this account the identification of species is unusually difficult, and leads many, only superficially acquainted with the group, to doubt the validity of many of the species. A close study, however, reveals marked differences in the habitat preferences of the various species, as well as differences in body proportions, numbers of gill rakers, and other characters by which they may be distinguished. Table 12 gives the usual range of variation for a number of the characters useful in distinguishing species. The extreme range of variation found for each species is indicated in the descriptions of the individual species.

TABLE 12.—USUAL RANGE OF VARIATION OF LAKE NIPIGON CISCOES

Species	Gill rakers	Body Depth	Body Width	Head	Eye	Snout	Inter-orbital	Caudal* peduncle length / depth	Dorsal* height / base
L. nipigon 33-46 cm.		3.4-3.8	6.3-7.4	4.0-4.5	4.5-5.1	3.3-3.9	3.5-3.9	1.2-1.4	1.2-1.4
	54-59								
L. nipigon 23-25 cm.		4.0-4.7	7.1-8.8	4.0	3.6-4.5	3.6-3.7	3.7-4.0	1.4-1.5	1.3-1.5
L. nigripinnis 30-36 cm.		3.5-4.0	7.0-8.0	4.0-4.3	4.0-4.2	3.6-3.9	3.6-4.1	1.2-1.7	1.3-1.7
L. nigripinnis 22-29 cm.	46-51	3.9-4.4	7.4-8.4	4.0-4.2	3.7-4.1	3.7-3.8	4.1-4.6	1.4-1.6	1.5-1.7
L. nigripinnis 16-17 cm.		4.3-4.9	7.9-8.6	3.7-3.9	3.2-3.8	3.6-4.2	4.1-4.5	1.5-1.6	1.7-1.8
L. artedi 20-24 cm.	43-49	4.1-4.9	7.0-9.0	4.1-4.5	3.7-4.3	Approx. equal to eye	3.7-4.2	1.4-1.8	1.4-1.6
L. hoyi 16-21 cm.	38-45	4.3-4.5	7.5-8.5	3.8-4.2	3.6-4.2	Approx. equal to eye	4.4-5.2	1.4-1.9	1.7-2.0
L. zenithicus 22½-29 cm.	35-38	4.1-4.3	8.1-9.8	3.8-4.3	4.0-4.5	3.4-3.6	4.4-4.6	1.6-1.9	1.4-1.5
L. reighardi 23-30½ cm.	32-36	3.8-4.1	7.5-8.0	3.8-4.1	4.0-4.6	3.3-3.6	3.8-4.3	1.3-1.7	1.4-1.6

*These values are obtained by dividing the caudal peduncle length by the caudal peduncle depth and the dorsal height by the dorsal base.

A. Specimens over twelve inches in length.
  B. Gill rakers 54 or more; eye 4½ to 5 in head, 1.6 to 2.0 in depth of caudal peduncle..... **nipigon**
  BB. Gill rakers fewer than 54.
    C. Gill rakers 46 to 53; eye 3½ to 4½ in head, 1.3 to 1.6 in depth of caudal peduncle..... **nigripinnis**
    CC. Not as in C. Occasional specimens of **artedi, zenithicus** and **reighardi** of over twelve inches may be looked for, but the key under AA. may be used for their identification.

AA. Specimens twelve inches or less in length,
  D. Gill rakers 54 or more..... **nipigon**
  DD. Gill rakers fewer than 54.
    E. Gill rakers 46 to 53.
      F. Head 3.8 to 4.0; eye 15 in total length to base of caudal..... **nigripinnis**
      FF. Head 4.1 to 4.5; eye 16 to 18 in total length to base of caudal..... **artedi**
    EE. Gill rakers fewer than 46.
      G, Gill rakers 40 or more.
        H. Interorbital width 3.6 to 4.5 in head; base of dorsal 1.4 to 1.6 in height of dorsal; depth of caudal peduncle 1.4 to 1.9 in length of caudal peduncle; head 4.1 to 4.5..... **artedi**
        HH. Interorbital width 4.4 to 5.2 in head; base of dorsal 1.6 to 2.0 in height of dorsal; depth of caudal peduncle 1.9 to 2.6 in length of caudal peduncle; head 3.8 to 4.2..... **hoyi**
        HHH. Interorbital width 4.2 to 5.0 in head; base of dorsal 1.4 to 1.8 in height of dorsal; depth of caudal peduncle 1.3 to 1.9 in length of caudal peduncle; head 3.8 to 4.3..... **zenithicus**
      GG. Gill rakers fewer than 40.
        I. Depth of caudal peduncle 1.9 to 2.6 in length of caudal peduncle; eye .9 to 1.1 in snout; interorbital width 4.4 to 5.2 in head; base of dorsal 1.6 to 2.0 in height of dorsal..... **hoyi**
        II. Depth of caudal peduncle 1.3 to 1.9 in length of caudal peduncle; eye 1.1 to 1.4 in snout; interorbital width 4.2 to 5.0 in head; base of dorsal 1.4 to 1.8 in height of dorsal; adipose length into the sum of the caudal peduncle depth and interorbital width 1.5 to 2.1..... **zenithicus**
        III, Depth of caudal peduncle 1.3 to 1.7 in length of caudal peduncle; eye 1.0 to 1.4 in snout; interorbital width 3.5 to 4.5 in head; base of dorsal 1.3 to 1.7 in height of dorsal; adipose length into the sum of the caudal peduncle depth and interorbital width 1.9 to 2.4..... **reighardi**

LEUCICHTHYS NIPIGON Koelz

TULLIBEE

PLATE II

Body deep and little compressed, width 6.8 [(6.3-7.4) 7.8]; depth 3.5 [3.2(3.4-3.8) 4.1]; head 4.2 (4.0-4.5); eye much smaller than in **L. nigripinnis** 4.8 [4.3 (4.5-5.1)]; snout 3.6 (3.3-3.9); interorbital 3.7 [3.4 (3.5-3.9)]; maxillary 2.8 (2.6-2.9); length of caudal peduncle 2.0 (1.8-2.1) in head, its depth 1.3 (1.2-1.4) in its own length.

Colour dark greenish above, silvery on sides and belly, dorsal and caudal fins tipped with black, lower fins usually with little or no pigment, caudal not so deeply forked nor so widely spread as in **L. nigripinnis**.

Dorsal fin with 10 to 12 rays, its base 1.9 [1.6 (1.8-2.0) 2.3] in head and 1.3 [(1.2-1.4) 1.6] in its own height; anal with 11 to 13 rays, its base greater than its height, 2.0 (1.8-2.2) in head and 0.9 (0.8-1.1) in its own height; pectoral and ventral approximately equal in length, the former usually a little the longer, 1.5 (1.4-1.6) in head; distance from insertion of pectoral to ventral insertion 3.3 (3.0-3.7)* in total length; scales 8, rarely 7—73 [67 (69-77) 81]—7 or 8; gill rakers 20+37 [(18+36—20+39) 21+43]. Length 19½ inches.

This, the largest species of cisco found in the lake, is one of the least common. Outside of Ombabika bay comparatively few specimens have been taken in our nets in Lake Nipigon proper. In the deeper parts of Ombabika bay (60-65 feet) quite a number have been secured, and in Black

*Specimens from Ombabika bay show considerably greater pectoral-ventral distance than specimens from the lake itself.

Sturgeon lake two specimens were taken at a depth of 30 to 40 feet. It appears to be a species of moderately shallow water, although the commercial fishermen take them occasionally in nets set for whitefish at depths of 15 to 25 fathoms. Those taken in this way, of course, may be merely stragglers from a typically shallower water habitat. The opinion that it is a relatively shallow water species is supported by the fact that it is found chiefly in the eastern and northern parts of the lake, that is, in the parts containing the principal areas of shallow water.

LEUCICHTHYS NIGRIPINNIS (Gill)

BLACK-FIN; MOONEYE CISCO

PLATE III

Body deep, usually with a pronounced hump at the nape, somewhat compressed, width 7.3 [6.5 (7.0-8.0) 8.8]; depth 3.7 [3.2 (3.5-4.0) 4.3]; head 4.2 (4.0-4.3); eye rather large 4.1 [3.8 (4.0-4.2) 4.6]; snout longer than eye 3.7 [3.3 (3.6-3.9)]; interorbital 3.9 [3.5 (3.6-4.1) 4.3]; maxillary 2.6 (rarely 2.7 or 2.8); lower jaw usually longer than the upper; caudal peduncle a little longer and decidedly more slender than in **L. nipigon**, its length 2.0 [(1.8-2.2) 2.3] in head, its depth 1.5 (1.2-1.7) in its length.

Very dark in general coloration; upper parts very dark green in life, preserved specimens appearing black; head silvery on the cheeks and opercles, dark above; fins all dark, more pronounced on the outer half, the pectorals and ventrals showing up conspicuously black against the silvery sides and belly; anal paler, especially on the posterior half; caudal widely spreading and rather deeply forked; occasional specimens with fins much lighter, only the tips dark, specimens from Ombabika bay being generally quite light in colour throughout.

Dorsal fin usually with 11, occasionally 9 or 10 rays, its base 2.1 (1.9-2.3) in head and 1.6 (1.3-1.7) in its own height; anal with 11 or 12 rays, its base 2.2 (2.0-2.4) in head, approximately equal to its own height (0.9-1.2); pectoral length 1.3, rarely 1.4 and ventral 1.4 (1.3-1.5) in head; distance from insertion of pectoral to ventral insertion 3.2 [3.0 (3.1-3.3) 3.6] in total length; scales 8, rarely 7 or 9—73 [68(70-75) 77]—7 or 8; gill rakers 18+30 [(17+30—19+32) 18+35]. Length 15¼ inches.

This is one of the commonest and most strikingly marked species, especially characterized by its black fins and large eye. It occurs throughout the lake, and at a great variety of depths. Although typically a deep water form and taken at a greater depth than any other species of fish in the lake

(340 feet), it is often found in comparatively shallow water, and apparently finds conditions quite suitable in Ombabika bay, where it is not uncommon. Its optimum depth is perhaps 18 to 20 fathoms in summer.

LEUCICHTHYS ARTEDI (Le Sueur)

LAKE HERRING

PLATE IV

Body slender, elongate, with little or no rise from nape to insertion of dorsal; little compressed, width 8.0 (7.0-9.0); depth of larger specimens (over 20 cm.) usually about 4.5 (4.4-4.9), some specimens deeper with dorsal and ventral surfaces more arched and depth 4.1 to 4.2 in length;* head short 4.3 (4.1-4.5); snout usually slightly longer than diameter of eye, but occasionally equal or even a little shorter; interorbital 4.0 [3.6 (3.7-4.2) 4.5]; maxillary 2.8 [(2.7-2.9) 3.0]; lower jaw usually slightly longer than upper; length of caudal peduncle 1.8 [1.6 (1.7-1.9) 2.1] in head, its depth 1.6 [(1.4-1.8) 1.9] in its length.

Colour dark green above, silvery below; outer edges of dorsal and caudal fins dark, lower fins usually without pigment.

Dorsal fin with 10 to 12 rays, its base 2.1 [(2.0-2.2) 2.4] in head and 1.5 (1.4-1.6) in its own height; anal with 12 or 13, occasionally 11 rays, its base 2.1 [(2.0-2.2) 2.5] in head, its height usually less than its base, but sometimes equal or even greater; pectoral length 1.4 (1.3-1.5) and ventral 1.5 (1.4-1.6) in head; distance from insertion of pectoral to ventral insertion 3.2 (3.1-3.4) in total length; scales 8, rarely 7—71 [64 (67-74) 81]—7 or 8; gill rakers 16+30 [15+26 (16+27—17+32) 20+37]. Length 11½ inches.

*The latter form approaches the smaller **L. nigripinnis** in shape, but has a shorter head. In relation to the total length the eye of **L. artedi** is also much smaller than that of **L. nigripinnis** of the same length. Specimens of the former averaging about 22 cm. in length to base of caudal fin have eye 16 to 18 in total length whereas **L. nigripinnis** of the same length has eye about 15 in total length.

This cisco may usually be distinguished on sight from the other species found in the lake by its slender, rounded form, short head, and very dark green back. It is common in shallow water (20-40 feet) in such bays as Ombabika, Windigo, and Gull, but is not uncommon in deeper water (100 feet) in other parts of the lake in the neighbourhood of shallow areas. Most of the specimens secured have been under ten inches in length and of very slender form, but in some places specimens up to nearly a foot in length have been taken and some of them have comparatively deep bodies.

LEUCICHTHYS HOYI (Gill)

BLOATER

PLATE V

Body usually slender, occasionally rather deep, moderately compressed, width 8.0 [6.9 (7.5-8.5) 9.8]; depth 4.4 [4.1 (4.3-4.5) 4.9]; head long 4.0 (3.8-4.2); eye 3.8 (3.6-4.2); snout approximately equal to eye; interorbital 4.8 (4.4-5.2); maxillary 2.5 (2.3-2.7); lower jaw usually longer than upper, a hook or protuberance near its tip; caudal peduncle long and slender, its length 2.2 [(1.9-2.3) 2.6] in head, its depth 1.7 (1.4-1.9) in its length.

A very silvery species, pale greenish above, a purplish iridescence along sides a short distance above the lateral line; fins usually unpigmented except for the dorsal and caudal which are often dark edged.

Fins long; dorsal with 9 to 11 rays, its base 2.4 [2.0 (2.2-2.6) 2.8] in head and 1.8 (1.6-2.0) in its own height; anal with 11 or 12 rays, its base 2.3 (2.1-2.4) in head and 1.1 (0.9-1.3) in its own length; pectoral length 1.3 (1.1-1.4) and ventral 1.3 (1.1-1.4) in head, but ventral usually very slightly shorter than pectoral; distance from insertion of pectoral to ventral insertion 3.1 [2.9 (3.0-3.2) 3.4] in total length; adipose long and narrow; scales 7 or 8—71 (66+76)—7 or 8; gill rakers 16+26 (14+24—16+29). Length 9 inches.

Hoy's cisco is characterized especially by its small size, light, silvery coloration, long narrow caudal peduncle, the ventral contour between the ventral and caudal fins almost a straight line, symmetrical with the dorsal contour behind the dorsal fin, the posterior portion of the body being thus long wedge-shaped. The head is rather sharply triangular as viewed from the side, the dorsal and ventral surfaces being almost straight lines. The projecting lower jaw, with a hook or protuberance in the mid-line near its tip, is also a characteristic feature of the species. The fins are all long, the dorsal especially high in comparison with the length of its base, the caudal long and deeply forked.

It is restricted to comparatively deep water (15 to 55 fathoms). It perhaps does not go as deep as *L. nigripinnis;* on the other hand, it does not frequent as shallow water as the Black-fin, apparently finding conditions in such shallow bays as Ombabika beyond its range of tolerance. It therefore appears to have the most limited vertical range of any of the species of ciscoes inhabiting Lake Nipigon. It is very fragile, the scales easily detached and the whole fish

soon going to pieces in the nets. Considerable numbers become entangled in the nets of the commercial fishermen, and those which have not gone to pieces when the nets are lifted have the abdomen greatly distended, hence their popular name "Bloats".

LEUCICHTHYS ZENITHICUS (Jordan and Evermann)

LONGJAW

PLATE VI

Body rather elongate, compressed, width 8.7 (8.1-9.8); depth 4.2 [3.8 (4.1-4.3) 4.4]; head 4.1 (3.8-4.3); eye 4.2 [3.6 (4.0-4.5) 4.8]; snout considerably longer than diameter of eye, 3.5 (3.4-3.6); interorbital 4.5 [4.2 (4.4-4.6) 5.0]; maxillary 2.6 (2.4-2.9); length of caudal peduncle 1.9 (1.7-2.2) in head, its depth 1.7 [1.3 (1.6-1.9)] in its own length; dorsal fin with 10 or 11, rarely 9 rays, its base 2.2 (1.9-2.4) in head and 1.5 [(1.4-1.5) 1.8] in its own height; anal with 11, occasionally 10 or 12 rays, its base 2.4 (2.2-2.6) in head and 1.1 (1.0-1.2) in its own height; pectoral length 1.5 (1.4-1.6) and ventral 1.5 (1.4-1.7) in head; distance from insertion of pectoral to ventral insertion 3.2 (3.0-3.4) in total length; scales 7 or 8—70 (65—75)—7 or 8; gill rakers 13+24 [12+21 (13+22—13+25) 15+27]. Length 12 inches.

LEUCICHTHYS REIGHARDI Koelz

REIGHARD CISCO

PLATE VII

Body fusiform, little compressed, width 7.8 [7.1 (7.5-8.0) 9.1]; depth 4.0 [3.7 (3.8-4.1) 4.4]; head long 3.9 (3.8-4.1); eye 4.3 (4.0-4.6); snout 3.4 (3.3-3.6); interorbital 4.0 [3.5 (3.8-4.3) 4.5]; maxillary 2.6 (2.4-2.7); length of caudal peduncle 2.1 [(1.9-2.2) 2.4] in head, its depth 1.5 (1.3-1.7) in its own length; dorsal fin with 10 or 11, rarely 9 rays, its base 2.2 [(2.1-2.3) 2.4] in head and 1.5 [1.3 (1.4-1.6) 1.7] in its own height; anal with 10 to 12 rays, its base 2.3 [(2.1-2.5) 2.6] in head, usually equal to or slightly greater than its own height (occasionally less); pectoral length (1.4) 1.5 or 1.6 (1.7) and ventral 1.6 (1.5-1.7) in head; distance from insertion of pectoral to ventral insertion 3.2 [(3.0-3.3) 3.6] in total length; scales 7 to 9—66 (62-72)—7 or 8; gill rakers 12+22 [11+19 (12+21—14+22) 14+24]. Length 13 inches.

This and the preceding species are quite similar in appearance. Both are medium-sized, light-coloured fish with long heads. The premaxillaries approach the position of the

premaxillaries in *Coregonus*, often making an angle of only 15° or 20° with the vertical. In life they are light olive or buffy green above, preserved specimens straw-coloured. The fins, except for the outer half of the dorsal and caudal, are usually without pigment.

Beyond these points of similarity the species are widely different. *Zenithicus* is the most compressed of the six species, *reighardi* much heavier, being quite wide and a little deeper; *reighardi* has a longer, wider and deeper head. The head of *zenithicus* is more pointed, the upper and lower surfaces more nearly straight lines than are those of *reighardi*, and the premaxillaries slightly less vertical. In *reighardi* there is a tendency for the isthmus and branchio-stegals to bulge below. In the latter species the interorbital space is relatively much greater than in *zenithicus*, the caudal peduncle shorter and deeper and the caudal not so deeply forked or so wide-spreading. *Reighardi* further has a shorter adipose, fewer gill rakers, fewer scales in the lateral line, and is usually a little darker above, although the tips of the dorsal and caudal fins in *zenithicus* may be darker than those of *reighardi*. *Zenithicus* is taken in the deeper water, some specimens coming from below 50 fathoms. The average depth at which our specimens have been taken is about 20 fathoms as compared with 15 or 16 in the case of *reighardi*. *Reighardi*, however, is the larger fish not only on account of its stouter body, but because it also grows to a greater length.

FAMILY SALMONIDAE

A. Vomer with a raised crest extending backward from the head of the bone, free from its shaft, this crest armed with strong teeth; hyoid bone with a broad band of strong teeth; species spotted with gray, without bright colours..... **Cristivomer**

AA. Vomer without raised crest, only the head being toothed; hyoid bone with weak teeth or none; species red spotted, the lower fins with bright edgings..... **Salvelinus**

CRISTIVOMER NAMAYCUSH (Walbaum)

LAKE TROUT

Body stout and moderately elongate, width 7.7 [(7.1-8.5) 10.0];* depth 4.5 (3.9-5.2); head stout, flat above, its length 3.7 (3.4-4.0); eye 6.8 [5.2 (6.0-7.5) 9.2]; snout 3.1 (2.6-3.4); mouth large, maxillary 1.8 (1.6-1.9) in head, extending considerably beyond a vertical through the eye; interorbital 3.7 (3.3-4.0); length of caudal peduncle 1.9 (1.6-2.3) in head; its depth 1.8 (1.6-2.1) in its own length.

Colour and markings vary widely; typically dark greenish or gray above, lighter on the sides, the green absent below the lateral line; belly white; sides with many light spots, the spots varying in size on different fish. On some they are about the size of 3 to 6 scales, on others they equal the area of 12 to 15 scales, spots smaller or absent on upper sides and back. On some specimens the spots on the back coalesce into elongate areas of various irregular shapes, often giving an appearance approaching vermiculations. Dorsal and caudal dusky with many rounded lighter spots; other fins plain or dusky; pectoral usually dusky and often partly marked with spots of lighter; cheeks and opercles marked similarly to sides, the lighter spots often coalescing to form elongate markings. Many specimens show little green, being merely grayish and varying from light gray to very dark; others are distinctly brownish, and have the lower fins tipped with salmon or orange.

Dorsal fin with 8 to 10 and anal with 8 or 9 divided rays, preceded by 1 or 2 fully developed undivided rays and one or more shorter rays, scales small 31 to 33–180 to 202–28 to 34.

The lake trout stands second in point of commercial importance of the lake Nipigon fishes. The total catch for the years 1918 to 1922 inclusive was 2,205,544 lbs.

In spring and early summer it is not taken in quantities by the fishermen in their gill nets, but later in the summer and in early autumn is caught in increasing quantities, chiefly at depths of 7 to 12 fathoms. Considerable numbers are also taken in pound nets. As spawning time approaches it moves into shallower water, finally being taken in very shallow water on the spawning beds. Spawning occurs on rocky or gravelly shoals, usually between October 1 and October 30. After spawning, it moves out into deep water,

*These averages are based on the measurements of 20 specimens of 60 cm. (26 inches) in average length, ranging from 30 cm. (13 inches) to 96.7 cm. (41¼ inches).

and is not taken in numbers again in the gill nets until the following summer.

That lake trout are not taken in gill nets in any quantity during a considerable part of the season is probably due to the fact that their habitat is much less a bottom one than that of the whitefish, for instance. The whitefish is largely a bottom-feeder, whereas ciscoes, which are plankton feeders, constitute the chief food of the trout. In only one case have we found whitefish in the stomach of a lake trout.

While lake trout are not taken on the bottom in the deeper waters of Lake Nipigon it appears that deep water is a necessity in a trout lake. The species is absent from Gull bay and Ombabika bay, both shallow bays having narrow connections with the lake.

The fishermen state that trout have improved in quality since the lake has been open to commercial fishing. The trout taken during the first two or three seasons are said to have been long and thin, with a very large head in proportion to the weight of the fish. Gradually, it is said, they have become heavier and deeper, and the change is attributed to the relative improvement in the food supply through the reduction in their numbers. The siscowet variety characteristic of the deep water of Lake Superior (Jordan and Evermann, 1911) does not occur in Lake Nipigon, one fisherman stating that he had seen only one or two specimens approaching this type in seven seasons. The maximum weight attained appears to be about 45 pounds.

The question of the existence of varieties or races of trout has received very little attention. It is said that there exists in Lake Nipigon a sort of lake trout known locally as "black trout," which ascends some of the rivers, notably the Sturgeon river, at spawning time. This form is described as being very dark in colour and of medium size, seldom attaining more than four or five pounds in weight. They have not been recognized in the lake during the summer, which suggests that their dark colour may be assumed on entering the dark river water. It is a fact, however, that very dark trout, all of medium size, do enter the Sturgeon river at spawning time

in large numbers. They also spawn earlier than the trout which spawn in the lake, usually beginning about September 20.

The fishermen recognize a third variety, which they call "deep water trout," and which are said not to come into water of less than 20 fathoms. They are believed to spawn between October 20 and November 10 at depths of 20 to 30 fathoms.

The lake trout is found throughout the Great Lakes region and in inland lakes northward to the Arctic. In the United States it occurs in northern New York, New Hampshire, and Maine, and in a few localities in the Western States.

SALVELINUS FONTINALIS (Mitchill)

SPECKLED TROUT

Body moderately elongate, width 7.7 (6.9-8.8); depth 4.2 (3.6-4.7); head large, its length 4.2 (3.8-4.5); snout somewhat obtuse, 3.4 (3.0-4.0); eye 5.6 (4.5-7.0), usually about 5.5 in specimens 15 inches in length, smaller in larger specimens and proportionately larger in smaller specimens; mouth large, maxillary 1.7 (1.5-1.8), reaching considerably beyond the eye; interorbital 3.1 (3.0-3.2); length of caudal peduncle 1.4 (1.3-1.5) in head, its depth 1.6 (1.5-1.7) in its own length.

General coloration above, very dark olive green; sides lighter with silvery lustre in some lights; back with darker to almost black vermiculations; sides with rounded olive green spots many of them with red centres surrounded by blue borders; lower sides pinkish; belly white; top of head dark olive green with irregular darker lines; cheeks and opercles olivaceous with iridescent reflections; dorsal fin olive green with darker vermiculations, caudal and lower fins pinkish or orange-coloured with dusky markings; anterior margins of lower fins white. Specimens from dark brown water such as occurs in many streams, brownish olive above, lower sides brownish to salmon-coloured and with a dark band between this colour and the white belly. A specimen 6½ inches long, taken on September 10, 1923, in Trout Creek, had seven broad dark blue vertical bands or parr marks, reaching half the distance between the lateral line and the mid-dorsal line, and the same distance below the lateral line. In two other specimens, 7¾ and 9½ inches long respectively, taken the same day in the same locality, the parr marks were also apparent although fainter, especially in the larger specimen in which they were very faint.

Dorsal fin with 8 or 9, and anal with 7 or 8 divided rays; preceding the divided rays in each case are 1 or 2 fully developed undivided rays and one or more shorter rays; scales very small, more than two hundred in the lateral line.

The Nipigon region is world famous for its speckled trout. Wright (1892) stated that "in the Nipigon fish [speckled trout] up to seventeen pounds in weight have been secured," but the largest specimen taken in recent years weighed 14½ pounds. It was caught by Dr. J. W. Cook of Fort William, Ont., in Rabbit Rapids, Nipigon river, in 1915, and was two feet ten inches in length.

Following is a list of the winners of the "Nipigon trophy" and the weights and lengths of the winning fish for each of the past seven seasons. This trophy is donated by the Hotel Department of the Canadian National Railways for annual competition by tourists for the largest speckled trout caught in the Nipigon waters.

1918, W. W. Butler, Montreal, P.Q., 6½ pounds, 25½ inches.
1919, A. S. Brown, Kingsville, Ont., 6¼ pounds, 24½ inches.
1920, W. H. Jessup, Syracuse, N.Y., 7½ pounds, 29½ inches.
1921, W. G. H. Browne, Toronto, Ont., 7 pounds, 24 inches.
1922, C. E. Abbott, Bessemer, Ala., 7 lbs. 9 oz., 27 inches.
1923, W. D. Randall, Hamilton, Ohio, 7½ pounds, 26½ inches.
1924, Robt. Bell, Port Arthur, Ont., 7 lbs. 9 oz., 27½ inches.

Speckled trout occur in many places in the lake and in many of the streams entering the lake, but they are fished for chiefly in the Nipigon river. Most of the specimens that have won the "Nipigon Trophy" have been taken just above Virgin Falls, which is two or three miles below the source of the river. Many of them have been caught on a "Cockatouch,"* but fly fishing is also practised, the favourite flies being No. 2, Silver Doctor, Parmacheen Bell, Montreal, Professor, and Jock Scott.

The regions where good trout fishing is still to be had are annually growing fewer, and efforts to restock streams that once supported speckled trout often give disappointing results. There has been a great deal of speculation as to the exact nature of its requirements, but very little definite information on the subject is at hand. Hankinson's (1922)

*The local name for the miller's thumb (**Cottus cognatus**).

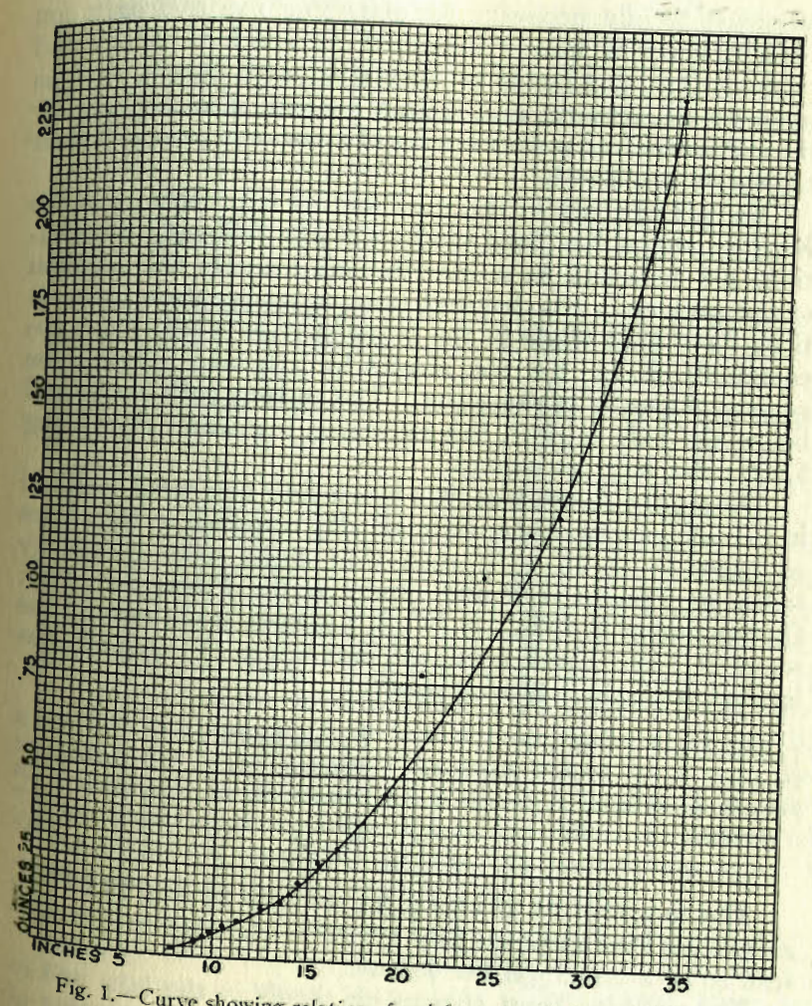

Fig. 1.—Curve showing relation of weight to length in speckled trout.

recent study of the habitat of the brook trout in Michigan is one of the few systematic studies of the question that has been made. Coker (1925) in a recent paper has drawn attention to the necessity for recording the hydrogen ion concentration of waters inhabited by speckled trout, and suggests that this factor in correlation with others, such as temperature, current, and oxygen content, may account for the difference in the distribution of trout and bass and their respective associates.

No special study of the trout and its requirements in the Nipigon region has been made, but the following observations are recorded as a contribution towards the solution of the problem. No chemical tests or temperature observations have been made in the Nipigon river where trout are commonly taken, but the results for the lake indicate the general character of the water. The current both above and below the falls is swift, the estimated low water flow being 5,500 cubic feet per second.

During the summer of 1922 brook trap-nets were operated in two streams near Macdiarmid. By reference to the tables on pages 18 to 21, it is seen that trout were commonly taken in Trout Creek and rarely in the Pustagone river. On September 3, 1923, Dr. W. A. Clemens made tests of the water of Trout Creek near the point where the trap-net was located, with the following results:

Temperature	10.5° C.	Carbon dioxide	3.5
Oxygen	7.8 c.c. per litre	Bicarbonate	93
Per cent. saturation of oxygen	98	Total acidity	10
		pH	7.7
		Colour*	118

The temperature at this point on July 16 was 13.25° C., and in the Pustagone on July 17, 22° C., so that the latter is seen to be a much warmer stream.

The speckled trout spawns on shoals in the lake and in streams usually towards the end of October or beginning of November.

*Determined by use of a U.S. Geological Survey standard colorimeter.

ESOX LUCIUS Linnaeus

THE PIKE

Body elongate, and moderately compressed, width 8.6 [(8.0-9.0) 10.1]; depth 5.8 [4.8 (5.3-6.4) 6.9]; head long, 3.5 (3.3-3.7); snout long, broad and flattish 2.3 (2.2-2.5), the lower jaw projecting; mouth large; eye 8.8 (8.3-9.3), one specimen 43 inches long had eye 12 in head; interorbital 4.8 (4.6-5.1); length of caudal peduncle 2.4 (2.0-2.7) in head, its depth 1.9 (1.7-2.3) in its own length; dorsal fin placed far back, with 17 or 18 developed rays preceded by 2 or 3 shorter rays; its base 2.2 (2.0-2.4) in head, its height 1.3 (1.0-1.5) in its own base; anal with 14 (13-16) developed, and 2 or 3 rudimentary rays, its base 2.9 (2.4-3.3) in head, its height usually somewhat greater than base but sometimes slightly less; pectoral length 2.5 (2.3-2.9) and ventral 2.6 [(2.4-2.8) 3.2] in head; scales 14 (13-16) – 124 (118-130) – 14 (12-16).

The pike is found in the rivers, and during the spring and early summer in shallow water in the lake, especially in weedy bays. Here it feeds on the smaller fish inhabiting such situations, but does not scorn anything in the way of animal food that comes within its reach, as is attested by the variety of creatures that have been found in its stomach. In Lake Nipigon the most unusual thing we have found it to have eaten was a mole shrew (*Blarina brevicauda*). In late summer, in common with the pike perch, it resorts to deeper water, being commonly taken in the fishermen's nets at depths of 60 to 75 feet. Occasionally specimens are taken from water over 100 feet deep. The fish is of some commercial importance, but the total shipments are comparatively small. In the neighbourhood of the summer hotel at Orient Bay village the pike is sought to some extent as a game fish. The largest specimen caught in our nets measured 43 inches, but larger specimens are sometimes taken by commercial fishermen. A specimen weighing 34 pounds was taken by an angler near the foot of Orient bay in 1924.

Ripe males and females were taken in the Sturgeon river on May 29, 1922, but it is probable that most of the pike had spawned before that date. The young have been occasionally taken in the seine in reedy bays and in the trap-net in the Pustagone river.

The pike is found throughout northern Europe and Asia

as well as in North America. On this continent it ranges from Pennsylvania to the Arctic, but is apparently confined to the mainland, no specimens having been reported from the Arctic islands.

FAMILY GASTEROSTEIDAE

A. Dorsal spines 4 or 5, in a straight line..... **Eucalia**
AA. Dorsal spines 8 to 11, not in a straight line..... **Pungitius**

EUCALIA INCONSTANS (Kirtland)

BROOK STICKLEBACK

Body less elongate than in the next species, rather compressed, width 7.5 (6.5-8.1); depth 5.3 (4.7-5.5) in specimens over 5 cm. in length, 4 to 5 in smaller ones; head 3.4 (3.2-3.6); eye 3.9 (3.5-4.0); snout approximately equal to eye; mouth very oblique; caudal peduncle comparatively stout, not keeled, its length 1.9 (1.6-2.3) in head, its depth 3.3 (2.8-3.6) in its own length; dorsal fin with 5 or 6 spines and 9 or 10, rarely 11 soft rays; first dorsal spines shorter than those behind; some specimens from the small lake near Fairloch with the first two or three dorsal spines reduced to mere sharp protuberances, sometimes all traces of the first entirely lost; anal with one spine and 9 or 10, rarely 8 soft rays; anal spines longer than dorsal spines; body without scales or plates.

Under the name *Gasterosteus pygmaeus*, Agassiz (1850) described, from Lake Superior, a stickleback which he took to be "the true pigmy of the genus." One of his specimens was less than eleven-sixteenths of an inch in length, the other two, one-quarter of an inch each, and he apparently considered this the maximum size attained. Eigenmann (1887) considered Agassiz's pigmy as a variety of *Eucalia inconstans*. More recently Wagner (1910) has shown that the Lake Superior form is not different from the typical *Eucalia inconstans*. The Lake Nipigon fish is also evidently of the typical form.

This species is not nearly so abundant nor so widely distributed in the lake as the next, and does not seem to find conditions so suitable as in some of the neighbouring smaller lakes. The largest specimen obtained in Lake Nipigon measured 4.4 cm., whereas in a small lake near Fairloch specimens measuring 6.4 cm. were secured. Its only associate

in the latter lake was *Pimephales promelas*. It was also found in Station lake, but in much smaller numbers and of a smaller size. Here its associates were *P. promelas*, *Margariscus margarita nachtriebi*, *Pfrille neogaeus*, and *Catostomus commersonii*. In Lake Nipigon it is generally confined to small, well-protected bays that support some vegetation, and here it has been taken most commonly in association with the tessellated darter, yellow perch, young of the common sucker, spot-tailed minnow, Iowa darter, and nine-spined stickleback. Numbers have been seen in small rocky basins near shore, in which considerable aquatic vegetation had become established. Its food consists of midge and caddis larvae, ostracods, *Eurycercus lamellatus*, *Sida crystallina*, etc. Spawning occurs about the same time as in the nine-spined stickleback.

This species has been found throughout Canada east of the Rocky Mountains. In the United States it occurs as far south as Central Ohio and in the basin of the Missouri to Kansas, but it is typically a northern species.

PUNGITIUS PUNGITIUS Linnaeus

NINE-SPINED STICKLEBACK

Body slender and somewhat compressed, width 8.5 (6.9-10.0); depth 6.0 (5.2-6.8); head 3.9 (3.7-4.2); eye 3.5 (3.2-4.0); snout 3.3 (3.2-3.5); mouth oblique; interorbital narrow, 6.2 (5.2-7.2); caudal peduncle long and slender, strongly keeled laterally, its length 1.4 (1.3-1.5) in head; dorsal spines 9 to 11, usually 9; rays of dorsal 8 to 11, usually 9; anal with one spine and 9 (rarely 10) rays; anal spine longer than dorsal spines; pectoral length 1.6 (1.5-1.7) in head; ventral spines weakly serrulate, their length 2.9 (2.5-3.4) in head.

This species is more typically northern and more widely ranging than the preceding, being found in Northern Europe and in North America as far south as the Great Lakes region. It occurs in both fresh and brackish water. In Lake Nipigon it is one of the most abundant of the smaller fishes, and appears to form no inconsiderable part of the food of the pike perch. It is also eaten by speckled trout, lake trout, yellow perch, and ling, but we have not found it in the stomach of the pike. Although commonly taken in sheltered bays, it is also found in more exposed situations and ranges

freely in the open water. Specimens with nearly ripe eggs were taken on June 20, 1922, and July 4, 1924.

Northward it is often of considerable importance on account of its extreme abundance. Richardson (1836) records that "in 1820 many sledge loads were taken from a small pond in the vicinity of Cumberland House for the purpose of feeding the dogs," and Bean (1903) says that "notwithstanding its small size this fish serves a very useful purpose as food for the salmon and trout, and Arctic explorers have utilized it in vast numbers for feeding their dogs."

FAMILY PERCOPSIDAE

PERCOPSIS OMISCO-MAYCUS (Walbaum)

TROUT PERCH

FIG. 2, PLATE VIII

Body elongate, scarcely compressed, tapering posteriorly; width 5.7 [4.3 (5.2-6.4)]; depth 4.3 (4.0-4.7), greatest depth about midway between head and insertion of dorsal fin; ventral surface of body in region between isthmus and ventral fins flattened and broad, gradually tapering posteriorly; head conical 3.4 (3.1-3.7); eye placed high 3.9 (3.5-4.3); snout 2.5 (2.3-2.7); interorbital 4.1 (3.8-4.4); mouth small, slightly inferior; caudal peduncle long and slender, its length 1.2 (1.1-1.3) in head; its depth 3.0 (2.5-3.3) in its length.

Colour above, brownish straw-coloured; below the lateral line, pearly with purplish reflections; ten or eleven rounded dark spots along lateral line; another series of six or seven smaller dark blotches between this and the dorsal surface and a few dark areas on the mid-dorsal line, especially in front of and behind the dorsal and adipose fins.

Dorsal fin with one weak spine (usually one and sometimes two smaller rudimentary spines) and 11 rays (occasionally 9, 10, or 12); inserted almost directly over the ventrals, its base 1.5 (1.4-1.7) in head; the longest ray approximately equal to the base of the fin; anal with one spine (and occasionally a rudimentary spine) and 5 to 7, usually 6 rays; its base 3.3 (3.0-3.7) in head, and 1.5 (1.4-1.6) in its own height; pectoral length 1.3 (1.2-1.4) and ventral 1.8 (1.7-2.0) in head, caudal deeply forked; scales 6 to 8—51 (48-54)—7 to 9.

Most of our specimens of the trout perch were taken in streams, chiefly at spawning time. By reference to the brook trap-net record on pages 18 to 21, the numbers so taken and the dates when they were running in largest numbers in the different years may be found. It is evident from these records that spawning in such a stream as the Pustagone river occurs towards the middle of July. In Trout Creek, where the water is considerably colder, the largest run of spawning fish occurs later. In the lake, trout perch have been taken in the seine on a few occasions, chiefly in shallow, well-protected bays over sandy or gravel bottoms, but only in Humboldt and Ombabika bays have any considerable numbers been taken in this way. Specimens have also been found in the stomachs of pike, ling, sauger, lake trout, and speckled trout. Its food consists chiefly of insect larvae and amphipoks.

The trout perch is found throughout the Great Lakes region and northward to Hudson bay.

FAMILY CENTRARCHIDAE

MICROPTERUS DOLOMIEU Lacépède

SMALL-MOUTHED BLACK BASS

The black bass did not occur in Lake Nipigon before its introduction in 1920. In that year a few parent fish were placed in the lake at the very end of Orient bay. A much larger number was planted at the same time in Keemley lake, two miles south of Orient bay. The bass have bred in Lake Nipigon, young of the year being taken on July 18 and August 15, 1921, July 21, and August 3, 1922, and July 31, 1923; and Mr. Neil McDougall, Sportsmen's Representative of the Canadian National Railways, took a four-pound bass in Orient bay during the summer of 1924.

This species is native to Black Sturgeon lake and to Bass lake, a small lake which drains into Nipigon river near Alexander portage. In the latter it is associated with the speckled trout, but it is not usual to find these two species together, at least in this region. In fact the bass is not a characteristic fish of the district, whereas Nipigon and speckled trout are almost synonymous in the minds of many sportsmen.

FAMILY PERCIDAE

A. Preopercle distinctly serrate; pseudobranchiae well developed; branchiostegals 7.
  B. Canine teeth on jaws and palatines; body elongate.....**Stizostedion**
  BB. No canine teeth; body compressed.....**Perca**
AA. Preopercle entire or nearly so; pseudobranchiae small or wanting; species of small size.
  C. Cranium broad between eyes; snout long, pig-like, projecting beyond the inferior mouth.....**Percina**
  CC. Cranium narrow between the eyes; snout pointed or blunt; projecting very little or none beyond the terminal or nearly terminal mouth.
    D. Premaxillaries protractile.....**Boleosoma**
    DD. Premaxillaries not protractile.....**Etheostoma**

GENUS **STIZOSTEDION** RAFINESQUE

A. Spinous dorsal with 2 or 3 rows of large black spots; pyloric caeca 4 to 7.....**canadense**
AA. Spinous dorsal with a large black blotch on last two membranes; pyloric caeca 3.....**vitreum**

STIZOSTEDION VITREUM (Mitchill)

YELLOW PICKEREL; PIKE PERCH; DORÉ; WALL-EYED PIKE

Body elongate, rounded, scarcely compressed, width 6.8 (5.8-7.3); depth 5.0 (4.5-5.5); head conical 3.5 (3.1-3.8); eye 5.6 (5.0-6.4); snout 3.5 (3.3-3.6); interorbital 5.6 (5.2-6.2); length of caudal peduncle 1.4 (1.3-1.6) in head, its depth 2.7 (2.6-2.9) in its own length.

General coloration a very dark greenish, nearly black on the back, the sides with many greenish yellow or golden areas.

Spinous dorsal fin usually with 14 spines, sometimes 15, rarely 13; second dorsal with 19 or 20, occasionally 21 rays, base of spinous dorsal usually slightly longer than head, but occasionally shorter, the longest spine 2.2 (2.0-2.5) in length of base; base of second dorsal considerably shorter than base of spinous dorsal, its height 1.9 (1.7-2.0) in its own base; anal II, 12 or 13, rarely 11, its base 2.3 (2.0-2.5) in head, its height approximately equal to its own base; pectoral length 1.9 (1.8-2.1) in head, ventral usually slightly longer than pectoral; scales 11 or 12—86 (80-91)—14 to 16; pyloric caeca 3.

Cheeks usually with fine scales above and immediately behind eye and naked below and behind; often finely scaled except for a small naked patch

behind; sometimes completely scaled; opercles usually completely covered with larger scales; preopercles finely serrate behind, coarsely toothed below.

The pickerel, as it is locally called, is not an abundant species in the lake. It is usually taken in shallow water, most of our specimens being taken at depths of from ten to twenty feet. Here it feeds on such small fishes as sticklebacks, miller's thumbs, darters, young ciscoes, etc., occasionally varying its diet with quantities of mayfly nymphs. During late August and September it migrates into much deeper water (60 to 90 feet), and it is then that it is most frequently taken by the gill-net fishermen. Here it apparently lives almost entirely on young ciscoes, chiefly *L. zenithicus* and *L. nigripinnis*.

The young have been taken on a number of occasions in our seine, usually over a sandy bottom, where its most common associates are the tessellated darter, the perch, and the young of the common sucker.

Spawning occurs in May or early June, usually in streams, although some are said to spawn in shallow sandy bays. Considerable numbers of pike perch are to be found in some streams, especially in their lower reaches during early summer, but as midsummer approaches they gradually migrate into deeper water, as noted above.

The pike perch is said to reach a weight of 25 pounds in other waters, but the largest specimen of which we have record in Lake Nipigon measured 27½ inches and weighed 8½ pounds. Its qualities as a game fish are not here highly esteemed because in that capacity it is so far surpassed by the famous Nipigon speckled trout.

It is a common fish in the rivers and lakes of Canada from New Brunswick to Great Slave Lake. It is predominantly a northern species, but has been reported in the United States as far south as Georgia, Alabama, and Arkansas. In the Great Lakes it is one of the most valuable of commercial species.

STIZOSTEDION CANADENSE (Smith)

SAUGER

Body slender, little compressed, width 6.7 [5.6 (6.2-7.1)]; depth 5.4 [4.5 (5.2-5.6) 6.2]; head more flattened above than in the preceding species, its length 3.4 (3.2-3.6); snout 3.5 (3.3-3.6); eye 5.6 [4.9 (5.3-6.1)]; interorbital 5.4 (5.1-5.6); length of caudal peduncle 1.4 (1.3-1.5) in head, its depth 2.8 (2.7-2.9) in its own length; spinous dorsal fin with 13 or 14 spines; second dorsal with 18 or 19 rays, rarely 16 or 17; base of spinous dorsal usually slightly shorter than head, the longest spine 2.2 [1.8 (2.1-2.4) 2.6] in length of base; base of second dorsal much shorter than base of spinous dorsal, 1.5 (1.3-1.8) in head, its height 1.7 (1.4-1.9) in its own base; anal II, 12, occasionally 11 or 13; its base 2.3 [2.0 (2.2-2.5) 2.8] in head, its height usually less than its base; pectoral length 2.0 (1.8-2.1) in head, ventral usually shorter than pectoral; scales 11, sometimes 10 or 12—86 (83-92)—12 to 16; cheeks and opercles scaled, the scales on the cheeks small; pyloric caeca 4 to 7; of 50 specimens examined for this character, 23 had 4 caeca, 20 had 5, 6 had 6 and 1 had 7.

The sauger is practically confined to the shallower parts of such bays as Humboldt, Ombabika, Windigo, and Wabinosh. Outside of these localities it has been taken only a few times. In these northern bays, however, it appears to be excessively abundant, as some of our catches of saugers here have exceeded our catch of any other species of fish in any part of the lake. It is a much smaller fish than the pike perch, our largest specimen being 17 inches in length. Most of our specimens have been taken in the two-inch gill-net; none in the 4½ inch mesh. On this account it is not taken by the fishermen. We have taken more specimens in water up to twenty feet in depth than at greater depths, although considerable numbers have also been taken at forty to fifty feet and a few at over sixty feet.

A ripe female 14 inches in length was taken in the Gull river on June 3, 1922. Most of the specimens taken in Windigo bay on July 26, 1923, had fed on mayfly nymphs, but small fishes constituted the principal item of the food of those taken elsewhere.

The species ranges from the St. Lawrence through the Great Lakes, in the Mississippi valley, westward to Montana and south to Tennessee and Arkansas.

PERCA FLAVESCENS Mitchill

YELLOW PERCH

Body oblong, moderately compressed, width 5.7 (5.3-6.1); back arched, deepest just behind insertion of dorsal fin; depth 3.8 (3.7-3.9); head 3.2 (3.0-3.3); eye 6.0 (5.5-6.3); snout 3.3 (3.1-3.5); length of caudal peduncle 1.6 (1.5-1.8) in head; its depth 2.2 (2.0-2.3) in its own length. These measurements apply to specimens more than 19 cm. in length to base of caudal. The perch taken in the main body of the lake, however, are of smaller size and differ from those described above in being slimmer, depth 4.2 (3.8-4.5); with longer head, 3.3 (3.1-3.4), and larger eye, 4.7 (4.4-5.0); first dorsal with 12 or 13 spines, its base approximately equal to head, its highest spine 2.2 (2.1-2.6) in its own base; second dorsal with 3, rarely 2, spines and 12 or 13 soft rays, its base 1.7 (1.6-1.8) in head and its height 1.5 (1.4-1.7) in its own base; anal with 2 spines and 8, rarely 7 rays; its base 2.9 (2.8-3.2) in head and its height 0.8 or 0.9 in its own base; scales 7 or 8—57 (54-61)—12 to 15. The smaller perch are decidedly green in colour, whereas the larger fish taken in northern bays are more yellowish.

In many of the smaller, sheltered bays in the southern end of the lake, especially near the foot of Orient bay, the perch occurs in great numbers, as many as 1,760 having been taken in one haul of perhaps 40 yards with a 50 foot seine. There are no large perch, however, in this part of the lake. The largest perch taken in the main body of the lake measured less than 6½ inches; none has been taken in our gill-nets, which include a length of 1½ inch stretched mesh. In the northern bays such as Humboldt, Windigo, and especially Ombabika, they are regularly taken in the 1½ and 2 inch gill-nets, the largest specimen secured measuring 10½ inches in length.

A similar difference in the size of perch taken in the same or neighbouring bodies of water has been referred to by Wagner (1910), Parker (1920), Birge (1923), and others. Wagner cites the occurrence of perch in Lake Mendota and Lake Monona in Wisconsin. Lake Mendota, the larger lake, contains a very large number of perch per unit area, but they are all small. Lake Monona, a smaller and somewhat shallower body of water, but freely connected to Mendota, which flows into it, contains a very much smaller number of perch, but they average twice as large in size.

Wagner's suggestion as to the reason for this difference is

as follows: Lake Mendota (for reasons unknown, although a greater relative plankton content is thought to play a part) may be more favourable for the hatching of perch spawn and the adequate nourishment of the young perch, as well as for their protection, or freedom from enemies. The absence of *Stizostedion* is suggested as a factor here. As a consequence, a relatively large proportion of the eggs laid develop to a stage where the perch need larger organisms for food. This very abundance of young perch brings about a struggle for the food supply, a struggle which results not so much in the extinction of the weaker individuals, but in a reduction of the amount of food obtained by each individual and hence a reduction in the rate of growth. In Lake Monona, on the other hand, it is supposed that the conditions for the development of perch eggs, and for the proper nourishment of young perch and their immunity from enemies is much less favourable. Hence a much smaller number, as compared with the number of eggs laid, reach the stage where larger food is taken.

Parker's example is drawn from two ponds situated about thirty miles southwest of Albany, N.Y. He says: "In the four or five years I have gone to this locality I have invariably caught very small perch in the large pond and large ones in the small pond. In fact, with one exception, I have never caught anything over six or seven inches long in the large pond, and never caught anything as small as this in the small pond." The species which he knows to inhabit the two ponds are: small pond—perch, pickerel, sunfish; large pond—perch, pickerel and a few black bass.

Birge's suggestion as to why the perch of Lake Mendota are so small is somewhat similar to that of Wagner. He states that in 1883 or 1884 there was an enormous mortality of the perch in Lake Mendota and that the perch that died were decidedly larger than those now found in the lake. His theory is that the epidemic did not affect the small perch, and that the death of the larger fish, which prey upon the small ones, enabled great numbers of the young to survive, but as the food supply was insufficient for this

greatly increased number, they did not reach the size attained in lakes where there has been a natural depletion of the smaller fish from year to year.

The condition found in Lake Nipigon corresponds to that occurring in the two sets of lakes cited above in that the perch are small in the large lake and much larger in Ombabika bay, which, by reason of its narrow connection with the main lake, might almost be considered as a separate body of water. This difference in the size to which perch grow is only one of the differences apparent between the fish life of Ombabika bay (and to a lesser extent of other shallow and well-protected bays) and that of bays more exposed to the influence of temperature and other water conditions obtaining in the main body of the lake. These differences have been described elsewhere (pages 7 to 9), and need not here be discussed further, except to add that the conditions under which are produced larger individuals and larger numbers of such species as sauger, round whitefish, log perch, spot-tailed minnow, and lake shiner produce in the case of the perch larger individuals, but fewer numbers of them. This would seem to support Wagner's and Birge's suggestion that in one locality conditions favour the growth of the perch, but must in some way be less favourable for the hatching of the eggs or survival of the young, whereas in other localities conditions must favour the hatching of the eggs and the survival of the young, but be unfavourable for their subsequent growth. The abundance of saugers in Ombabika bay may account for the survival of fewer perch, but it is also felt that conditions, apart from the adverse influence of overcrowding, are not as favourable for the growth of perch throughout the main body of the lake as they are in certain restricted localities. The absence or partial dwarfing of other species under similar conditions would seem to support this view.

The perch is essentially a lake species, and northern in general distribution. In Canada it is found from the Atlantic to Saskatchewan, but it occurs as far south as North Carolina in the United States.

PERCINA CAPRODES (Rafinesque)

LOG PERCH

Body long, slender, spindle-shaped; width 6.8 [(6.2-7.4) 8.2]; depth 5.3 (5.0-5.7); head 3.6 (3.5-3.9); eye 4.2 (3.7-4.6), placed high; snout 2.8 (2.6-3.0), long, tapering and bluntly pointed, pig-like, overhanging the small, inferior mouth; interorbital flat, its width 4.9 (4.3-5.4); length of caudal peduncle 1.3 (1.2-1.4) in head, its depth 2.5 (2.3-2.8) in its own length; first dorsal fin with 14 or 15 spines, its base 1.1 to 1.2 in head, its height 2.5 (2.2-2.7) in its own base; second dorsal with 14 to 16 rays, its base 1.4 (1.3-1.5) in head, its height 1.6 (1.5-1.7) in its own base; anal with 11 or 12 rays, its base 1.9 (1.7-2.1) in head, its height approximately equal to its base, pectoral length 1.4 (1.3-1.5) and ventral 1.5 (1.4-1.6) in head; scales 6 to 8—79 (76-81)—10 to 12; a few pores of lateral line sometimes missing; cheeks and opercles scaled; scales absent in front of and for a short distance at sides of dorsal; breast naked; a single row of enlarged scales, coarsely toothed, on the mid-ventral line between the vent and the ventral fins, some or all of these sometimes shed. Largest specimen 3½ inches.

This species has been taken from only two or three localities in Lake Nipigon, most of our specimens from that lake being secured in Ombabika bay. It is evidently more common in Black Sturgeon lake, where we took quite a number. All our specimens were taken over rocky or stony bottoms, a few from rather swift water in Gull river and in Rapid Creek. It is a species of rather wide distribution, the northern form (*P. c. zebra*) being found in the lakes of northern Indiana, Michigan, Wisconsin, and northward, while the typical *P. caprodes* ranges south to Virginia, Kansas, Alabama, and Texas. It is the largest of the darters, in some localities attaining a length of 6 or 8 inches.

BOLEOSOMA NIGRUM (Rafinesque)

TESSELLATED DARTER

Body elongate, tapering from shoulders backwards, little compressed, width 6.9 (5.5-8.5); depth 6.0 (4.7-7.6); deepest just behind head; head short 3.9 (3.6-4.4); eyes placed very high, protruding, 3.9 (3.5-4.2); snout 3.2 (3.0-3.5); bluntly pointed, decurved, the small mouth at its lower angle; premaxillaries protractile; interorbital very narrow; gill-membranes narrowly connected, free from the isthmus; length of caudal peduncle usually slightly less than head length, its depth 2.8 (2.5-3.3) in its own length; dorsal fin with 8 or 9 spines and

11 to 13 soft rays, the spinous and soft portions narrowly separated and approximately equal in height, which is less than half the length of the head; anal with one spine and 8 to 10 soft rays; pectorals reaching beyond ventrals, their length usually slightly less than length of head; ventral length 1.6 (1.4-1.9) in head; scales 5 or 6—45 to 52—6 or 7; anteriorly some of the rows of scales above the lateral line incomplete leaving a naked patch on the nape and below the first dorsal. There are five or six rows of scales between the insertion of the second dorsal and the lateral line, one of these rows ends anteriorly under the end of the first dorsal, each row below this extends progressively farther forward until the row above the lateral line extends nearly or quite to the point of origin of the lateral line; ventral surface in front of ventral fins naked; behind ventrals sometimes closely scaled, but more often naked for a considerable distance; cheeks naked; opercles usually scaled except at the lower edge, sometimes nearly naked except for a few small scales above; lateral line begins rather high up, gradually bends down becoming median. Largest specimen 2½ inches.

This is the commonest and most widely distributed darter of the lake, occurring almost everywhere in shallow water, being often the only fish found on bare, sandy beaches. It seems to prefer a sandy bottom with some aquatic vegetation, but it is not uncommon over mud and gravel. It does not seem to be nearly so common in streams as in some situations in the lake, although a good number have been taken in our trap-nets in various streams. Forbes and Richardson (1920) found that "its preference for swift waters is not so marked as in the case of more typical darters." The darter lies on the bottom, hidden among stones or aquatic plants or buried in the soft ooze or mud. When alarmed it darts quickly for the nearest place of concealment, often burying itself in the ooze or soft mud of the bottom. Spawning occurs in June.

This species ranges from New England through the Great Lakes and northward at least as far as the Assiniboine river. In the United States it is found as far west as Colorado and Montana.

ETHEOSTOMA IOWAE Jordan & Meek

IOWA DARTER

Superficially resembles the tessellated darter both in form and colouring and often found associated with it; the saddle-shaped markings on the back smaller, paler and less distinct. Width 7.1 (6.7-7.5); depth 5.0 (4.6-5.4); head 3.7 (3.5-4.0); eye 3.7 (3.5-4.2); snout about equal to eye or a little shorter,

rather blunt, decurved, the mouth at its ventral angle; premaxillaries not protractile, joined to the forehead by a medium fleshy bridge; gill membranes narrowly connected, free from the isthmus; length of the caudal peduncle approximately equal to head length, its depth 2.9 (2.7-3.1) in its own length; first dorsal fin with 8 or 9 spines; second with 8 to 11 soft rays; anal with 2 spines and 6 or 7 rays; scales 5—57 (55-60)—7 to 9; lateral line usually slightly bowed upwards anteriorly, lacking on the posterior half or more of the body; cheeks and opercles scaled; breast naked; belly covered with ordinary scales. Largest specimen 2⅛ inches.

A specimen taken in Orient bay on September 11, 1923, was brilliantly marked with blue and red as follows: There were eleven bright rusty red vertical bands on the sides and alternating with these eleven dark blue vertical bands; the reddish bands wider above than below, the blue bands usually wider below; back crossed by eight dark saddle-shaped areas, the ground colour of the back and upper sides straw colour, the lower sides and belly yellowish; an irregular band of orange red extended from a point behind the insertion of the pectoral nearly to the anal, with splashes of the same colour around the insertion of the pectoral and extending towards the ventral; dark blue bands extended forwards from the eye and downwards below the eye and on to the opercle; opercles with splashes of rusty red, especially above; first dorsal fin blue on the lower half, above this a narrow transparent band, then a reddish band and another bluish band edged with darker; lower parts of the membranes of the second dorsal bluish, and the rays marked by short vertical streaks of rusty; caudal speckled with many short narrow brown bars; pectorals similarly marked but fainter; pectorals and anal with splashes of red. A specimen taken in a small lake on Shakespeare island, on July 8, 1924, was similarly marked, except that the blue was replaced by a deep bluish green.

The Iowa darter has been taken in Lake Nipigon in two small, well-protected bays near the foot of Orient bay and in Ombabika bay, and was the only darter found in a small lake on Shakespeare island. It has often been taken with the tessellated darter, but, unlike the latter, it does not appear to care for the more exposed situations or for running water. Whether it is the muddy bottom of these protected bays, the quieter water or some other factor or combination of factors that limits its distribution we are unable to say. Females with nearly ripe eggs were taken in Ombabika bay on June 19, 1924.

The range of this species includes the Upper Mississippi Valley and northward to Swift Current river and Fort Qu'Appelle, Saskatchewan.

FAMILY COTTIDAE

A. Gill membranes broadly united to the isthmus, not forming a fold across it..... **Cottus**

AA. Gill membranes almost free from isthmus, forming a broad fold across it; lateral line chain-like; vomer with teeth; a small slit behind last gill..... **Triglopsis**

GENUS **COTTUS*** (ARTEDI) LINNAEUS

A. Preopercular spine short and little curved, head broadly rounded in outline; lateral line normally terminating below base of second dorsal.

B. Pelvic rays constantly I, 4; palatine teeth normally present... **bairdii**

BB. Pelvic rays usually I, 3; no palatine teeth..... **cognatus**

AA. Preopercular spine long and spirally curved; head spatulate in outline when viewed from above; lateral line complete; no palatine teeth..... **ricei**

COTTUS COGNATUS Richardson

MILLER'S THUMB; FRESH WATER SCULPIN; COCKATOUCH

FIG. 3, PLATE VIII

Body spindle-shaped, stout forwards, tapering gradually to the tail; greatest width of body at point of insertion of pectoral fins, 5.2 (4.3-6.2); depth 4.8 (4.4-5.5); head 3.3 (3.1-3.4), broad, its width 1.2 (1.0-1.4) in its length; eye 4.0 (3.6-4.5); snout 3.5 (3.1-3.8); mouth wide, maxillary reaching beyond a vertical through front of orbit, occasionally through middle of orbit, lips very thick; interorbital narrow 8.3 [6.3 (6.9-9.6) 10.0]; short preopercular spine directed backwards and upwards, almost straight, sometimes slightly hooked, usually covered by skin, often one or two very small concealed spines below it; skin smooth except behind the pectorals where there is an area bearing small sharp prickles, this area sometimes extending nearly the length of the pectoral fin.

Colour brownish mottled with darker, sometimes with several dark saddle-shaped areas crossing the back, lower surface white; fins barred with brownish; first dorsal with an orange red border.

First dorsal fin with 8, sometimes 7 spines, its base 1.5 (1.3-1.7), and height 3.9 (3.0-4.8) in head; second dorsal with 16 to 18, usually 17 rays, its base 0.8 (0.7-0.9) and height 2.3 (2.0-2.6) in head; little or no space between end of first dorsal and beginning of second dorsal; anal with 12, rarely 11 or 13 rays, its base 1.1 or 1.2 and its height 2.1 (1.8-2.5) in head; ventral usually with one spine and 3 soft rays,* quite often 4 and occasionally 3 on one side and 4 on the other,

*Based on Hubbs (1919) key.

*Of twenty specimens examined, eleven had ventral rays I, 3, seven had I, 4 and two I, 3 on one side and I, 4 on the other.

its length 1.7 (1.6-2.0) in head; pectoral nearly as long as head (1.0-1.3) in head length, sometimes reaching point of insertion of anal but usually slightly short of this point; lateral line incomplete, usually ending beneath the 5th or 6th ray of second dorsal fin, but occasionally extending as far as the 12th or 13th ray. Largest specimen 3¾ inches.

This sculpin frequents creeks, rivers, and stony beaches. It lies on the bottom concealed among stones and, when disturbed, darts quickly from one hiding place to another. Under the name cockatouch it is a favourite bait among those who angle for the famous Nipigon river speckled trout, and for this purpose is caught among stones along the river's edge.

The nomenclature of our Cottids has been very much involved, owing partly to their great variability. Dr. W. C. Kendall, who examined my collection of this species, found them "so variable that having only one or two specimens of certain forms one could easily discern pronounced 'specific differences'." Being unable, however, to correlate any of the conspicuous differences, such as are represented by fin rays, extent of lateral line, length of maxillary, etc., with other variations, he concluded that the collection represented a single species, viz., *Cottus franklinii* Agassiz. Carl L. Hubbs, who also examined the collection, writes: "I have had the privilege recently of examining large series of specimens representing this species from Lake Bennet, Alaska; Slave and Athabaska lakes; numerous localities in Labrador, the Great Lakes region, New England, and southward as far as the Potomac system in West Virginia. Throughout this area local variations within the species do indeed occur, but they do not exhibit much constancy or geographical regularity, and apparently can not be recognized nomenclaturally. In this view the synonymy of *cognatus* will include *Uranidea gracilis* and *Cottus franklinii*."

COTTUS BAIRDII Girard

MILLER'S THUMB

Body spindle-shaped, width 5.4 (4.7-6.5); depth 4.4 (4.2-4.6); head 2.9 (2.8-3.0), its width 1.2 in its length; eye 3.7 (3.6-3.7); snout 3.7 (3.5-4.0); mouth

fairly large, maxillary nearly reaching a vertical through middle of orbit; interorbital 8.8 (8.0-9.8); preopercular spine straight or very slightly curved, directed up and back, its length not one-half diameter of eye, one very short spine below it; body without prickles.

Body marked with many irregular dark markings, the most prominent of which are three very irregular bands, one about one-third the distance from the insertion to the end of the second dorsal and directed downwards and forwards, another band towards the end of the second dorsal and a third at the base of the caudal fin, traces of two other bands are seen forwards, one at the front of spinous dorsal and the other towards its end. The fins are barred but not so prominently as in the preceding species.

First dorsal with 8 spines, its base 1.8 (1.7-2.0) and height 3.7 (3.5-4.0) in head; second dorsal with 17 or 18 rays, its base 1.0 (0.9-1.0) and height 2.4 in head length; anal with 13 or 14 rays, its base 1.2 and its height 3.4 in head; ventral rays I, 4, its length 1.9 (1.7-2.0) in head; pectoral length 1.2 in head, its tip reaching a vertical through anal insertion; lateral line reaching nearly to middle of second dorsal. Largest specimen 1¾ inches.

Only three specimens of this species were taken, all in Ombabika bay in shallow water.

COTTUS RICEI Nelson

RICE'S SCULPIN

Body quite slender, regularly tapering from insertion of pectoral fins to caudal, width 5.6 (5.3-6.0) equal or slightly greater than depth which is 5.7 (5.0-6.3); head broad and very much depressed, its length 3.2 (3.1-3.3) in specimens 3½ to 5 cm. in length, 3.5 or 3.6 in specimens 6 to 7 cm. in length to base of caudal; head width 1.1 (0.9-1.2) in its length; eye quite small 5.3 (4.5-6.3); snout 3.3 [2.8 (3.1-3.4) 3.9]; mouth small, maxillary not reaching a vertical through front of eye; interorbital 8.0 (6.3-9.3); preopercular spine long, strongly hooked backward and upward concealed in a flap of skin which is thus raised above the general level of the opercle; immediately below this one there is a short downward or backward directed spine, and in front of this is another still shorter downward directed spine; top of head and body entirely covered by prickles.

Colour of preserved specimens pale straw colour, finely mottled with brownish on top of head and on back and sides of body; four irregular dark bars or saddle-shaped areas on back and upper sides, the first just back of insertion of second dorsal fin, the last at base of caudal fin; fins except ventrals and anal finely barred with brownish,

First dorsal fin with 7 or 8, rarely 9, spines, its base 1.9 [1.5 (1.7-2.2)] and height 3.5 [2.5 (3.3-4.1)] in head; second dorsal with 17 or 18 rays, its base longer than head (0.8-0.9), and height 2.3 (2.2-2.5) in head; anal with 13, occasionally 12 rays, its base 1.1 (1.0-1.2) and height 2.8 (2.2-3.1) in head; ventral

rays I, 4, its length 1.8 (1.7-1.9) and pectoral length 1.2 (1.1-1.3) in head, the latter usually reaching a vertical through anal insertion, sometimes to that of third anal ray; lateral line complete. Largest specimen 3¼ inches.

This is a deep water species of which comparatively few specimens have been recorded. It is known from lakes Ontario, Huron, Michigan and Superior. In Lake Nipigon we have found a few in the stomachs of lake trout and ling, and on June 26 and 27, 1924, seven specimens were taken in the seine from shallow water (3 feet) in Ombabika bay. The latter ranged in length from 1⅝ to 2¼ inches, whereas specimens of over three inches were found in the stomach of a ling taken at a depth of 105 feet near the source of the Nipigon river. It is of interest to note that our only specimens of *C. bairdii* were also taken in Ombabika bay. The Lake Nipigon form of *C. ricei* agrees with the specimen from Lake Superior recorded by Hubbs (1919) in having prickles over the entire body. It is believed that in Lake Nipigon this species is found at a less depth than that frequented by *Triglopsis thompsoni*.

TRIGLOPSIS THOMPSONI Girard

DEEP WATER SCULPIN

Body broad, width usually exceeding its depth, width at base of pectorals 6.0 (4.9-7.1); depth 6.6 (5.3-8.3); head long and depressed, its length 3.1 (2.9-3.3), its width 1.3 (1.1-1.6) in its length; eye quite large 4.8 (4.2-5.6); snout 3.5 (2.9-4.0); mouth large, the maxillary usually reaching middle of eye, occasionally beyond; interorbital 8.2 (7.1-9.3); preopercle with 4 spines, nearly or quite straight, the first directed up and back, the second back, the third down and the fourth forward and down, the longest (first) not nearly as long as eye; another spine at upper posterior edge of operculum; top of head back of eye rough with small tubercles which extend backwards in two lines to origin of lateral line on each side.

Colour of preserved specimens straw colour, mottled with darker above; fins with short dark bars on the rays, membranes colourless.

Fins all quite long in comparison with those of other members of the family found in the lake; first dorsal with 8 or 9 spines, its base 1.9 [1.5 (1.8-2.0) 2.3] in head; second dorsal with 13 or 14 rays and base 1.3 [1.1 (1.2-1.3) 1.5] in head, usually nearly twice as high as first dorsal, its height 1.6 in head, but varying widely in height (1.3-2.3) in head; distance between first and second dorsal usually about half diameter of eye; anal with 14, occasionally 15 rays, its base 1.3 (1.1-1.4), and height 3.0 (2.4-3.3) in head; ventral rays I, 3, its length 2.0 (1.6-2.5) and pectoral length 1.2 (1.0-1.4) in head, tip of pectoral usually reaching slightly beyond a vertical through anal insertion; lateral line chain-like, nearly complete, reaching middle of the caudal peduncle. Largest specimen 4½ inches.

This species is apparently confined to the deep waters of the Great Lakes and is presumed to be descended from a species of *Oncocottus* left in these lakes on their elevation from the sea. All our specimens from Lake Nipigon were taken from the stomachs of ling (*Lota maculosa*). Its food consists principally of *Pontoporeia hoyi* and chironomid larvae.

FAMILY GADIDAE

LOTA MACULOSA (Le Sueur)

LING; LAWYER; EEL-POUT

Body long and somewhat eel-shaped but stouter in front and compressed posteriorly; greatest width often greater than greatest depth, especially in the larger specimens, width 6.9 (6.1-8.2); depth 6.7 (5.7-7.3); head 4.5 (4.3-4.8), broad and strongly depressed; eye small 8.2 (6.6-9.4); snout 3.1 (3.0-3.3); maxillary reaching a vertical through the posterior border of the orbit; interorbital 3.6 (3.4-3.9); a long chin barbel and shorter ones before the nasal openings, chin barbel four times as long as nasal barbel, which is one-half or less than one-half diameter of the eye; anterior dorsal fin with 11 to 16 rays, its base 2.7 (2.2-3.2) in head, posterior dorsal long with 66 to 79 rays, its base 2.2, rarely 2.4, in total length, the height of the two dorsal fins approximately equal, 4.3 or 4.4 (3.4-5.2) in head length, a deep notch between the two dorsal fins; anal with 63 to 72 rays, its base 2.6 (2.4-2.8) in total length, its height usually not quite so great as that of the dorsals; ventrals inserted before the pectorals; pectoral length 1.6 (1.4-1.7) and ventral 1.7 (1.6-2.0) in head; scales very small, embedded 27 to 29 between the second dorsal and the lateral line, cheeks and opercles with small, embedded scales evident above, smooth below; fins all show embedded scales. Largest specimen measured 30½ inches and weighed 7 pounds 6 ounces, but specimens up to 3 feet are reported.

The ling is so abundant in deep water as to be a nuisance to the fishermen who find it in great numbers in gill-nets set for whitefish. It has been taken most commonly in our nets between 75 and 125 feet; we have never taken it below 200 feet. A specimen 27 inches long was taken on July 13, 1922, in a wire trap-net in 6 feet of water off the dock at Macdiarmid, and smaller specimens (9½" and 22": were

taken in the brook trap-net in Trout Creek in September, 1923. Judging from our catches its most common associates are the common whitefish, the cisco (especially *L. zenithicus*, *L. reighardi*, and *L. nigripinnis*), the northern sucker, and the lake trout. It is a competitor of the latter, subsisting chiefly on ciscoes, although many stomachs have been found to contain the deep water sculpin (*Triglopsis thompsoni*), sometimes in very considerable numbers, and occasional specimens have been found to have eaten *Mysis relicta* almost entirely. It is accused of following the whitefish to their spawning grounds and devouring their spawn. It is occasionally eaten by lake trout, but apart from this it is of no economic value, those taken in the fishermen's nets being destroyed. The Indians despise it, and even their dogs will not eat it if any other sort of fish can be had. This appears to correspond with the general estimate of the species as a food fish, throughout its range, although in a few places it is highly esteemed. Melvill (1915, p. 22) reports that along the east coast of James Bay it is considered an excellent food fish by all the inhabitants, Europeans and natives alike. Bean (1903) says that in Montana it is in great demand for food, and remarks that "the quality of the fish appears to depend chiefly on the nature of the habitat of the fish." Richardson (1836) records that the roe, when well bruised and mixed with a little flour, was baked into very good biscuits, and that the liver was also considered a delicacy, but that the flesh was eaten only in times of great scarcity. This he regarded as strange, because the burbot, its European representative, was considered "a delicate flavoured fish."

We have been able to learn very little concerning its breeding habits. A ripe female was taken on May 26, 1922, but we have been told by natives of the district that it spawns much earlier. Richardson (1836), who had the species under observation in Pine Island lake during the winter of 1819-20, states that it spawns in February, and Melvill found that in the neighbourhood of James Bay spawning occurred in February or March. Prince (1906) describes the eggs deposited by a specimen in the tanks of

the Ottawa Fisheries Museum about January 20, 1906. The eggs are very minute, having diameter of 1.77 mm., and are so light that the slightest movement in the water carries them hither and thither. In still water they sink to the bottom.

The ling is found from New England through the Great Lakes region northward to the Arctic ocean. Preble (1908) records it "in nearly every lake and stream throughout the Mackenzie region, and also in the Arctic ocean," and Melvill found it along the east coast of James Bay, in most of the lakes and rivers, particularly in the estuaries during the winter time. "They grow to a large size—up to 25 pounds, or even more." In Alaska it is said to reach a length of five feet and a weight of 60 pounds.

APPENDIX

Tables 1 to 10 inclusive of the appendix contain comparative measurements of a considerable number of specimens of each of the six species of ciscoes (*Leucichthys*) occurring in Lake Nipigon. For each specimen is given the length in millimeters from the tip of the snout to the end of the vertebral column, the number of scales in the lateral line, counting only to the end of the vertebral column, the number of gill rakers on the first gill arch, and certain body proportions such as head length, body depth, body width, etc. The values given for each of these proportions have been obtained by dividing the actual measurement for each of the body parts indicated, by the length of the specimen. The value given is therefore in thousandth parts of the body length, and hence is directly comparable for the various specimens. There is also given the average value for each of these body proportions, this average value, except where otherwise stated, including all of the specimens listed before it on the same table. In some species, specimens from Ombabika bay seemed to have certain constant differences from those taken in the lake proper. These differences, however, were not constant for all species except in the case of the eye. The eye of all species of ciscoes taken from Ombabika bay appears to be larger than for the same species taken from the main body of the lake. Other differences, if any exist, are so small as to require a larger series of measurements to enable one to arrive at any definite conclusions. The Ombabika bay specimens have, however, been listed separately, so that such comparisons as are warranted by the series may be made.

It should be remembered in comparing these measurements with those of other workers that they were made on fresh specimens.

TABLE 1.—COMPARATIVE MEASUREMENTS OF CISCOES

Species	*L. nipigon*													
Specimen No.	844	89	75	73	1116	78	1117	708	654	729	798	90	710	Average
Length	460	437	400	383	375	370	355	352	345	344	342	336	334	372
Scales	74	69	68	71	74	77	72	74	73	69	71	77	81	73
Gill rakers	21+36	20+35	19+36	20+36	20+37	20+36	19+36	19+40	21+43	22+37	19+36	20+39	18+36	20+37
Head length	230	222	233	240	237	238	245	244	245	243	243	235	240	238
Body depth	270	293	310	284	277	292	290	270	278	296	316	274	266	286
" width	137	156	158	149	136	154	135	148	148	138	158	146	135	146
Caudal peduncle														
Length	115	125	110	112	112	116	124	113	122	119	117	111	111	116
Depth	80	92	88	85	88	83	87	88	87	94	95	89	87	88
Eye	46	49	52	49	48	51	48	48	49	49	50	53	49	49
Snout	67	59	70	64	64	68	73	71	67	70	73	62	64	67
Interorbital	60	66	60	62	67	62	65	67	71	62	67	65	63	64
Maxillary	80	78	90	80	80	85	96	91	91	93	88	80	85	86
Snout to occiput	159	153	158	168	160	173	169	168	165	163	167	167	162	164
Ventral to pectoral	326	284	285	278	304	281	301	298	304	311	307	292	273	296
Pectoral length	159	162	155	162	157	155	166	158	159	169	155	158	166	160
Ventral length	152	149	160	157	147	159	166	161	154	169	161	164	165	159
Dorsal height	159	165	170	162	155	159	169	173	162	174	164	179	175	167
" base	113	130	140	149	131	132	124	128	128	122	123	116	132	128
Anal height	109	98	113	103	91	103	121	114	107	102	102	119	111	107
" base	113	112	125	124	125	119	118	128	111	105	108	128	120	118
Adipose length	65	55	65	66	65	84	62	70	53	67	73	74	70	67

TABLE 2.—Comparative Measurements of Ciscoes

Species	*L. nipigon* (Ombabika bay)									*L. nipigon*		
Specimen No.	1259	1127	1257	1258	1124	1128	1125	1123	Average	451†	895‡	893‡
Length	398	390	370	364	362	352	346	341	365	250	237	232
Scales	80	79	74	71	74	67	74	69	73	74	70	72
Gill rakers	20+37	20+34	19+37	18+36	21+40	18+36	18+38	18+39	18+38	19+36	20+37	19+37
Head length	231	232	241	239	235	253	243	248	240	252	253	250
Body depth	291	246	289	266	285	298	289	279	280	248	213	241
Body width	133	128	145	140	149	136	147	138	140	132	114	140
Caudal peduncle												
Length	128	126	116	121	119	116	118	106	119	120	124	125
Depth	95	85	85	82	83	94	85	89	87	84	84	84
Eye	47	49	51	55	48	53	52	54	51	56	59	69
Snout	65	64	62	63	64	73	68	67	66	68	68	69
Interorbital	63	62	65	66	68	65	65	66	65	68	63	65
Maxillary	80	85	78	81	80	91	84	85	83	81	91	95
Snout to occiput	158	169	165	165	171	179	169	177	169	172	171	177
Ventral to pectoral	294	308	319	329	323	321	329	317	317	290	295	349
Pectoral length	161	162	170	179	168	170	159	161	166	170	177	185
Ventral length	161	154	162	156	149	170	156	155	158	158	169	181
Dorsal height	153	162	159	165	155	185	153	158	163	160	169	181
Dorsal base	126	108	114	104	108	128	124	138	119	120	127	121
Anal height	106	108	100	118	*	111	107	103	108	106	101	119
Anal base	113	103	103	110	105	128	118	111	111	126	110	116
Adipose length	53	51	48	69	66	62	64	59	59	68	59	69

*Injured. †From main body of lake. ‡From Ombabika bay.

TABLE 3.—Comparative Measurements of Ciscoes

Species	*L. nigripinnis*													
Specimen No.	847	1119	280	1120	281	1118	1030	843	1029	833	712	283	1031	Average
Length	360	350	336	330	329	327	325	324	323	320	314	314	304	326
Scales	72	71	75	73	74	74	72	73	72	74	72	70	74	73
Gill rakers	17+31	18+31	17+31	19+32	17+32	18+32	16+32	17+33	17+34	17+31	18+32	18+30	15+31	17+32
Head length	242	234	238	233	243	235	243	247	243	241	236	245	240	240
Body depth	283	260	295	281	310	266	234	256	276	250	255	266	252	267
Body width	139	114	140	136	155	131	135	134	146	128	137	140	153	137
Caudal peduncle														
Length	131	129	116	127	112	113	122	130	113	119	134	105	118	120
Depth	86	74	80	90	91	90	80	82	84	83	83	86	79	82
Eye	53	56	54	56	61	58	58	57	60	61	59	59	59	58
Snout	65	63	65	61	65	66	62	66	62	72	64	72	63	65
Interorbital	69	57	60	64	59	58	65	59	59	63	57	57	66	61
Maxillary	85	86	92	86	94	92	92	93	93	91	89	91	92	91
Snout to occiput	161	168	162	164	169	173	172	174	179	175	175	172	176	171
Ventral to pectoral	339	303	324	324	313	312	308	315	322	313	280	296	303	311
Pectoral length	189	177	186	185	173	174	188	185	189	178	172	172	188	180
Ventral length	175	166	170	185	182	168	163	170	173	169	169	159	184	170
Dorsal height	167	163	161	173	170	162	166	176	179	156	169	159	191	168
Dorsal base	111	109	116	109	131	119	129	108	111	119	108	108	115	115
Anal height	106	114	113	115	116	110	117	111	105	106	111	107	118	111
Anal base	100	109	116	103	122	119	117	111	108	103	108	118	99	110
Adipose length	78	74	70	78	82	73	77	71	62	59	72	70	56	70

TABLE 4.—Comparative Measurements of Ciscoes

Species	*L. nigripinnis*										
Specimen No	1032	728	846	1052	1053	823	Average	1025	1048	1168	Average
Length	287	284	274	247	235	220	258	172	165	160	166
Scales	77	72	68	75	77	69	73	72	*	70	71
Gill rakers	20+32	17+30	18+31	16+30	17+31	17+32	17+32	18+30	17+32	17+30	17+31
Head length	253	240	241	253	243	245	246	265	255	263	261
Body depth	240	243	255	227	230	227	237	230	230	209	223
Body width	131	120	120	132	136	127	128	116	127	116	120
Caudal peduncle											
Length	118	127	120	117	123	114	120	134	127	109	123
Depth	85	77	88	79	79	82	82	84	81	73	79
Eye	61	63	62	67	64	66	64	73	67	81	74
Snout	66	63	62	65	64	66	64	73	67	63	68
Interorbital	59	58	50	57	53	57	56	64	57	59	60
Maxillary	91	93	91	97	89	95	93	99	97	100	99
Snout to occiput	178	164	172	180	174	177	174	186	188	194	189
Ventral to pectoral	310	309	321	308	319	318	314	276	291	294	287
Pectoral length	187	187	182	182	183	186	185	197	188	188	191
Ventral length	174	187	175	182	174	191	181	192	182	175	183
Dorsal height	178	172	186	182	170	186	179	192	188	188	189
Dorsal base	122	106	109	106	111	114	111	110	106	113	110
Anal height	108	113	120	121	115	114	115	110	103	125	113
Anal base	118	102	124	113	111	104	112	110	97	119	109
Adipose length	63	58	66	79	68	59	66	81	73	69	74

*Scales removed by net.

TABLE 5.—Comparative Measurements of Ciscoes

Species	*L. nigripinnis* (Ombabika bay)								*L. artedi* (Ombabika bay)					
Specimen No	891	889	886	887	890	888	894	Average	486	488	487	885	892	Average
Length	275	274	244	238	238	235	220	246	217	208	194	180	175	195
Scales	66	65	68	73	*	*	*		74	71	73	81	69	74
Gill rakers	17+33	19+32	17+32	19+34	17+31	17+33	17+32	17+33	15+31	16+30	18+35	17+34	17+33	17+33
Head length	245	245	254	256	254	247	259	251	224	231	247	222	234	232
Body depth	244	234	227	225	223	213	225	227	207	226	232	233	246	229
Body width	131	119	123	118	128	121	132	125	129	130	142	125	131	131
Caudal peduncle														
Length	127	113	139	122	118	126	114	123	136	113	129	125	143	129
Depth	80	84	80	86	80	83	82	82	76	79	85	78	86	81
Eye	64	66	70	67	69	72	76	69	55	63	64	61	63	61
Snout	64	68	64	67	67	62	69	66	60	63	67	58	60	62
Interorbital	55	62	59	53	65	55	61	59	58	60	67	53	60	60
Maxillary	89	92	92	101	95	94	93	94	78	80	85	83	86	82
Snout to occiput	178	172	170	185	181	170	191	178	159	168	180	164	168	168
Ventral to pectoral	298	292	287	273	290	294	314	293	311	298	314	333	286	308
Pectoral length	174	168	193	193	189	174	186	182	166	156	178	156	177	167
Ventral length	174	164	184	193	185	187	186	182	161	159	170	150	171	162
Dorsal height	171	172	176	193	181	196	181	181	166	163	180	156	160	165
Dorsal base	116	131	102	122	118	106	114	116	111	115	108	108	114	111
Anal height	116	109	115	122	122	115	118	117	99	106	119	106	109	108
Anal base	109	109	102	126	118	106	114	112	113	111	108	122	103	111
Adipose length	73	51	70	67	71	68	77	68	57	64	59	61	63	61

*Scales removed by nets

TABLE 6.—Comparative Measurements of Ciscoes

Species	*L. artedi*								*L. artedi*				
Specimen No.	824	1035	295	452	1036	98	103	Average	779	780	186	469	778
Length	234	227	215	214	213	213	212	218	185	185	181	181	180
Scales	73	71	73	67	70	71	72	71	71	64	77	68	73
Gill rakers	17+31	17+31	16+30	16+33	14+29	15+27	17+32	16+30	15+26	18+29	16+28	16+30	16+27
Head length	235	236	223	238	242	230	226	233	232	227	215	227	216
Body depth	203	216	209	224	232	239	231	222	219	230	210	232	228
Body width	111	117	121	136	141	122	118	124					
Caudal peduncle													
Length	128	128	140	112	122	122	132	126	135	143	122	119	125
Depth	79	79	74	75	82	88	80	80	84	84	75	75	81
Eye	60	55	58	56	61	56	61	58	65	62	61	61	56
Snout	60	59	53	68	63	59	57	60	57	54	55	64	56
Interorbital	56	53	60	65	68	54	54	58	54	54	50	55	56
Maxillary	85	84	81	84	87	82	75	83	81	78	77	83	78
Snout to occiput	173	163	156	173	174	153	155	164	168	162	156	166	158
Ventral to pectoral	325	322	312	294	300	291	311	308	319	297	315	309	294
Pectoral length	175	167	151	159	188	150	151	163	173	173	166	157	144
Ventral length	171	159	142	168	178	150	142	159	157	157	157	160	156
Dorsal height	162	167	149	164	174	150	151	160	157	173	149	149	161
Dorsal base	115	110	102	114	117	108	94	109	108	108	116	105	111
Anal height	103	101	93	98	117	94	94	100	103	100	94	89	103
Anal base	103	110	107	96	113	117	104	107	108	108	108	105	117
Adipose length	60	57	51	51	61	59	57	57	68	49	55	61	67

TABLE 7.—Comparative Measurements of Ciscoes

Species	*L. artedi*											*L. hoyi*	
Specimen No.	1045	471	1050	100	1046	174	1026	1051	285	106	Average †	270	1169
Length	177	174	173	169	168	157	156	156	155	155	170	207	201
Scales	65	75	67	74	*	*	69	68	*	*	70	66	68
Gill rakers	18+33	16+29	17+28	15+29	16+32	16+29	15+26	16+30	17+27	17+30	16+29	16+28	16+27
Head length	243	224	231	231	244	229	246	237	235	232	231	251	254
Body depth	237	230	202	231	214	207	224	212	203	206	219	222	221
Body width												145	102
Caudal peduncle													
Length	119	124	127	127	131	127	122	122	123	116	125	135	124
Depth	85	83	75	83	83	77	77	77	77	84	80	72	70
Eye	62	60	64	59	65	64	64	64	65	61	62	63	60
Snout	65	60	58	56	60	57	64	61	58	58	60	63	66
Interorbital	62	60	58	59	60	57	64	61	55	61	58	51	50
Maxillary	90	86	81	77	86	86	90	87	87	84	83	97	104
Snout to occiput	172	170	165	166	167	166	179	173	171	161	167	174	184
Ventral to pectoral	288	284	301	272	286	300	308	308	300	283	298	328	323
Pectoral length	169	155	145	170	161	153	160	179	165	154	175	198	189
Ventral length	158	155	162	154	161	153	160	173	161	154	159	208	179
Dorsal height	164	161	162	166	161	153	160	173	174	168	162	200	181
Dorsal base	113	115	100	112	113	118	115	115	135	110	113	116	90
Anal height	113	92	104	95	107	96	96	103	107	97	100	140	129
Anal base	119	115	104	121	119	108	115	109	126	110	113	109	104
Adipose length	56	57	58	59	54	45	64	51	61	65	58	68	85

*Scales removed by nets. †Includes last 5 specimens listed in Table 6.

TABLE 8.—Comparative Measurements of Ciscoes

Species	*L. hoyi*													
Specimen No.	272	841	454	1170	243	453	456	271	842	732	791	731	730	Average †
Length	200	197	196	196	191	186	186	180	175	175	165	164	163	183
Scales	73	72	76	72	73	72	70	74	*	71	*	72	70	71
Gill rakers	17+27	15+30	15+24	16+27	14+24	15+29	15+26	14+28	16+29	15+27	14+26	16+27	16+28	16+26
Head length	240	254	258	250	249	261	250	250	257	257	251	256	255	253
Body depth	205	228	240	235	220	231	209	225	220	222	228	241	245	226
Body width	118	117	133	122	120	124	134	128	117	114	118	137	129	124
Caudal peduncle														
Length	103	137	122	117	123	100	124	103	117	102	115	122	110	117
Depth	68	74	69	74	73	73	69	67	74	71	64	70	69	70
Eye	65	66	66	61	68	73	64	67	69	65	67	67	67	66
Snout	65	69	69	66	65	70	69	67	69	69	67	67	63	67
Interorbital	55	51	54	52	52	56	54	53	51	57	55	50	49	53
Maxillary	103	101	105	110	102	102	102	106	109	109	94	107	101	103
Snout to occiput	173	180	186	184	170	185	183	178	180	183	179	189	184	181
Ventral to pectoral	345	294	317	321	325	339	312	333	314	326	333	311	344	324
Pectoral length	193	193	179	189	181	223	183	189	211	194	212	201	190	195
Ventral length	188	203	179	194	172	226	188	194	205	182	200	183	187	193
Dorsal height	185	190	179	189	172	210	183	194	200	188	182	195	172	188
Dorsal base	105	104	105	102	94	105	107	122	114	103	97	104	104	105
Anal height	113	137	112	130	128	132	123	128	131	126	115	122	110	125
Anal base	115	117	102	112	99	116	113	103	114	109	103	113	117	110
Adipose length	75	71	74	71	65	81	78	78	80	65	67	76	64	73

*Scales removed by nets. †Includes 2 specimens listed at end of Table 7.

TABLE 9.—Comparative Measurements of Ciscoes

Species	*L. zenithicus*							*L. zenithicus* (Ombabika bay)				
Specimen No.	1173	1161	1162	1255	1171	1160	Average	1132	900	897	899	Average
Length	286	284	277	274	274	237	272	248	244	239	225	239
Scales	65	67	72	67	69	74	70	70	70	72	70	71
Gill rakers	13+25	13+24	13+23	13+23	14+23	13+25	13+24	13+22	13+25	13+25	13+25	13+24
Head length	245	246	251	248	234	249	246	262	242	247	244	249
Body depth	263	229	245	237	245	241	243	240	225	234	244	236
Body width	115	102	123	104	113	114	112	121	119	113	124	119
Caudal peduncle												
Length	119	130	123	124	135	133	127	117	131	132	136	129
Depth	73	67	73	75	75	76	73	87	74	75	76	78
Eye	58	55	56	60	49	63	57	63	61	61	62	63
Snout	73	68	72	68	66	73	70	77	68	71	71	72
Interorbital	56	53	57	57	47	52	54	58	55	59	58	58
Maxillary	96	99	97	91	89	103	96	101	84	88	96	92
Snout to occiput	187	176	184	179	179	186	182	191	176	182	187	184
Ventral to pectoral	332	299	325	310	325	312	317	315	311	297	311	309
Pectoral length	164	158	181	175	161	173	169	173	164	163	178	170
Ventral length	157	158	166	149	172	173	163	169	164	176	173	171
Dorsal height	171	158	170	173	190	177	173	191	164	171	196	181
Dorsal base	105	109	123	120	124	120	117	109	111	113	111	111
Anal height	108	111	112	102	117	110	110	113	102	100	124	110
Anal base	98	99	112	102	106	110	105	101	94	92	107	99
Adipose length	70	77	76	66	73	80	74	69	70	71	69	70

TABLE 10.—Comparative Measurements of Ciscoes

Species	*L. reighardi*															Average	
Specimen No.	832	1028	782	1165	1156	1157	1158	1159	1163	1253	1166	1167					1134*
Length	305	305	300	292	281	276	274	271	260	250	241	231	274				261
Scales	66	65	72	63	65	70	62	71	64	63	66	67	66				67
Gill rakers	11+21	13+23	12+21	12+21	14+22	14+23	12+21	12+23	12+22	13+21	13+21	12+22	12+22				11+23
Head length	262	254	250	260	256	243	254	251	254	262	249	251	254				266
Body depth	261	262	258	271	261	257	262	232	250	244	245	225	252				272
Body width	125	141	135	130	140	120	135	129	127	132	120	110	129				142
Caudal peduncle																	
Length	121	119	133	130	107	115	135	114	112	136	131	121	125				117
Depth	87	79	85	84	84	85	88	74	83	84	79	82	82				86
Eye	61	59	55	57	64	54	55	57	62	62	58	63	59				59
Snout	72	75	73	79	78	72	77	72	75	72	73	69	74				76
Interorbital	69	65	62	68	60	54	64	59	62	68	71	65	64				61
Maxillary	98	102	93	97	94	98	97	103	105	100	100	100	99				105
Snout to occiput	190	189	182	187	192	178	188	181	194	190	187	180	186				195
Ventral to pectoral	305	331	317	301	330	319	299	313	315	276	299	299	309				295
Pectoral length	164	167	163	175	160	156	153	166	165	168	174	173	165				170
Ventral length	170	148	160	164	156	152	146	159	154	164	170	151	158				174
Dorsal height	180	157	177	178	178	163	172	162	162	172	187	173	172				188
Dorsal base	125	118	117	110	117	116	117	114	112	100	120	121	116				111
Anal height	118	102	113	116	107	109	109	100	110	108	112	108	109				115
Anal base	125	102	100	113	114	116	109	100	112	100	116	117	110				115
Adipose length	72	62	60	75	66	69	73	63	73	72	79	69	69				80

*From Ombabika bay.

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PLATE I.

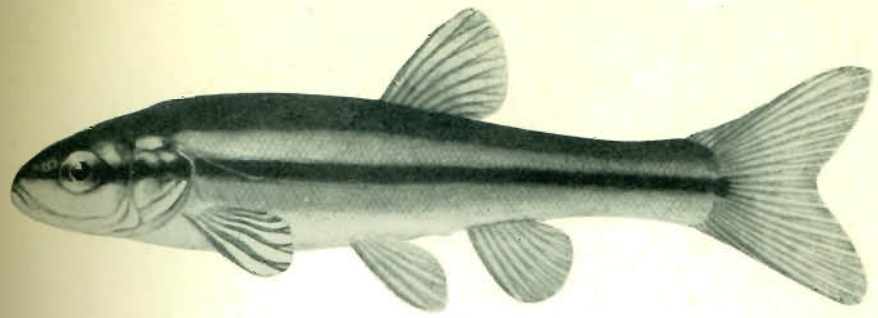
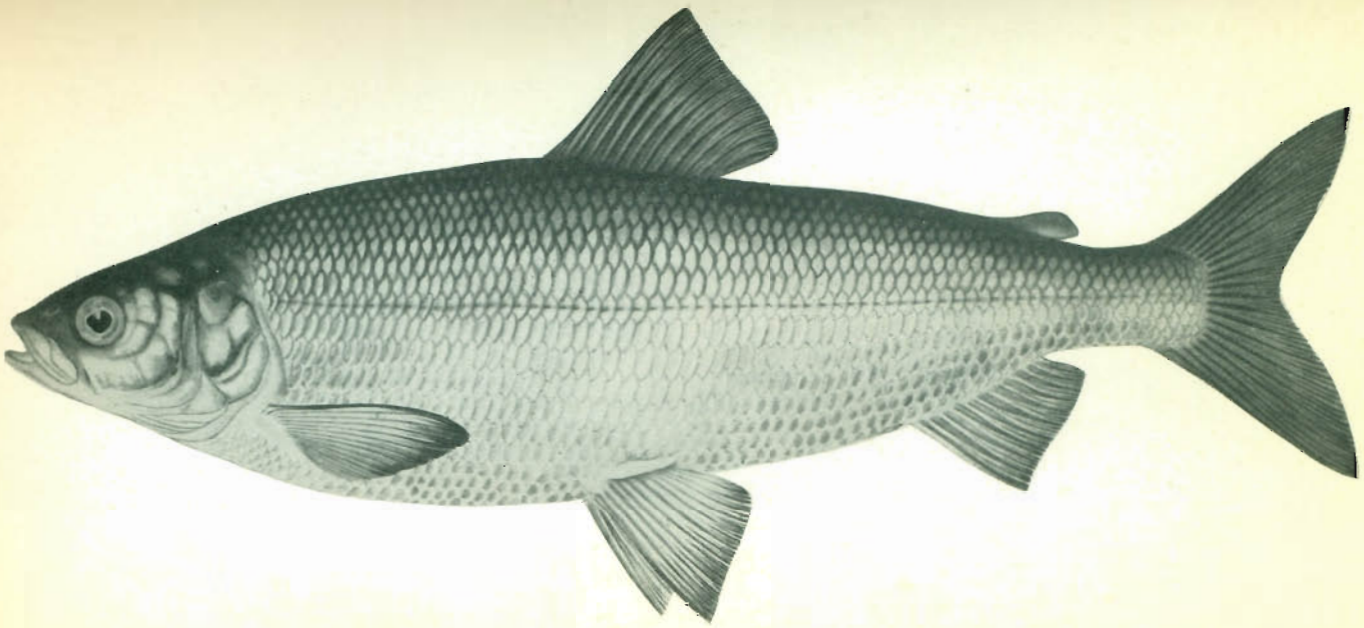


Fig. 1. *Pfrille neogaeus.*

Fig. 2. *Margariscus m. nachtreibi.*

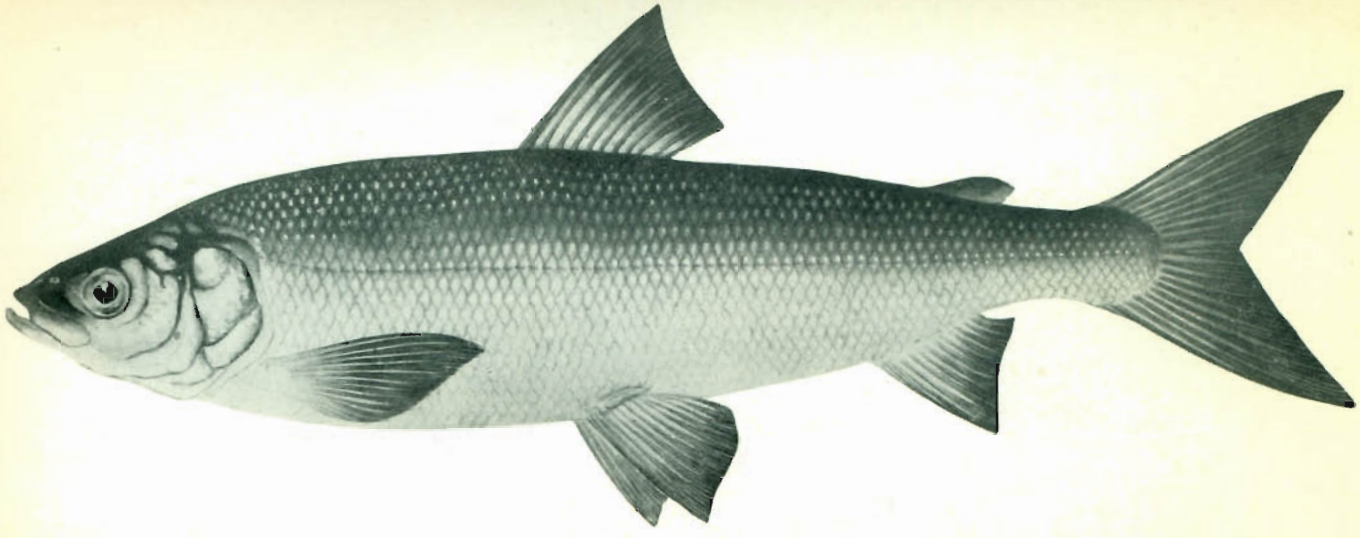
Fig. 3. *Couesius plumbeus.*

PLATE II.



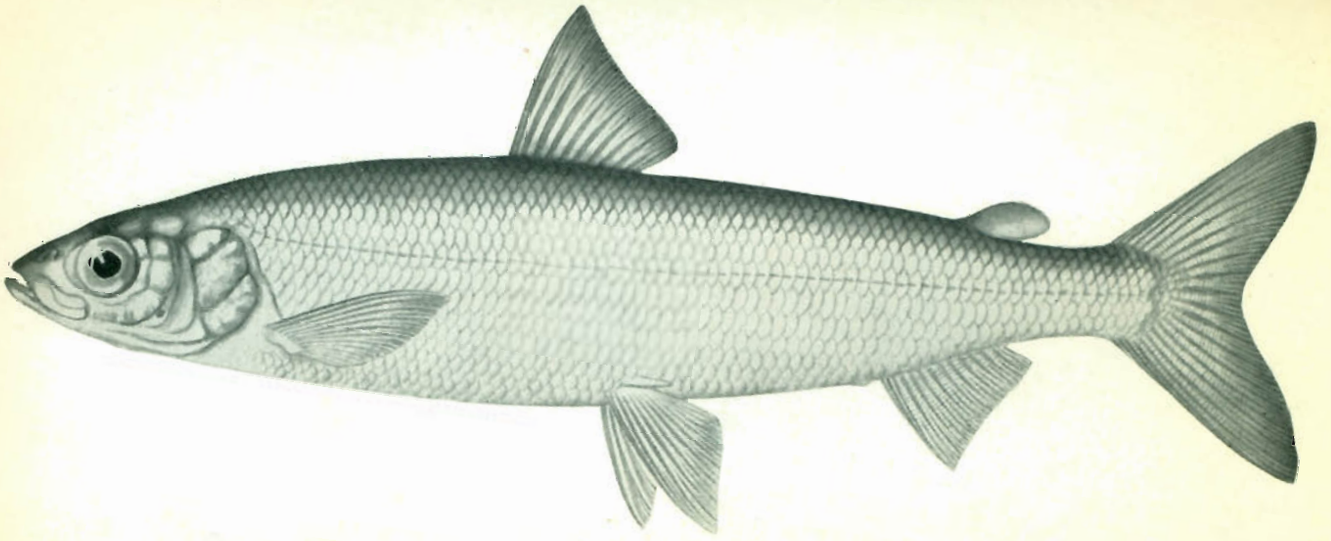
Leucichthys nipigon.

PLATE III.



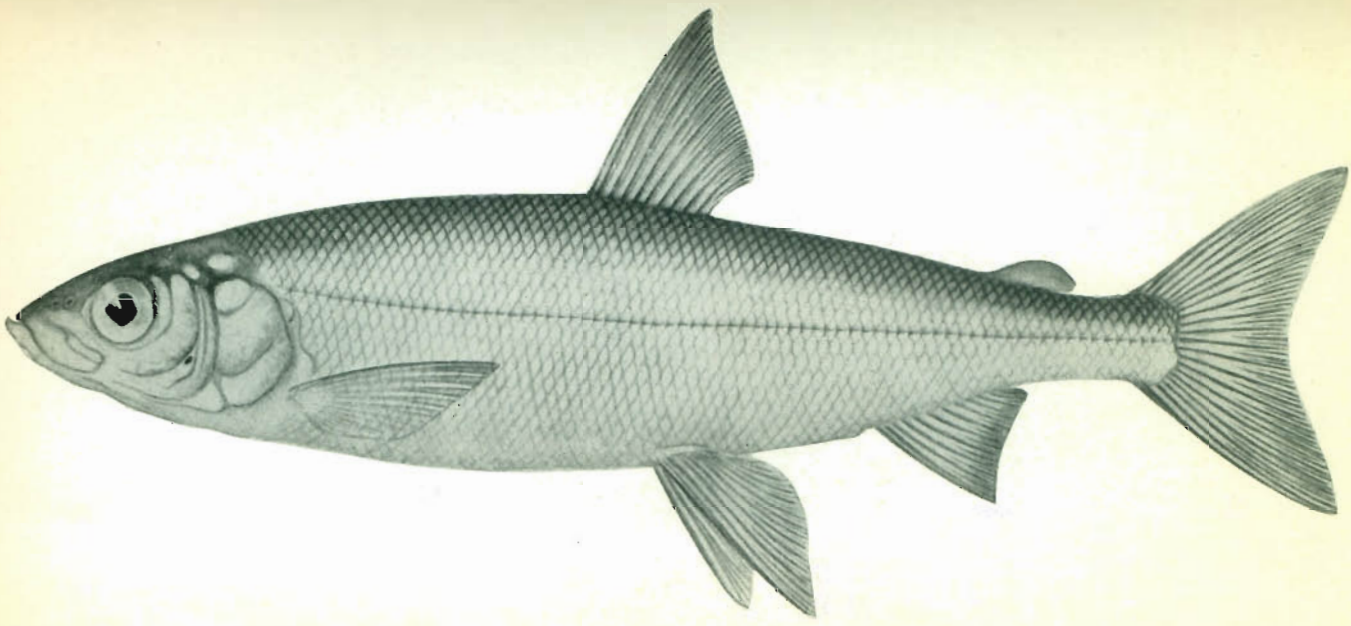
Leucichthys nigripinnis.

PLATE IV.



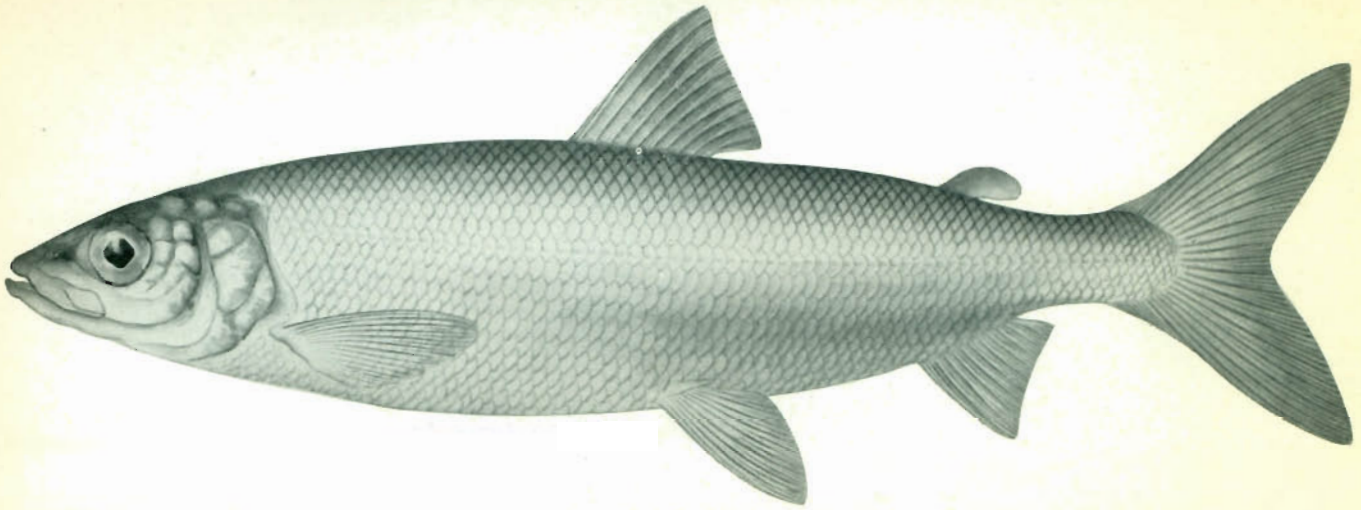
Leucichthys artedi.

PLATE V.



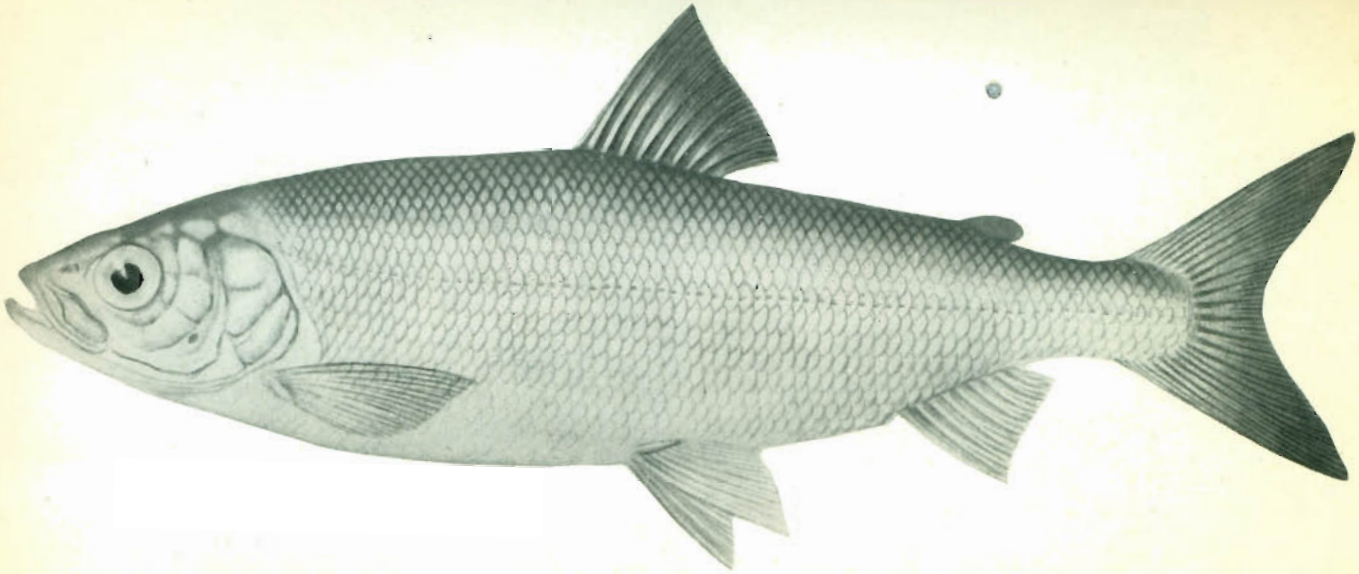
Leucichthys hoyi.

PLATE VI.



Leucichthys zenithicus.

PLATE VII.



Leucichthys reighardi.

PLATE VIII.

Fig. 1. Young of *Prosopium quadrilaterale*.

Fig. 2. *Percopsis omisco-maycus*.

Fig. 3. *Cottus cognatus*.

PLATE IX.

Fig. 1.—Typical stretch of rocky shore near Macdiarmid.

Fig. 2.—A clean sandy beach near Sand Point.

PLATE X.

Fig. 1.—Aquatic vegetation in a small bay near the foot of Orient bay.

Fig. 2.—Macdiarmid and the Lake Nipigon fishing fleet.

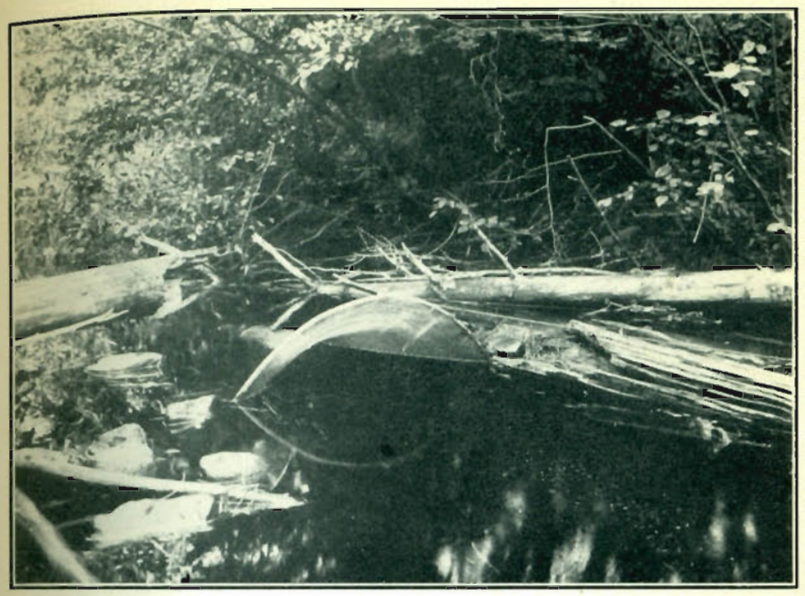


Fig. 1.—Trap-net in Pustagone river.

Fig. 2.—Seining in a shallow bay.