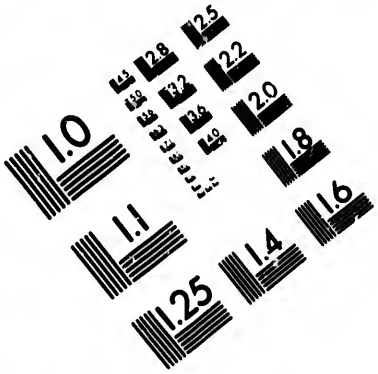

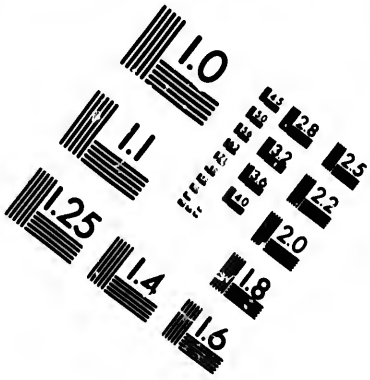

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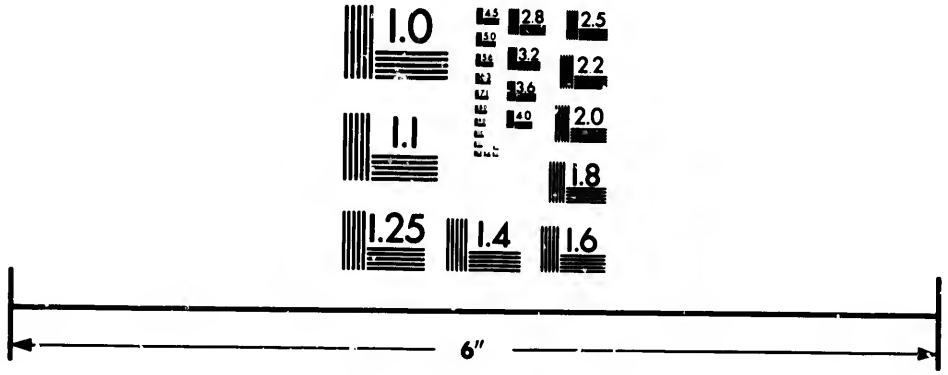

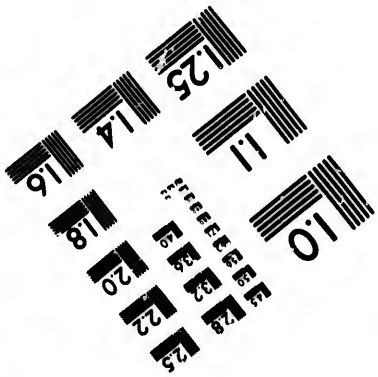

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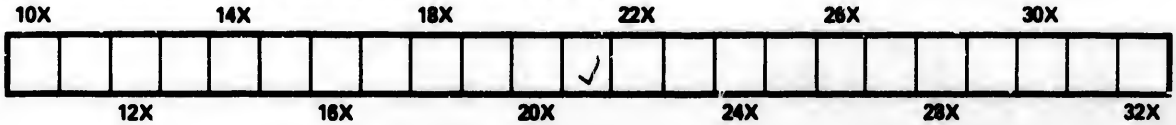

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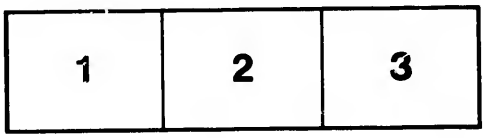

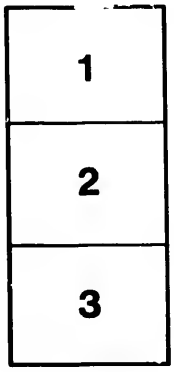

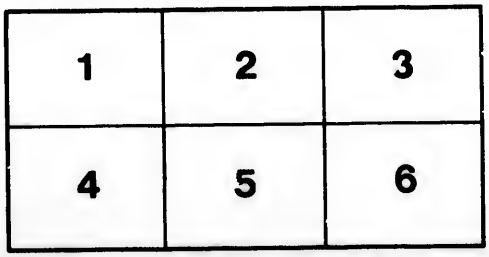

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PRELIMINARY REPORT

ON THE

FISH AND FISHERIES OF ONTARIO.

BY

PROF. RAMSAY WRIGHT,

UNIVERSITY OF TORONTO.

TORONTO, January, 1891.

Dr. G. A. MACCALLUM,

Chairman of the Ontario Fish and Game Commission.

SIR,—I have the honour to transmit herewith a Preliminary Report on the Fish and Fisheries of Ontario.

Your Commission had originally intended to collate the information received in answer to a series of questions distributed to persons interested in the subject throughout the Province. The answers, however, appeared to indicate that a Preliminary Report containing a synopsis of what has already been published in regard to it, with descriptions and figures of the species of fish occurring in Ontario, would tend not only to render more precise the replies to future investigations of your Commission, but also to awaken a widespread interest in the whole matter In preparing this synopsis I have been chiefly indebted to the publications of the U. S. Fish Commission, which has with great liberality furnished the illustrative plates, but I have consulted, where necessary, the Dominion Fishery Reports and the Reports of the Ontario Crown Lands Department, as well as other available sources of information.

The first section of the Report deals with geographical considerations likely to affect the distribution of the various species of fish occurring within the waters of the Province, the heights above sea-level, depths and temperatures being indicated where possible.

This is followed by a short account of the natural history of fish sufficient to explain the technical terms used by Ichthyologists in distinguishing the various species. Attention is called to the desirability of the extension of our knowledge as to the conditions of life of our food-fishes.

The third section furnishes a detailed account of the natural history of the species of fish reported from the Province, special attention being given to those of economic importance.

Thereafter the statistics contained in Dominion Reports and the legislative enactments of the Dominion Government as far as these affect Ontario are summarized, and the adequacy of the close seasons fixed considered.

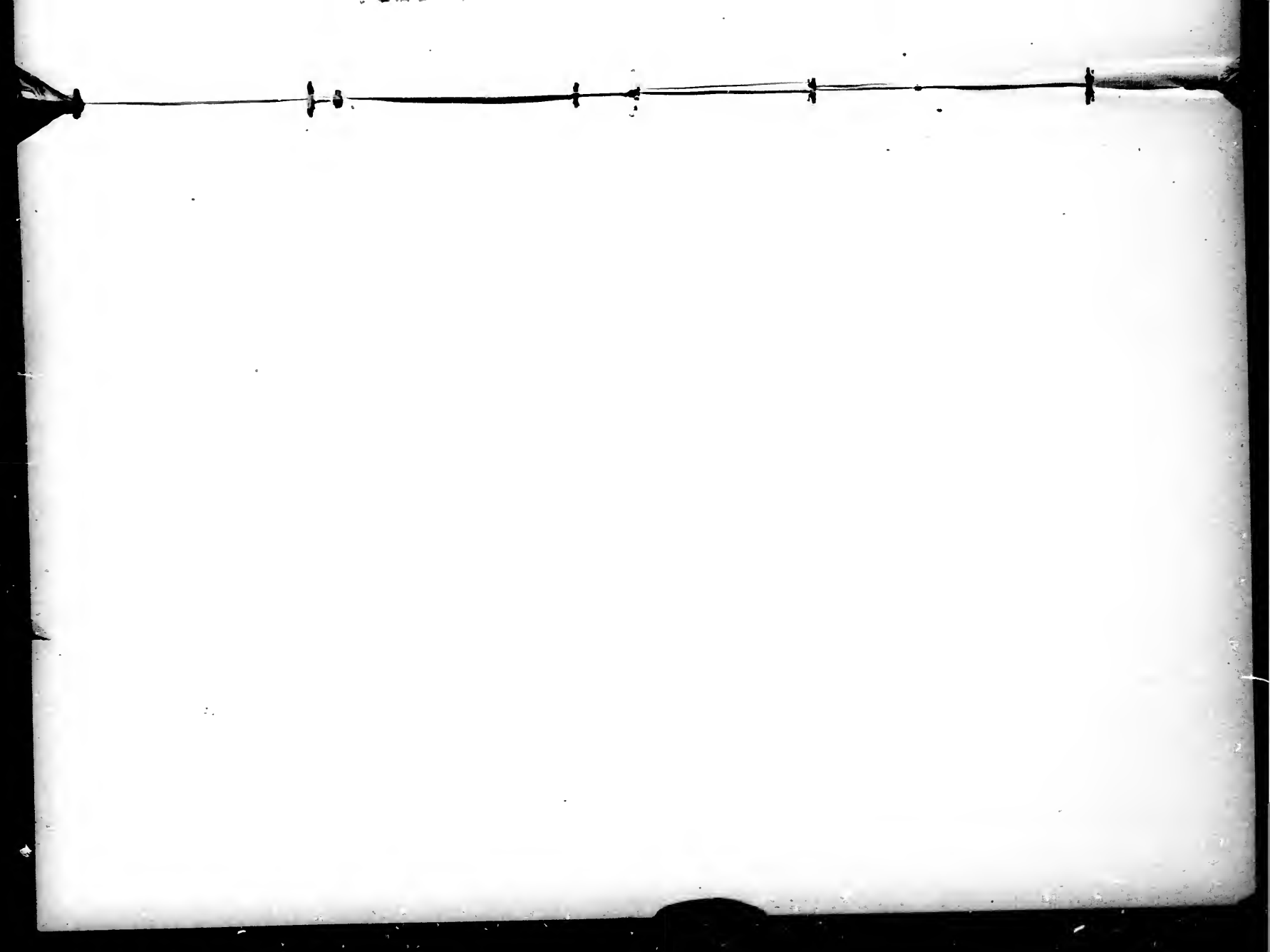
A short account of the apparatus employed in catching fish and the methods of preparing them for the market follows, succeeded by a discussion of the causes of and remedies for reported decreases in the catch of fish.

Finally the problems are indicated which would occupy the attention of a Permanent Fish Commission for the Province of Ontario.

I have the honour to be, Sir,

Yours respectfully,

R. RAMSAY WRIGHT.



GEOGRAPHICAL CONSIDERATIONS.

The Province of Ontario, it is said, owes its poetic Indian name to its "beautiful prospect of hills and waters." It is with the inhabitants of the latter that the present section of this Report deals, and it appears therefore to be an indispensable preliminary that some general account of the geographical disposition of the numerous lakes and rivers of the Province should be given.

The most important of these furnish the boundaries which separate Ontario from the United States on the south and from the neighbouring parts of the Dominion of Canada on the east and north-west.

Thus the international boundary line between the Province and the States of New York, Pennsylvania, Ohio, Michigan, Wisconsin and Minnesota passes through the River St. Lawrence and the chain of the Great Lakes, then by Pigeon River and the head-waters of Rainy Lake and River to the Lake of the Woods, a distance of some 1,600 miles, while the north-west boundary line, which separates it from Manitoba and Keewatin, stretches for some 800 miles through English River, Lac Seul, Lake Joseph and the Albany River to the mouth of the latter in Hudson's Bay. From this point, the northern boundary—the Ontario sea-coast—extends for 250 miles along James' Bay to a point midway between Hannah Bay House and the mouth of the Nottawa River and due north of the head of Lake Temiscaming. The meridian which joins this point and the head of the lake forms an artificial boundary line of 275 miles in length between this part of Ontario and the North-Eastern Territory on the east, which is completed further south and east through a stretch of another 500 miles by the natural boundary, separating it from the Province of Quebec, formed by the lake above named and the magnificent Ottawa River which issues from it.

The territory so bounded contains upward of 200,000 square miles, and its most distant points from east to west and from north to south are respectively upwards of 1,000 and 700 miles apart. All the waters named, and others included within the area of the Province belong to two great water-systems, the Hudson's Bay system in the north, and the St. Lawrence system in the south. The water-shed separating these—the so-called "Height of Land"—extends, so far as it lies within the Province, south and west from Lake Abittibe to within 100 miles of the north channel of Lake Huron, and then runs parallel therewith, and with the coast line of Lake Superior, occasionally approaching within 50 miles of the coast or receding, as, for example, round Lake Neepigon, to a distance of 150 miles. West of Lake Neepigon, the height of land approaches Thunder Bay between Dog Lake and Lake Shebandowan which belong to the St. Lawrence system on the one hand, and Lac des Milles Lacs, which is tributary to the Hudson's Bay system on the other. It then crosses the international boundary at a point immediately west of Arrow Lake.

At no point does the height of land attain any great elevation above the sea; the highest levels in fact are reached comparatively abruptly from the shores of the Great Lakes, and the height of land is therefore constituted by the most elevated tracts of a great plateau extending between the Great Lakes and James' Bay.

The geological character of this plateau, which forms by far the greater part of the Province of Ontario, affords so complete an explanation of the very characteristic inland waters of the Province, that some reference thereto will assist the reader in forming a conception of their arrangement.

A line drawn from the outlet of Lake Ontario, (near Kingston) to Matchedash Bay in the Georgian Bay, (near Midland in the accompanying map), divides Ontario into two very unequal parts. The northern part is almost entirely formed of rocks of the Laurentian and Huronian series, consisting largely of gneiss and crystalline limestones, which, although apparently altered in their structure, present evidence of being the most ancient sedimentary rocks, and have on this account been termed Archæan. They offer, however, a very different degree of resistance to the eroding and transporting powers of water than do the more recent sedimentary rocks which have not undergone metamorphosis, and thus, instead of continuous river channels, we have series of irregular depressions and clefts converted into lakes by the accumulation of rain and melted snow, and connected with each other by short rapid rivers and falls. This country is generally densely wooded, and in many places, owing to the protrusion of the crystalline rocks through the surface clays, unfitted for agriculture, but nevertheless there are large areas, especially north of the height of land, where the rocks are not exposed and which consequently furnish large tracts of arable land. Only two regions north of the line referred to are underlaid by rocks of more recent origin than the Huronian and Laurentian series. These are firstly, the triangular tongue between the Ottawa and St. Lawrence Rivers as far west as a line drawn from Brockville to Arnprior, which is underlaid by Cambrian and Lower Silurian strata; and secondly, the northern Palæozoic area of James' Bay, a low, level and swampy region, free from rocks and lakes, extending from the south-west shore of the bay towards the height of land, and involving a considerable part of the area traversed by the Albany and Moose Rivers. This region, whose steadily flowing rivers, uninterrupted by lakes, present a difference between high and low water mark of about ten feet, necessarily offers somewhat different conditions of life to the finny tribe than the Laurentian region. It is surrounded by a curved rim of Archæan rocks, the unyielding nature of which brings it about that the rivers flowing towards James' Bay meet with a great and rapid descent at the point where they pour over it. The Long Portage of the Abittibe River, marked in the accompanying map, indicates the position of this rim at the point in question. It is similary situated in the Moose and Albany Rivers, but the sides of the rim converge northward to the shores of James' Bay.

The second and very much smaller part of Ontario is that south of the line described above. It is underlaid by Silurian and Devonian strata in ascending geological order from north to south and west, and is crossed by the great Niagara escarpment, an abrupt rise which extends from the Niagara River by Hamilton, Georgetown, etc., to Cabot's Head in the Georgian Bay. Both east and west of this rise, the country, which forms a continuous tract of fertile farming land, presents a very different aspect from the rugged landscape of the northern Archæan region. On the east the surface is more undulating, the ground gradually rising from Lake Ontario in a series of ridges composed of drift materials to a height of some 700 feet. Some lakes, like Rice Lake and Lake Scugog, are situated in the midst of these drift ridges, others are situated along the line of junction with the Archæan region to the north. To the west of the escarpment on the other hand, the land slopes away gently towards Lake Huron and Lake Erie, and although, as we shall see, important rivers find their way into both these lakes, yet it differs from the country to the east in the absence of small inland lakes.

After this short preliminary sketch of the geography of the Province, some further details are necessary as to the waters bounding and inclosed by the subdivisions described. Most important, of course, are the Great Lakes, indeed, it is they alone which are at present important from an economic standpoint, but it is desirable from a scientific point of view that both of the great water-systems should be considered with the view of eliciting information as to the differences in the fish-fauna of each.

THE GREAT LAKES.

These magnificent expanses of fresh water form part of a semicircle of lakes stretching from the Pacific ocean to the Atlantic concentrically with Hudson's Bay, viz.—Great Bear Lake, Slave Lake, Athabasca, Wollaston, Deer Lake, Lake Winnipeg, Lake Manitoba, Lake of the Woods, Superior, Huron, Erie, Ontario and the St. Lawrence. They are considered to represent the ancient shore of the ocean retiring before a rising continent. Many curious facts as to the inhabitants of these lakes are intelligible if we bear in mind the physical changes which geologists tell us they have undergone in the past.

Lake Superior, the largest expanse of fresh water on the globe, forms an inexhaustible reservoir for the St. Lawrence system, containing, as it has been estimated to do, some 4,000 cubic miles of water. Its north shore is bold and picturesque, varying in height from 300 to 1,360 feet, and deeply indented in some parts, where innumerable harbours facilitating commerce and fisheries are formed.

Its greatest length is some 420 miles, measured on a curve from east to west; its greatest breadth is 160, while its area has been calculated at 32,000 square miles. Taking into consideration its great depth (in some places it reaches 1,200 feet), it is not wonderful that such a large body of water should materially influence the temperature of its shores, and should not be easily affected by seasonal alterations. The temperature of its surface waters in July has been observed to be 39°F (= 4° C), that of the atmosphere being 51°. (10.5° C), while the thermometer at some distance in the interior registered 70° and 80° (=25°-26° C).

The waters of the lake are derived from a basin drained by more than two hundred streams; several of these are of considerable size, but almost all are impetuous torrents, descending from the height of land for 50 to 150 miles. Proceeding from the head of the lake eastwards, the most considerable are the Kaministiquia, the Neepigon, the Pic on the north, the Michipicoten, the Agawa, the Montreal, the Batchawaung and the Goulais on the east side. Of these, the Kaministiquia is the only one navigable for large vessels for any distance from its mouth; it flows into Thunder Bay at Fort William. The Kakabeka Falls, situated near the fork of the branches draining Lake Shebandowan and Dog Lake, are said to be scarcely inferior in grandeur to the Falls of Niagara.

The Neepigon River, the largest on the north shore, takes its origin in Lake Neepigon, an oval sheet of water 30 miles north-west of Lake Superior, and 313 feet higher than that lake; it discharges itself through several small lakes and a wide deep channel into Neepigon Bay. The water of this river and lake, so celebrated for the large speckled trout with which they swarm, has earned for the lake its Indian name, which signifies "Deep Clearwater Lake." The lake,

which measures 120 miles in length by 60 in breadth, is deepest in the southern and eastern parts, where a depth of 540 feet has been ascertained, and in consideration of the area drained by the streams which it receives and the volume of water discharged through its outlet, may be regarded as one of the most important head-waters of the St. Lawrence. Its largest affluents are the Kayosk or Gull River on the west and the Sturgeon River on the east.

The second river in point of size on the north shore is the Michipicoten, a large clear rapid river which has long served as an important canoe-route to Hudson's Bay. The other rivers on the east shore are of the same character, receiving tributary streams which pour their water through rapids and falls, often of considerable height, into the main current.

Lake Superior discharges its water into Lake Huron through the St. Mary River, a stretch of 25 miles, part of which, descending 22 feet in three-quarters of a mile, is very rapid, forming the Sault Ste. Marie. The strait so formed where it widens into Lake Huron is interrupted by a series of islands which run parallel to the north shore and which may be regarded as a continuation of the promontory into which the Niagara escarpment is continued. These islands, of which the chief is Manitoulin Island, together with the promontory referred to, separate the so-called North Channel and the Georgian Bay from the main body of the Lake lying to the south. The latter has a surface of 14,000 square miles, while the Georgian Bay, from Nottawasaga Bay to Shebanahning (Killarney) and the eastern extremity of Grand Manitoulin Island, has been estimated to have an area of 6,000 square miles. The North Channel on the other hand, exclusive of its islands, has been reckoned to contain 1,700 square miles. As before observed, Lake Huron is 22 feet lower than Lake Superior, and therefore 578 feet above sea level. Its average depth is as great as that of Lake Superior, but even greater depths have been ascertained in places—over 1,800 feet having been found off Saginaw Bay on the American side. The greatest length of the Lake is 280 miles; its average breadth, 70. Like Lake Superior, it is distinguished, especially in the north-western parts, for the peculiar transparency of its waters.

Emptying themselves into the North Channel and the Georgian Bay are the following large rivers:—The Mississaga, the Serpent, the Spanish, the Wahnapitæ, French River, the Maganetawan, and the Severn. The last mentioned serves as the outlet of Lake Simcoe, but all of them drain a country studded with innumerable lakes and lakelets. The French River has a special importance as forming an almost direct line of communication through Lake Nipissing between the Upper Lakes and the Ottawa. Its navigation is much obstructed by falls and rapids, for in its 40 miles from Lake Nipissing it falls through 87 feet. The watershed between Lake Nipissing, the height of which is 665 feet, and Upper Trout Lake—the source of the Mattawan, (a branch of the Ottawa)—is 714 feet high. Lake Nipissing itself is one of the larger inland lakes, measuring 40 miles from east to west, and with a maximum breadth of 20 miles from north to south. Its area is estimated at 300 square miles. The northern shores of the lake are low, generally of flat rock and sand, and the water shallow with a sandy bottom. Its principal affluent is the Sturgeon River, a stream of considerable size flowing from the north, which forms one of the outlets of Lake Tamagaming, a fine sheet of water, 800 feet above sea-level, with an area of 330 square miles, which has a second outlet towards the Ottawa system through the Montreal River. Of the streams flowing from the Province into the main body of Lake Huron the most important are the Maitland and the Saugeen.

At its extreme southern extremity Lake Huron contracts itself into the St. Clair River, a stream which flows due south for 44 miles between moderately high banks before expanding into the small lake of the same name. Lake St. Clair is 30 miles long by 24 wide, with an area of 360 square miles, and a depth of 12 to 22 feet. It, again, communicates with Lake Erie by the Detroit River, which varies considerably in width, and is studded with numerous islands.

Lake Erie differs considerably from the other lakes, and especially from the Upper Lakes in its depth; its average depth is only 80 feet; the west end is shallow, the deepest points, which do not exceed 220 feet, occurring off Long Point on the north shore. It is 240 miles long, 57 broad at its broadest point, and has an area of 9,000 square miles. The fall from Lake Huron through the St. Clair and Detroit rivers is very gentle, so that Lake Erie exhibits a difference of level of 13 feet from Lake Huron; it is in the Niagara River, which forms the outlet of the Lake at the eastern extremity, that the great fall occurs over the Niagara escarpment, so that in its stretch of 36 miles from Lake Erie to Lake Ontario a difference of levels of 230 feet is achieved, two-thirds of which is accomplished at the Falls. Lake Ontario is 185 miles wide, 40 broad, and has a maximum depth of 600-700 feet. Few rivers of importance fall in on the North Shore; of these the Trent, which, with the aid of its tributary, the Otonabee River, drains several small lakes before falling into the Bay of Quinte, may be mentioned.

At its eastern end the outlet of the lake into the St. Lawrence River, which here first attains its name, is studded with the "Thousand Islands," and before the river is augmented by the Ottawa at Vaudreuil it expands into several quiet lake-like reaches and plunges down in long and picturesque intervening rapids.

To complete the account of the St. Lawrence system, a short reference to the affluents of the Ottawa River, situated within the Province of Ontario is necessary. Lake Temiscaming, the largest and deepest expansion of the Ottawa, receives the most northerly of these; it is a magnificent stretch of navigable water, 67 miles in length, and varying in breadth from 6 to 8 miles. The ascertained height is 612 feet. The River Blanche, which drains a clayey region of the Height of Land, and the Montreal River which comes from the north-west, and in its course receives one of the outlets of Lake Tamagaming, are the chief tributaries. Immediately to the east of Lake Nipissing is the watershed between the Georgian Bay and an important affluent of the Ottawa, the river Matawan. Between the mouth of this river and the City of Ottawa, several important streams, which drain the lakes of the south-eastern tract of the Archæan region, fall into the Ottawa on its right bank, viz., the Petewawa, 140 miles long, with a drainage area of 2,200 square miles, Black River, 120 miles long, with an area of 1,120 square miles, and the Madawaska, 240 miles long, and an area of 4,100 square miles.

Geologists, it is indicated above, have found evidence of many changes in the outlines of the St. Lawrence Basin. At one time the Great Lakes must have been salt water, their northern shores forming the coast line of the high Archæan land to the north. Maritime plants on the north shore of Lake Superior, and marine shrimps in its depths which were able to accommodate themselves gradually to the change in salinity of the water as the land rose, are still found as evidence of this. But, even since their conversion into inland seas, the outlines of the modern lakes by no means agree with what they must have been in the past. Lake Erie, for example, is a comparatively modern way for the waters of the Upper Lakes to escape to the sea, and it is probable that Lake Nipissing

and the Ottawa valley formed at one time the chief outlet, although Lake Simcoe and the chain of lakes connecting with the Trent Valley may also have formed a similar outlet. It is probable that further research may prove the different character of the fauna of this lake to be due to its geological history.

THE HUDSON'S BAY SYSTEM.

With the exception of the great rivers flowing from the Height of Land to James' Bay, their immediate neighbourhood and the larger lakes in their course, comparatively little is known of the part of Ontario belonging to this system. A rapid survey of these with reference to the map will therefore suffice.

Lake Abittibe is situated seventy miles north of Lake Temiscaming, and just on the other side of the watershed from the head waters of the River Blanche. It is situated in a northward continuation of the clay plain in which that river arises, and is 245 feet higher than Lake Temiscaming, being only 60 feet lower than the Height of Land portage. The other branches of the Moose River similarly originate in lakes, often of considerable size, near the Height of Land, and the same is true of the Kenogami and other rivers flowing northward into the Albany. The latter river, from its origin in Lake St. Joseph, flows east and north through upwards of 500 miles on its way to the sea. Between Lake Joseph and Lac Seul is the height of land which separates the tributaries of the Nelson River from those of the Albany. The area of Ontario, bounded on the east by this watershed, and that between Lake Superior and the tributaries of Rainy River, is of very considerable size, and everywhere studded by lakes great and small; over 2,500 square miles of water are included in this tract of the Province. Lac des Milles Lacs is one of the largest of these lakes; it discharges into Rainy Lake through the Seine River, but the Lake of the Woods and Lac Seul are the chief reservoirs of the Nelson River system within Ontario. These discharge themselves into Lake Winnipeg by the Winnipeg River in the one case, and its tributary, the English River in the other. The Lake of the Woods is seventy miles in length and has an area of over 1,000 square miles, the greater part of which, 627 square miles, lies within the limits of the Province. It is 1,062 feet above sea-level, but 350 feet higher than Lake Winnipeg and consequently the River Winnipeg offers a series of magnificent falls and rapids in its course. The Lake of the Woods is very irregular in its contour, a peninsula jutting in from the east, separates the southern shallower part--"Lake of the Sand Hills"—from the northern deeper portion, which is studded with islands and is almost sub-divided into three separate bays or lakes, connected by narrows, Lac Plat on the west, Clearwater Lake in the middle, from which the Winnipeg River issues at Rat Portage, and Whitefish Lake on the east.

Lac Seul nearly equals the Lake of the Woods in area, but occupies a long narrow irregular cleft, which resembles in character the lake-like reaches of English River, through which it joins the Winnipeg. In conclusion it is only necessary to remark that this district of Ontario is interesting as containing the highest waters of the Province.

This short account of the Lakes and Rivers of Ontario will facilitate reference in discussing, where possible, the geographical distribution of species, but it must be insisted that a systematic survey with this end in view is necessary before any authoritative statements as to the geographical limitation of species within the waters of the Province can be made.

NATURAL HISTORY OF FISH IN GENERAL.

Some little acquaintance with the elements of Ichthyology is necessary for the proper understanding of the scientific terms used by naturalists in describing Fish, and comparing them with each other. This may be acquired by the attentive examination of any common form like our ordinary Catfish or Bullhead (fig. 1).

Fig. 1.—Common Catfish, or Bullhead. ½ (*Amiurus nebulosus*).

This fish is known to zoologists as *Amiurus nebulosus*, Le Sueur; its scientific name, like that of all other animals and plants, is a double name, this being necessary to indicate the particular species to which it belongs, for there are other kinds of catfish in North America sufficiently like this to be united with it in the same "genus" Amiurus. The specific name "nebulosus" was given by Le Sueur to this particular kind on account of its yellowish brown skin being often clouded by black, but the colouration is very variable, and there appears to be in the South a mottled variety sometimes regarded as a distinct species, but probably only a geographical variety or sub-species, the name of which is written *A. nebulosus* var. *marmoratus*.

All catfishes and their allies belong to a "family" called Siluridæ, which contains very numerous genera in the fresh waters of the tropics of both the Old and New Worlds, and which, with a host of other families possessed of a well formed bony skeleton, belongs to the sub-division Teleostei of the class PISCES —one of the primary divisions into which all back-boned or vertebrated animals are divided.

With all other vertebrates then, the catfish shares certain essential characters, such as the possession of a brain and spinal cord protected by a skull and spinal column. Of these, the skull serves in addition for the protection of the nose, eyes and ears, as well as for masticating the food, and, in the fish, carrying out the movements

of respiration. The body is divisible into three regions, head, trunk and tail, which have different duties to discharge, and consequently differ in form and structure. The head lodges the brain and sense organs, secures food and shelters the gills; the tail is chiefly locomotive in function, while the trunk differs from both in being hollowed out so as to enclose the intestines and other viscera in the so-called body-cavity. From the trunk there project the two pairs of limbs or members corresponding to our arms and legs, but which are here called on account of their position and form the pectoral and ventral "fins."

These must be carefully distinguished as the "paired" fins, from the "unpaired" fins, which occupy the middle line of the trunk and tail, sometimes forming, in other fishes, a continuous fold as far forward on the under or ventral surface as the end of the intestine, but more frequently interrupted as in this species into dorsal, caudal and anal fins. There are in fact two dorsal fins in the Catfish, but the hinder of the two, instead of being supported by fin-rays, only includes within it some fatty tissue and is therefore called the "adipose" fin.

The fin-rays which support the fins are either hard or soft, *i.e.*, bony or spine-like in their whole length, or else fringed and jointed. For the purpose of distinguishing different species it is often desirable to count the number of rays in the various fins, and express them in a formula, using Roman numerals for the hard, and Arabic for the soft rays.

Thus, for this species, the formula is:

Dorsal, - - -	I, 6.
Anal, - - -	22.
Pectoral, - - -	I, 6.
Ventral, - - -	I, 7.

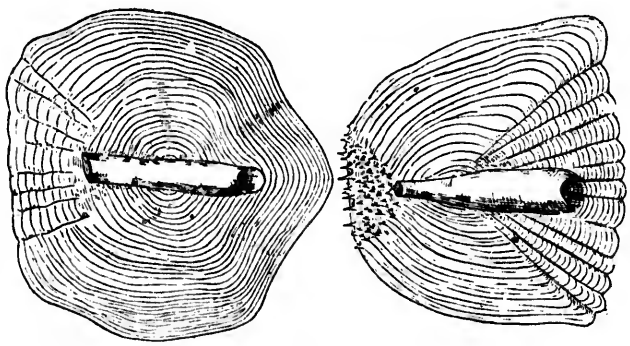
Certain apertures are to be noted, viz.: the mouth bounded by the upper and lower jaws and leading into the cavity of the mouth, which opens behind into the gullet and at the sides and floor by the gill-slits (five in number on each side) into the right and left gill or branchial chambers. The opening into the gullet is occupied by tooth-bearing bony plates above and below, the superior and inferior pharyngeal plates, and the inner opening of the gill-slits which are separated by the "gill-arches," are screened by a series of short projections on the concave surfaces of the gill-arches, those looking into the cavity of the mouth. The projections, which are often in other fish of considerable length, are called "gill-rakers," and serve to strain the water that flows out over the gills.

The latter occupy the gill-chambers and are attached in two rows to the outer convex faces of the four gill-arches. They are concealed by the gill-cover, a flap which bounds the gill-chamber externally, and the free margin of which can be applied tightly against the shoulder-girdle, the bones of which strengthen the wall of the gill-chamber below and behind. Supporting the main part of the gill-cover are the "opercular" bones, while a series of "branchiostegal rays" strengthen its lower free margin. Between the gill-openings on the ventral surface is the narrow unperforated floor of the mouth, which in many fishes forms a very narrow "isthmus."

The intestine opens posteriorly by a vent or anus in front of the anal fin. Behind the anus are the openings of the reproductive and urinary organs, separate in the females, but on a common urogenital papilla in the males.

The organs of the senses are visible to a certain extent from a surface inspection: thus the nostrils are two apertures on each side which lead into the front and hind ends of the olfactory sacs; round the mouth there are grouped eight sensitive feelers or "barbels" (not present in all fish): the eyes, although small, are evident enough, but the ears are entirely sheltered within the skull and have no communication to the outside. Finally there are certain small holes and slits chiefly on the head and along the lateral line of the body, which open into canals containing sense-organs in the skin, and generally protected by bony scales.

The Catfish, except for a few scales of this sort chiefly situated below the orbit (suborbital), is destitute of the ordinary scaly covering of a fish. Its skin is soft, and slimy, there being innumerable cells in the skin constantly forming this layer of mucus on the surface. But in most fish, the skin is strengthened by bony scales, which may have minute teeth projecting through the surface as in the Sharks and Sturgeons, or a continuous coat similar to tooth-enamel, as in the bony pike, but are generally covered entirely by the soft epidermis. These scales are usually either rounded (cycloid) or with a jagged hinder edge (ctenoid), fig. 2. Their number in longitudinal or vertical rows is often used for distinguishing



A. B.

Fig. 2.—A, Cycloid Scale from Lake Herring. B, Ctenoid Scale from Rock Bass. 6/1.

species, especially those that are perforated for the organs of the lateral line referred to above. The formula for the number of scales is then written L. 63 (as *e.g.* in the Common Sucker), but if it is desirable to take into account the number of longitudinal rows above and below the lateral line, these are counted in an oblique row fron the beginning of the dorsal fin downwards to the lateral line and from that towards the ventral surface, the formula being then expressed (as *e.g.* in the Lake Mullet) scales 6—42 to 48—5, the figures 42-48 indicating the number of scales in the lateral line.

Certain terms used in classifying fish are taken from the skeleton; a short description of the various parts of the Catfish skeleton is therefore inserted. It is divided into the skeleton of the head, of the trunk, and of the paired limbs. The skeleton of the head is again sub-divided into the cranium proper—which

contains the brain and shelters the ears—and the jaws and gill-skeleton. The shape and the position of the various bones entering into the cranium may be seen from fig. 3, A. and B. In many fishes the cranium is largely cartilaginous,

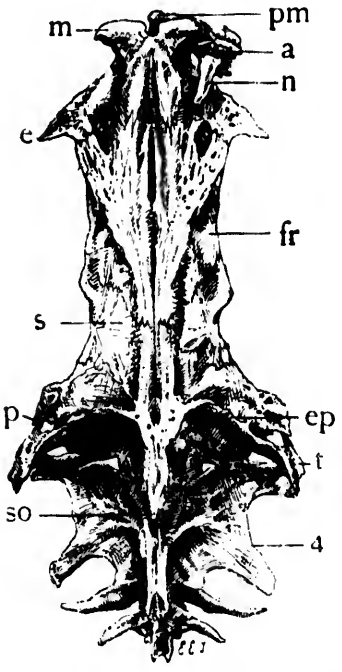


Fig. 3 A.—Cranium and Anterior Vertebræ of Catfish from above.

M, mesethmoid; pm, premaxilla; a, antorbital; n, nasal; e, parethmoid; fr, frontal; s, sphenotic; p, pterotic; ep, epiotic; t, supraclavicle; so, supraoccipital spine; 4, transverse process of fourth vertebra.

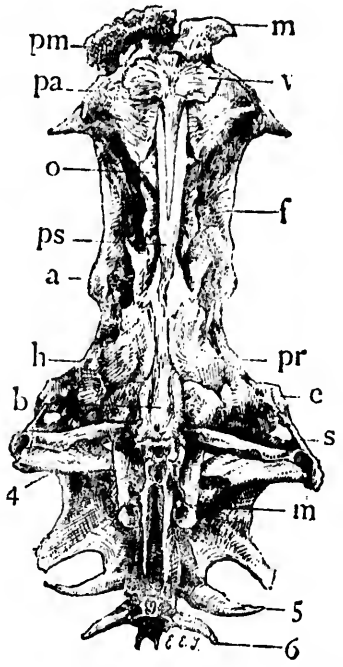


Fig. 3 B.—Cranium and Anterior Vertebræ of Catfish, from below.

Pm, premaxila; m, mesethmoid; v, vomer; pa, parethmoid; o, orbitosphenoid; f, frontal; ps, parasphenoid; a, alisphenoid; pr, prootic; h, articular surface for hyomandibular on sphen, and pterotics; b, basioccipital with exoccipitals on either side; s, supraclavicle; m, "malleus;" 4, 5 and 6, transverse process of 4th, 5th and 6th vertebræ.

gristle or cartilage being only partly replaced by bones. In the Catfish, however, there is little of this left in the adult fish. Attention is called to the position of the vomer the teeth on which sometimes furnish easily accessible characters to the systematic zoologist. It is applied to the under surface of bones formed in cartilage, the foremost of which, the middle ethmoid, carries in front the premaxillæ, tooth-bearing plates which form a considerable part of the margin of the upper jaw on each side and which can in some fish be thrust out from their support or "protracted." The rest of the margin of the gape above is usually formed of the

maxillæ, but these are small in the Catfish and merely serve to support the large barbels. Fig. 4 illustrates how closely the jaws are related to the hyoid arch,

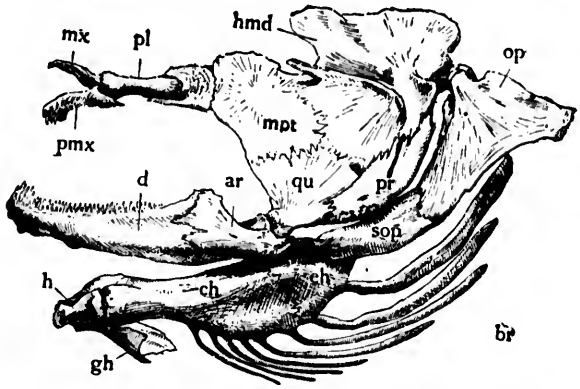


Fig. 4.—Jaws and Hyoid Arch of Catfish, from the side.

Mx, maxilla; pmx, premaxilla; pl, palatine; hmd, hyomandibular; op, operculum; mpt, metapterygoid; qu, quadrate; pr, preoperculum; sop, interoperculum; d, dentary; ar, articular; h, hypohyal; gh, glossohyal; ch, ceratohyal; eh, epihyal; br, branchiostegal rays.

which is similar in general character to the following gill-arches, but which is altered in form by reason of its carrying the jaws and the skeleton of the gill-cover. Indeed the jaws are regarded as another similar arch in front of that, formed of an upper palato-quadrate and a lower mandibular segment, part of the latter carrying teeth (dentary) and part forming a joint with the quadrate, but all suspended to the skull by the hyomandibular, the upper part of the hyoid arch. The lower part of this arch is sub-divided as shown in the figure, and forms a bony support for the tongue, while its hinder margin performs, with the attached branchiostegal rays, a similar function for the free part of the gill-cover, these rays being related to it in a manner somewhat similar to that in which the bones of the gill-cover—preoperculum, operculum proper, and interoperculum (there is no suboperculum in the Catfish)—are related to the hyomandibular part of the arch.

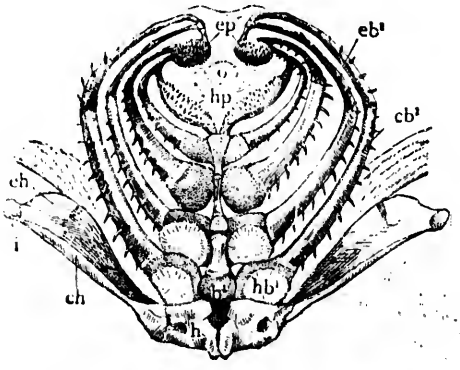


Fig. 5.—Visceral Skeleton of Catfish.

H, hypohyal; ch, ceratohyal; eh, epihyal; i, interhyal; b¹, first basibranchial; hb¹, cb¹, eb¹, hypo-cerato- and epibranchials of first arch; o, œsophagus; ep and hp, epi- and hypopharyngeal tooth plates.

The mode in which the skeleton of the gill-arches proper is sub-divided and the relationship to the superior and inferior pharyngeal (epipharyngeal and hypopharyngeal) tooth-plates, may be gathered from fig. 5.

The vertebral column is formed of vertebræ, each of which has a rounded body hollowed out on both faces (amphicœlous), from which there projects an upper arch protecting the spinal cord and terminating above in an upper or neural spinous process (fig. 6). Between the neural spines are inter-spinous bones which

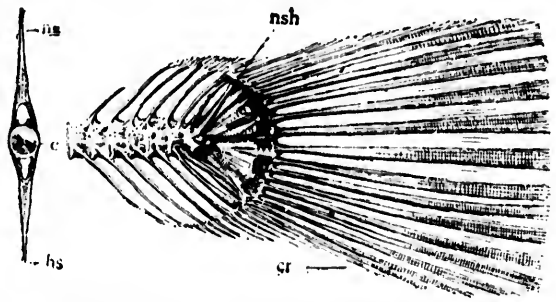


Fig. 6.—Caudal Vertebra and Caudal end of Vertebral Column in the Catfish.
Ns, neural spine; c, vertebral centre; hs, hæmal spine: nsh, bony sheath of the notochord; cr, caudal rays.

carry the fin-rays of the unpaired fins. In the tail region there are also ventral arches and spines which protect the blood-vessels running to the tail, and the ribs further forward in the trunk region correspond to these, although they do not meet in the middle line below.

The caudal fin of the catfish appears quite symmetrical, and in some species (plate 5), is equally forked; a close inspection of the skeleton, however, shows that it is chiefly situated on the lower surface of its axis, which is here abruptly turned up. This apparent symmetry (homocercal condition) is absent in some fish like the Sturgeon, (plate 1), where the vertebral column turns up, sub-dividing the tail very plainly into two unequal lobes (heterocercal condition).

In the catfish some anterior vertebræ are united very intimately to each other, and to the skull and pectoral arch, in consequence of certain peculiar connections between the ears and the air-bladder, but this is not usual in fish.

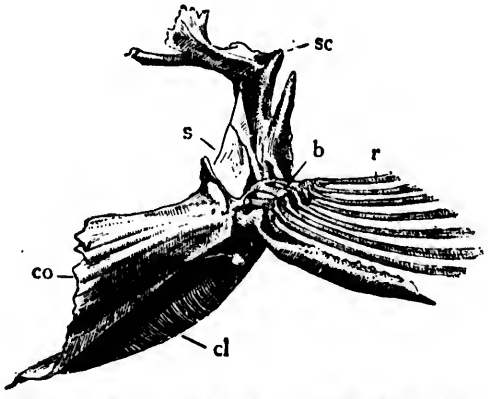


Fig. 7.—Pectoral Girdle of Catfish from behind.
Co, coracoidal, s, scapular portion of primary shoulder-girdle; cl, clavicular, sc, supra-clavicular portions of secondary shoulder-girdle; b, basal elements, r, rays of the fin-skeleton.

On the other hand the union of the pectoral arch to the skull is not uncommon, and is effected by a three-pronged bone, the supraclavicle or suprascapula (fig. 7). The arch is formed of right and left halves which fuse with

each other in the middle line below, but each half at an early date is formed of two elements, a primary element formed in cartilage, and a secondary larger one formed beneath the skin. The so-called basal elements of the pectoral fin correspond in part to the limb bones of higher animals, but they are unimportant in size as compared with the fin-rays, the foremost of which can be set and used as an effective weapon by the catfish.

Systematic zoologists rarely employ the form of the viscera to any extent in framing comparative descriptions of different species. The following points as to the arrangement of the viscera should, however, be noted.

The intestinal canal is a comparatively short tube which is marked off into three regions, the stomach, small intestine and large intestine. All these parts are supported to the wall of the body-cavity in which they lie by the mesentery, and another part of the same membrane the "peritoneum" also lines the body-cavity. Its colour may vary from black to silvery. Connected either permanently, or in the young fish merely temporarily, with the gullet is the air-bladder, a part of the intestine which serves as a float, and may have other subsidiary functions.

The stomach may merely be a slightly enlarged part of the intestinal tube, but may have a blind projection as in the catfish, "cœcal type," or be bent into U-shaped form, "siphonal type." It is separated from the first part of the small intestine by a muscular valve, the pylorus, from which a number of blind tubes attached to this part of the intestine in many fishes (but not the catfish) derive the name of *pyloric cœca*. Opening into this part of the intestine also is the bulky liver, which is provided with a large gall-bladder.

The heart in the catfish is situated far forwards in the region of the throat. It collects the blood from the veins and drives it up the gill-arches, from which it flows out at the top into the dorsal aorta as arterial blood. Behind the air-bladder is the kidney, formed of right and left halves intimately united, and connected by folds of mesentery with the dorsal surface of the body-cavity are the ovaries in the female (the roe) and the testes (the milt or soft roe) of the male.

As a general rule the eggs of fish are fertilised after they have been deposited by the female, and it may be observed that the fewer the eggs are in number the more anxiously are they looked after by one or both parents. The various species of catfish all appear to be attentive to the fry for some time. Some notions as to the development from the egg may be gathered from fig. 8. While still within the body of the mother, the egg measures about one-eighth of an inch in diameter; it has two coats, the outer of which is penetrated by minute canals through which the necessary nourishment for the growth of the egg passes inwards. When the egg is laid, the space between the two coats increases in size and the two constituents of the yolk) the formative yolk, which gives rise directly to the body of the embryo, and the large food-yolk which is utilized as food by the embryo) formerly evenly distributed, now tend to accumulate at opposite poles. The formative yolk with its contained nucleus begins to divide, the result being a disc of small cells lying on the surface of the food-yolk. The cells gradually extend over the whole of the egg, those at the formative pole arranging themselves into the three layers of the embryo, which already during the second day assumes a fish-like form. It is from these three layers that all the organs of the fish are developed. The embryo does not escape from its shell till the sixth day, when, although only one-third of an inch in length, development has already advanced to a considerable extent. Thus the heart is seen in front of the yolk-sac, from the vessels of which it collects the blood enriched by contact with the yolk, and propels it by way of the gill-arches throughout the entire system. After all the food is

extracted from the yolk-sac, the latter is absorbed, and the young fish begins to feed for itself. At the end of three months the adult form is attained, the fish being then hardly an inch in length.

The length of time which the hatching process takes, and the rapidity with which the developmental process runs vary much in different species of Teleosts, and is largely dependent on the temperature of the water, spawn deposited in

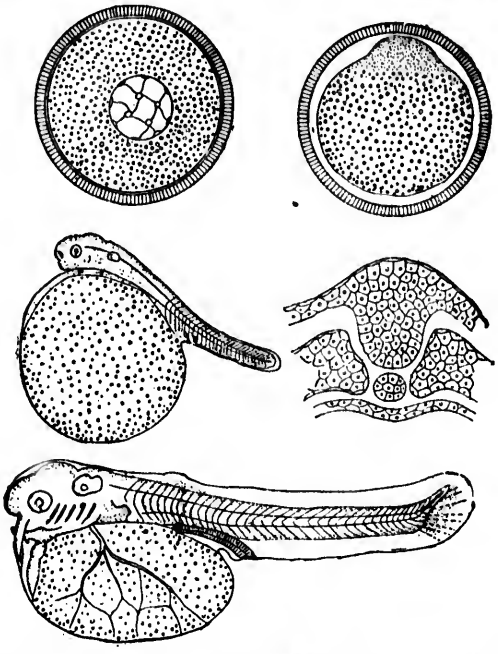


Fig. 8.—Diagram of several stages in Development of Catfish. (Modified from Ryder).

1, ovarian egg; 2, egg in which formative yoke has separated to upper pole; 3, embryo of second day; 4, section through such an embryo, showing epiblast with nervous system above, hypoblast below, and between them the mesoblast and the notochord; 5 embryo of sixth day.

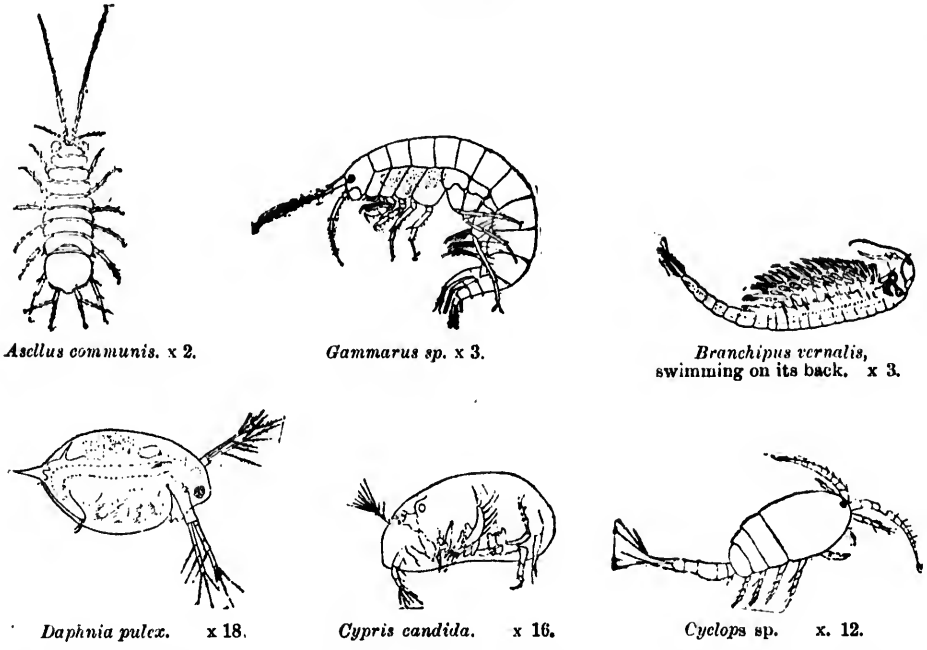
the cold water of October and November not hatching till the following spring in contrast with the rapid process depicted above, which occurs in the early summer. The great difference in size which is to be observed between the eggs of different species is not merely proportional to the size of the species, although, as we shall find, large varieties of brook trout lay larger eggs than small varieties; it is largely a question of the relative amount of food-yolk provided for the embryo, and may be therefore also attributed to the hatching habit of the species, the longer or shorter time which the embryo takes to burst the egg-shell and to begin to feed for itself.

The following table gives the number of eggs that have been counted to a quart in different species:—

Mackerel	1,267,728
Pickerel (*Stizostedium vitreum*)	120,000
Whitefish	36,000
Striped Bass	24,363
Brook Trout	11,000
Lake Trout	8,720
Atlantic Salmon	4,272
Winninish	3,300

Teleosts differ very much in the nature of their food and in their manner of securing it. Some, like the Catfish, Sturgeon and Suckers, are bottom feeders, and such are often furnished with protractile lips, the better to secure the molluscs, worms, aquatic insect-larvæ or fish-spawn on which they live. Others, like the Whitefish, are dependent on the crustacean life with which our fresh waters swarm, (fig. 9), the young living on the minute *Entomostraca*, the adult on the

FIG. 9.



Asellus communis. x 2. *Gammarus sp.* x 3. *Branchipus vernalis,* swimming on its back. x 3.

Daphnia pulex. x 18. *Cypris candida.* x 16. *Cyclops* sp. x. 12.

larger shrimp-like forms. Others again, more agile, leap to secure the insects on which they feed, while many are carnivorous, feeding on other smaller species of fish. Unquestionably the microscopic life of the fresh waters is the prime source of much of the food of our fresh water fishes, and most comprehensive investigations are therefore being carried on in regard to the life of the larger bodies of fresh water in Europe with the object of ascertaining the conditions which appear favourable to the abundance of food-material of this character, and the species which appear to contribute most to the sustenance of the fish.

As the smaller species of fish serve as food for the larger rapacious forms, which may thus be regarded as inimical to them, so also the various fish-eating birds and reptiles may be regarded as enemies of the class. There are, however, some more insidious enemies which are deserving of mention—the various fish-eating insects, and the various parasites, animal and vegetal, which afflict fish.

Amongst the former are specially to be noted the larger water-beetles, *Dytiscus* and *Acilius*, which may completely devour small fish by the aid of their rapacious jaws; the larger and smaller water-bugs and water-boatmen, *Belostoma*, *Notonecta* and *Ranatra*, which attack fish by grasping them with their powerful front legs and then sting them and suck their blood by their sucking proboscis.

Among the latter are to be distinguished the crustacean parasites of the gills (fig. 10) or of the surface of the body, which may become so numerous as to cause death (p. 446). Again there are various worm parasites (no species of fish is exempt from its share) which, however, appear rarely to cause any serious mortality. In many cases unripe stages of such worm parasites occur in fish, which only reach their full development in fish-eating birds, but one

Fig. 10.—*Ergasilus* with egg-sacs from gills of sunfish. × 10. *Achtheres* from gills of catfish × 6.

species of such immature forms occurring in the Pike, and possibly also in some Salmonoids, is the larva of *Bothriocephalus latus*, the broad tape-worm of man. It is only found abundantly in those northern countries where fish are eaten raw. Among the worm parasites may be mentioned certain thread-worms which (like the guinea worm) live in the skin of their host, and may often cause serious abscesses in the fins of affected fish. Certain leeches (*Piscicola*) also may attach themselves to the skin and suck the blood of their victims with fatal results.

Obscure diseases of fish of epidemic character have not been properly investigated yet. Some are no doubt attributable to bacteria, others, like the salmon disease, to more visible fungus-growths such as *Saprolegnia*, but the subject of the wholesale dying-off of fish is one which requires further looking into.

Preservation of Fish.

Should any reader of this report desire information as to any particular variety occurring in his locality, he is invited to send specimens to the author at the University of Toronto. These ought to be suitably preserved before shipment, either by putting on ice when caught and shipping promptly, or by immersion in a strong pickle formed of 1½ lbs. salt, ¼ lb. saltpetre and ¼ lb. boracic acid to the gallon of water, or in strong spirits of wine. The preservative fluid used should be poured into the mouth, and if possible injected into the vent and through a small slit into the body-cavity. When alcohol is used as a preservative fluid it should be diluted with one-third water, so as to obviat shrinkage of the tissues, and changed once or twice before shipment. The label accompanying a specimen should always give the exact place and date of capture, and any other information which occurs to the collector, such as colouration when fresh, which is especially desirable if alcohol is used as the preservative fluid.

NATURAL HISTORY OF ONTARIO FISH.

The Class of the Fishes is divided by zoologists into six sub-classes, containing:—

I. The Lancelet or Amphioxus.
II. The Lampreys and Hag-fishes.
III. The Sharks and Rays.
IV. The Ganoid Fishes.
V. The Teleost or Bony Fishes.
VI. The Dipnoi or Lung-Fishes.

Of these the 1st and 3rd are not represented in fresh waters, and need not concern us here. With few exceptions our fish belong to the fifth sub-class.

Sub-class II.—Cyclostomi.

The fishes that belong to this group are eel-like forms of parasitic habits, attaching themselves by means of their circular mouths to larger fish, of which they suck the blood. Their skeleton differs very much from that of other fish: it consists of a brain-case formed of cartilage, supports for the gills of the same material, and a notochord running underneath the spinal cord. There are no true jaws, nor limbs, nor ribs as in other fish. One of the families—the Myxinidæ—is entirely marine, the other—the Petromyzontidæ—has some fresh-water species.

They are at once recognized by the circular sucking-mouth (fig. 11), the horny teeth within it, the single nostril on the top of the head, and the separate openings of the seven gill-pouches on each side of the head.

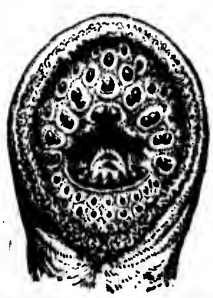


Fig. 11.—Mouth of River Lamprey. (*Petromyzon concolor.*)

The only species in Ontario waters is *Petromyzon concolor*, the Silvery Lamprey, a small species of no economic importance found in the Great Lakes and living partly as a parasite of the lake Sturgeon, to which it attaches itself and forms

raw sores by the aid of its rasp-like teeth. They ascend brooks in spring to spawn, and it is probable that the young are at first toothless and blind, living in sand until they attain a considerable size. Further information is desirable as to this Lamprey from a scientific point of view, but it is of no economic importance, whereas the Marine Lamprey, which attains a size of three feet, was formerly much valued as an article of food. It ascends rivers in the spring to spawn and resembles, therefore, in this respect its representative in the lakes.

Sub-Class IV.—The Ganoidei.

This group embraces but few living forms—most of them North American—but very many fossil representatives are known, so that the living species are really only to be regarded as straggling survivors of a formerly numerous group.

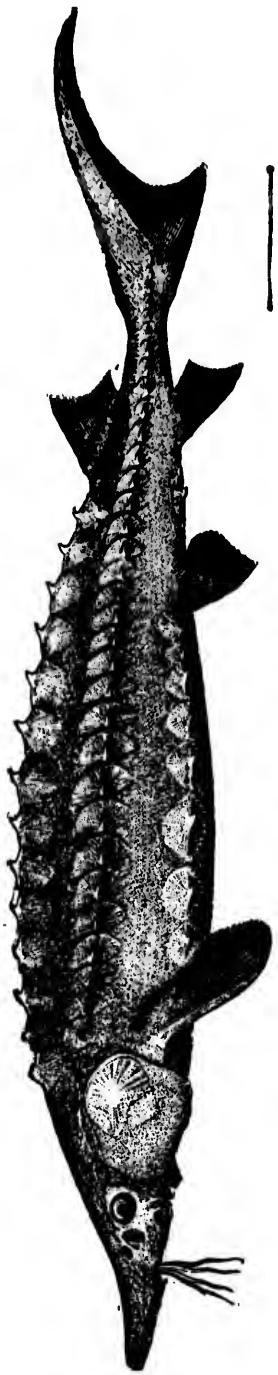
The name Ganoid is taken from the enamelled scales so well developed in the bony pike. In many respects the structure is intermediate between that of the Sharks on the one hand, and that of the Teleosts and Lung-fishes on the other.

Two divisions of the group are recognized—the cartilaginous and the bony Ganoids. Both are represented in Ontario, the one by the Sturgeons (family Acipenseridæ), the other by the Bony Pikes or Gar Pikes (Lepidosteidæ) and the Mud-fishes (Amiidæ).

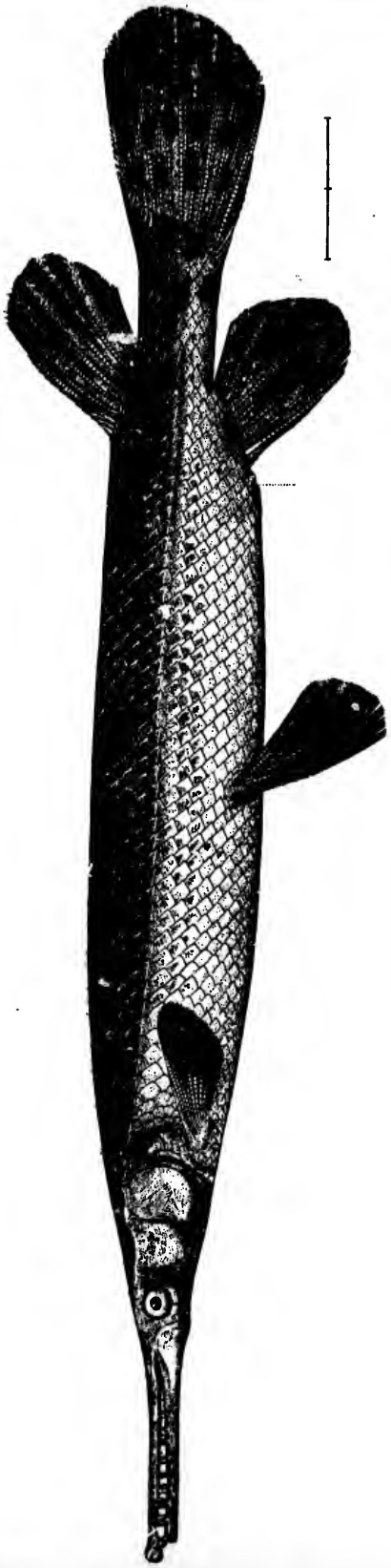
Of the various families the Sturgeons (*Acipenseridæ*) approach most closely to the Sharks in their structure. Thus the skin possesses minute bony plates roughened with teeth which recall the shagreen of the Shark. The skeleton is cartilaginous throughout, although the skull is encased by a series of flat bones formed from the skin, and similar in this respect to the bony shields on the trunk. The latter are very characteristic for the family; they are in five rows—a median dorsal series and a lateral and ventral series on each side—all are keeled and provided with a spine. The snout or rostrum, which is of considerable size in the allied paddle-fishes (*Polyodon*) and shovel-nosed Sturgeons (*Scaphirhynchus*) of the Mississippi Valley, is conical in form and carries in front of the mouth, which is on the under surface, a row of four barbels. The Sturgeons are bottom feeders, the position of the mouth and its protractile lips are therefore very advantageous for this kind of life. The air-bladder is of large size and has a wide opening into the gullet.

The pectoral and ventral fins are situated low down, the latter far back, but still in front of the dorsal and anal fins, which are similar in form and are separated from the caudal fin by a slenderer part of the tail the "caudal peduncle." The caudal fin is unequally divided by the continuation of the vertebral column, and is distinctly "heterocercal." The gills are, however, much more like those of the Teleost, consisting of a double row of gill-filaments attached to each of the four gill-arches, and, in addition, of a single row attached to the hyoid arch, the so-called opercular gill. The free edges of these look into the gill-chamber, which is enclosed by an operculum, in which, however, only two of the four bones usual in the Teleosts are found. There are no branchiostegal rays. Another rudimentary gill (the pseudobranch) is situated within a rudimentary gill-slit between the jaw and the hyoid arch, known as the "spiracle," and common in the Sharks and Rays. Although the pseudobranch is frequently present in the Teleosts, the spiracle itself is always absent, and it is hardly to be detected in the other families of Ganoids referred to.

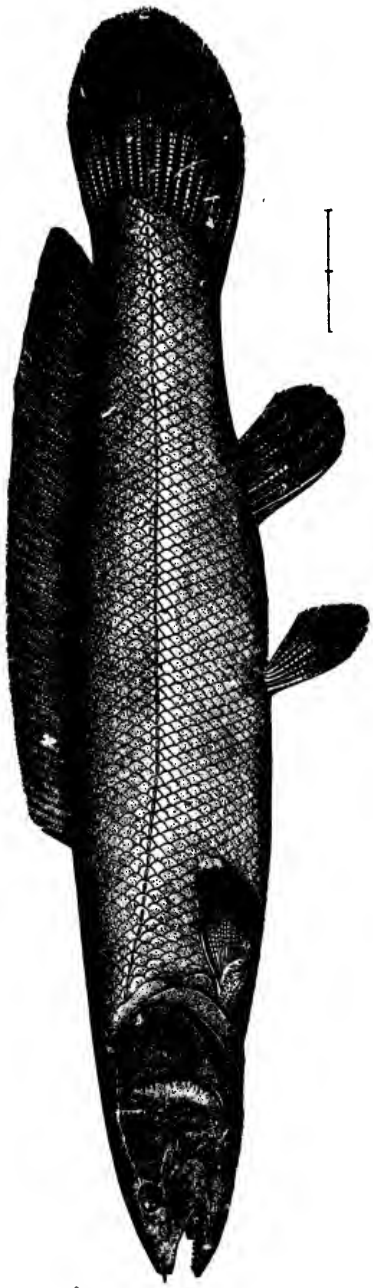
The only member of the family occurring in the Province is the Lake Sturgeon or Rock Sturgeon (*Acipenser rubicundus*). Like the other members of the genus, this species attains a considerable size, up to six feet, and to a weight



The Lake Sturgeon (*Acipenser rubicundus*).



THE SHORT-NOSED GAR-PIKE (*Lepidosteus platystomus*).



The Bowfin or Mudfish (*Amia calva*).

of from 50 to 100 pounds. Most of the other species are marine forms that only ascend rivers to spawn, but this one is permanently confined to the lakes. It varies much with age, the young having a slender long snout, which becomes quite blunt in the adult, also sharp hooks on the bony shields, which become smooth with age, while the ventral shields grow smaller and finally disappear. The dorsal shields average 13 in number (11-16), the laterals 34 (30-39), the ventrals 8-10, while the fin-formula is D 35, A 26.

This species owes its scientific specific name to the reddish colour of the sides of the body; the dorsal surface, however, is dark in hue.

The Sturgeon is hardly appreciated at its true value in Ontario, the greatest proportion of the fish caught in Canadian waters being shipped to the States for sale. It is a fish nevertheless, of high economic importance, its flesh being of excellent nutritive quality and good although somewhat meaty flavour. The sounds or air-bladders furnish the best quality of isinglass, and the roe the expensive delicacy "caviare," but these accessory products are not properly taken advantage of in the Province.

On the whole the Sturgeon frequents comparatively shallow water, and is therefore oftener taken in pound-nets than in gill-nets (p. 464) but it is most easily captured in the spring of the year at spawning-time when numbers congregate about the mouths of rivers. The spawning time may be as early as the middle of May, but in Lake Superior it is delayed till July. At this time the habits of the fish render them comparatively defenceless; they run in schools, depositing their spawn along seams in rocky ledges as has been observed at the head of the Niagara River, the females followed by the males, and both rolling over and over on the bottom, and then suddenly leaping from the water and falling back with a splash. They can often be successfully gaffed, or taken by hauling a grapnel hook along the bottom—a method which must wound many fish which afterwards escape; finally they are sometimes speared even in comparatively deep water (25 to 30 feet) by Indians, by means of a long spear with detachable handle, the iron of which has a line fastened to it.

The eggs are of large size (one-ninth of an inch in diameter) and very numerous (from one to two millions in a large fish). Comparatively few of these can meet with the necessary conditions for their successful development, as the adults are not met with in the numbers which might be anticipated.

A comparatively short time—four to five days—suffices for the hatching process, the embryos escaping at the end of this period.

Nothing is known of the food of the embryo fish, but it is undoubtedly formed of minute forms of life which afterwards give place to the shell-fish (*Physa, Planorbis, Limnæa, Valvata, etc.*) on which the adult feeds.

Unlike the Sturgeons, the bony Ganoids are utterly worthless as food, but as before remarked, they have a high claim to scientific interest. They approach the ordinary bony fishes in that the gill-cover has all the four bones, and the branchiostegal rays. The air-bladder is almost lung-like in character and accounts for the circumstance that the fish are able to live out of water for a very considerable time, and are often to be seen leaping and snapping air.

Externally the difference between the Gar-Pikes and the Bowfins or Mudfishes is very marked, for the enamelled coat of armour of the former is far more unlike the scaly coat of an ordinary fish than is the skin of the latter, but in their internal structure they offer a very close agreement.

Three species of Bony Ganoids occur in Ontario, two Gar-pikes (*Lepidosteus osseus* and *L. platystomus*) and the Mudfish (*Amia calva*).

The Gar pikes have an elongated, almost cylindrical body covered with the

obliquely arranged lozenge-shaped scales which are so characteristic of the genus. The jaws are elongated into a beak which is twice the length of the head in the long-nosed species (*L. osseus*), but shorter and broader in the other species. In both the beak is very well provided with teeth, there being several rows of small teeth and one row of larger size.

As in the Sturgeon, there is a hyoidean half-gill attached to the deep surface of the gill-cover, but the spiracles do not open to the outside and are small in size. One of the peculiarities of the skeleton is that the vertebræ instead of having cup-like surfaces as in the *Amia* and the ordinary bony fishes are united by a ball and socket joint, the socket being on the hinder surface of each vertebra.

The remaining representive of this important group, *Amia calva*, is of common occurrence in the Great Lakes and sluggish waters southwards. In various places it is known under different popular names:—Lake Dogfish from its voracity, Mudfish from the waters it frequents, Bowfin from the characteristic long dorsal. In shape the Mudfish somewhat recalls the Shad tribe, and it is perhaps to this division of the bony fishes to which it is most nearly allied. All naturalists are agreed that the Amia is the leading representative of an extinct transition group between the ancient Ganoid fishes and the modern Teleosts.

From the latter, however, there are still many points of distinction; such as the completeness of the cartilaginous skull under the outside dermal bones encasing it, the presence of a similar dermal bone between the lower jaws and of two peculiar file-like structures attached to the hinder edge of the gill-opening.

The general colouring of the Mudfish is dark olive-green above, pale below, but the males are marked by a round black spot bordered by yellow at the base of the caudal, which is absent in the females.

Sub-Class V.—Teleostei.

The general structure of the Teleosts has been described on p. 429; it now remains to give some details as to the peculiarities of the various subdivisions of the group.

They are primarily classified into Physostomous and Physoclystous Teleosts:—*i.e.* those in which the air-bladder opens into the gullet in the adult, and those where it is completely shut off. Even in those forms where the air-bladder does open by a tube into the gullet, its importance as a breathing organ is quite unlike that in the Bony Ganoids, and its functions are therefore regarded as being more closely related to the locomotion of the fish. Those Teleosts in which the air-bladder is closed are regarded as further removed from the Bony Ganoids than the others, and it is therefore desirable to treat of the latter first

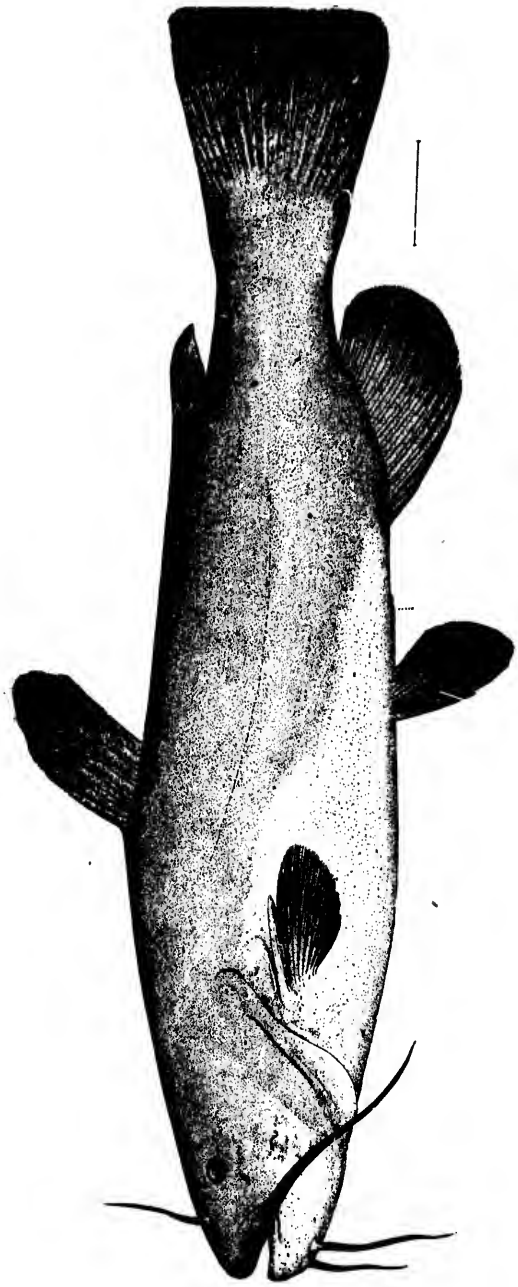
Physostomi.

In this division the scales are usually cycloid, and the fin-rays (with the exception of one or more anterior ones, modified into defensive spines) soft.

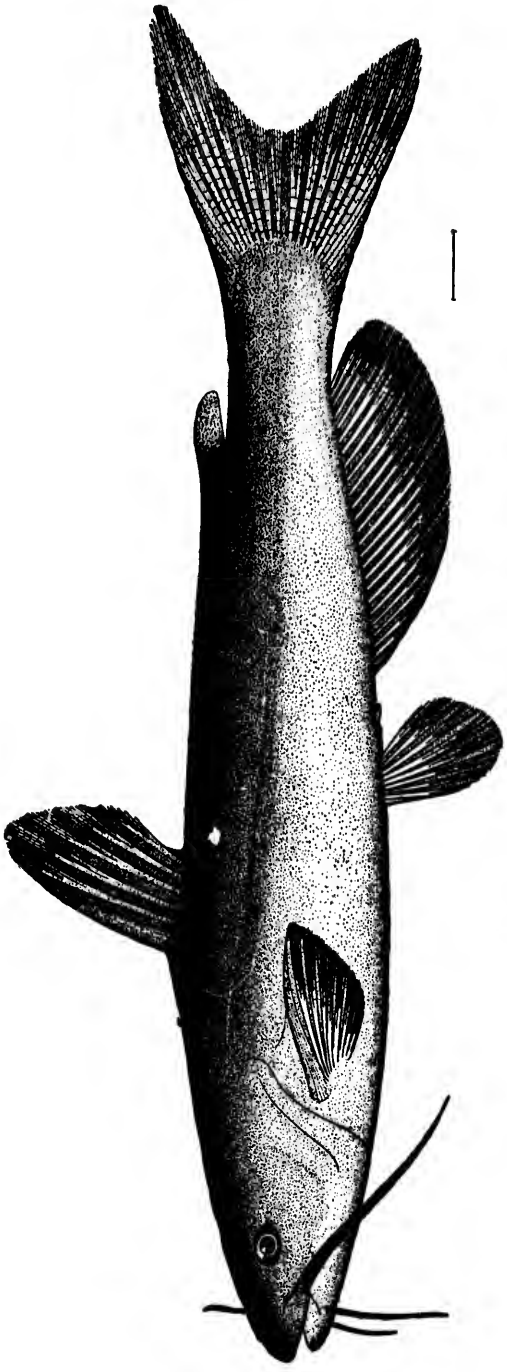
The most primitive families are undoubtedly the Catfishes, Suckers and Minnows, and they all agree in possessing the connection between the air-bladder and the ear referred to at p. 434, besides other anatomical features which it is impossible to describe.

A sufficient account has been given above of the structure of a typical representative of the family Siluridæ, and it only remains to make a brief reference to the other species of the family that occur in Ontario.

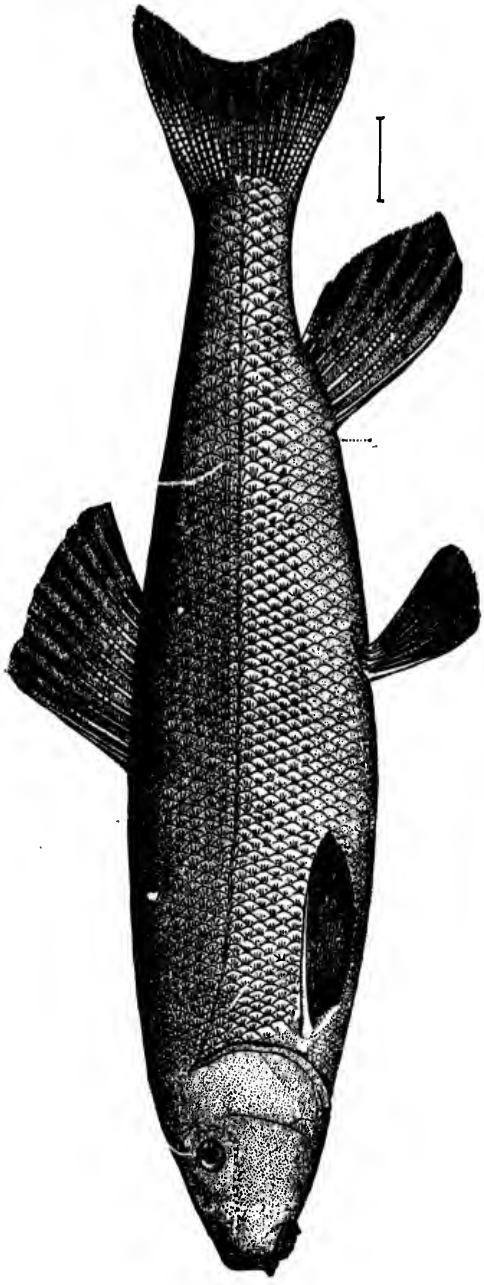
In addition to the ordinary Catfish (*Amiurus nebulosus*), two other species occur within the Province—*A. vulgaris*, which differs in being somewhat slenderer and in having the lower jaw projecting beyond the upper, and



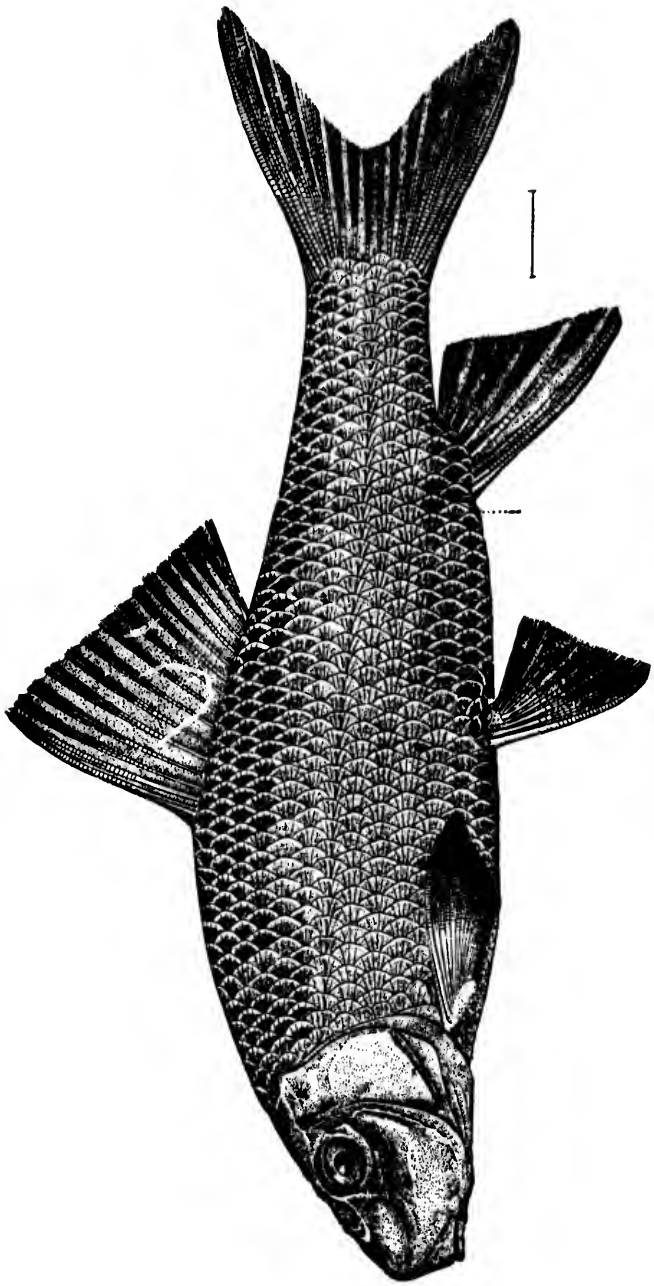
The Bullhead (*Amiurus vulgaris*).



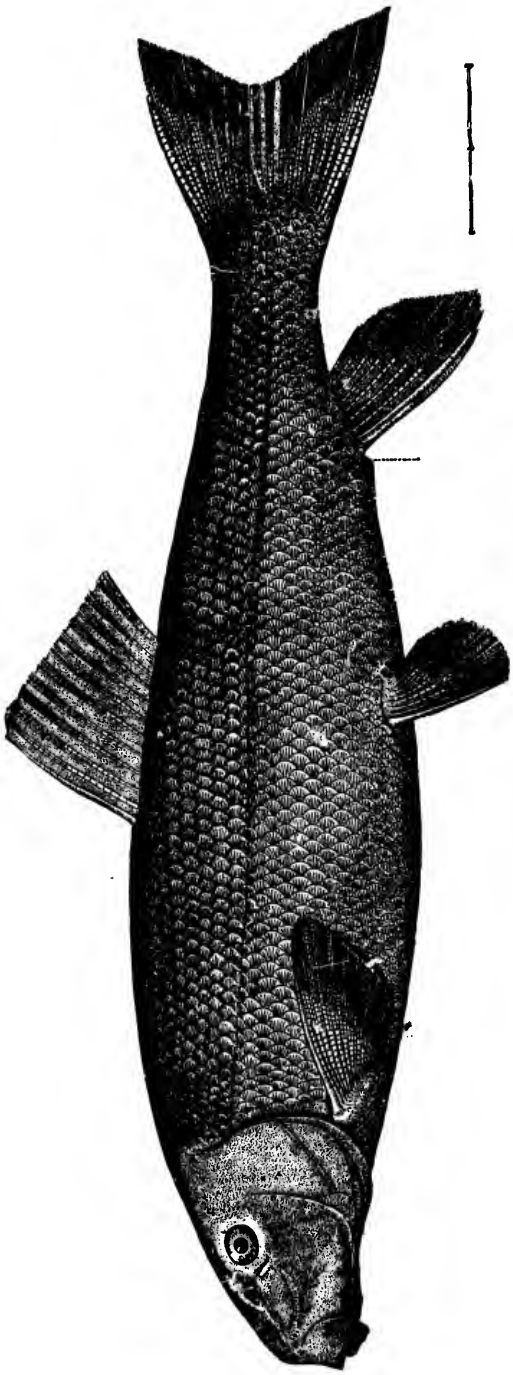
The Great Fork-tailed Catfish (*Amiurus nigricans*).



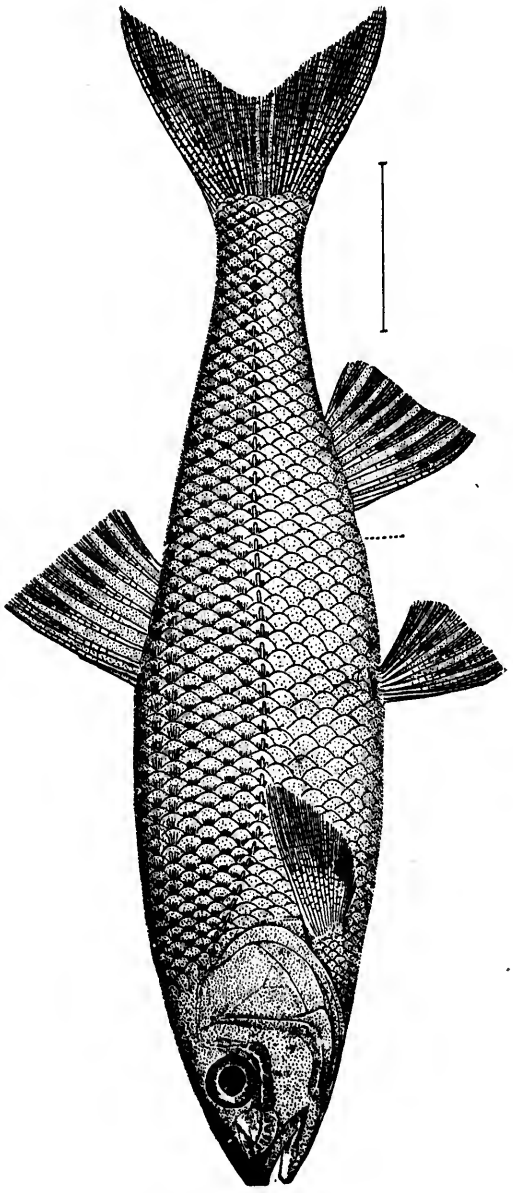
The Common Sucker (*Catostomus teres*).



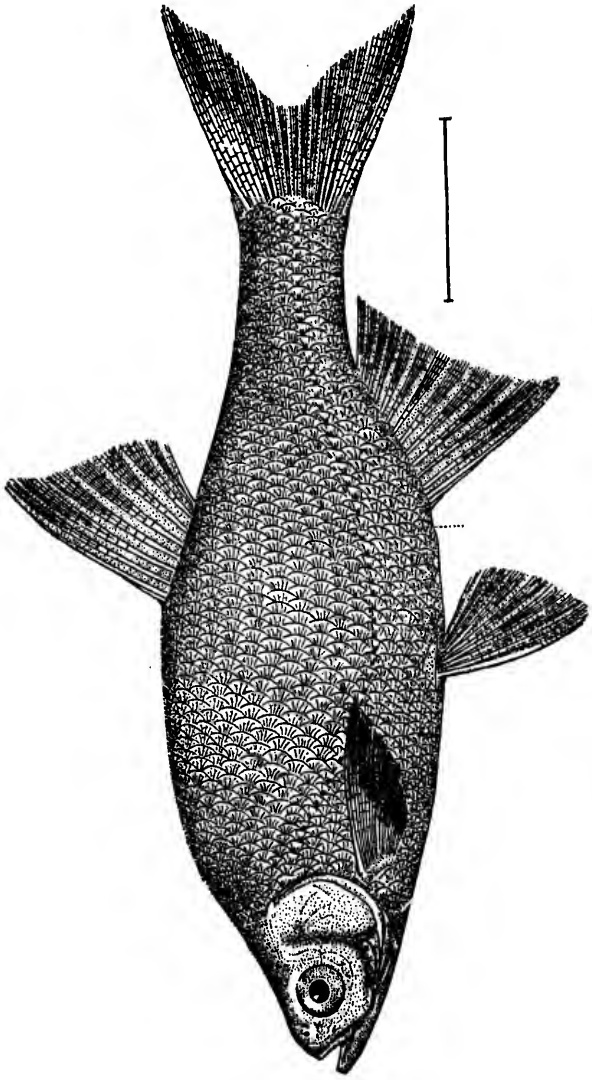
The Carp Mullet (*Mœrostoma carpio*).



The Red Horse (*Moxostoma macrolepidotum*).



The Fall-Fish or Silver Chub (*Semotilus bullaris*).



The Golden Shiner or Bream (*Notemigonus chrysoleucus*).

A. natalis, a species with a broad head and a longer anal fin than the above, (A 24-27). Further information is desirable as to the geographical distribution and any differences of habit of these species.

The great Catfish of the lakes and larger rivers, (*Amiurus nigricans*) plate 5, is at once distinguishable by its great size—it may run to a weight of 100 lbs.—and its forked tail. The young may be known by the fin-formula (D, I, 5; P, I, 9; A. 25) from the above species. Apart from its only being found in large bodies of water, it appears to share the mode of life of the smaller species, but little appears to be known as to the peculiarities, which a species so distinct is sure to possess.

For completeness sake, reference may be made here to the small Stone-Cats (*Noturus*) which are inconspicuous on account of their size (4-5 inches), but differ from the Catfish proper in their habits of lurking beneath stones, and in the length of the adipose fin which is almost continuous with the tail-fin. Two species are reported from the Great Lakes region—*N. gyrinus* and *N. flavus*—the latter being characterized by its serrated pectoral spine.

The Suckers (CATOSTOMIDÆ) are a family of fish which can hardly be said to be of economical importance, for their flesh is coarse, watery and destitute of flavour, but they, like the Minnows, are at least important as furnishing food to the carnivorous fishes. Their great abundance also, especially when they ascend streams in the spring, has caused them to be occasionally used by farmers for fertilizing purposes.

They differ from the Catfishes in their coat of cycloid scales, the conical head narrowing to the small mouth, which is destitute of the surrounding barbels, but has protractile fleshy lips, and toothless jaws. There are no spines as in the Catfish, the anal fins are always shorter than in that family and there is no adipose fin. The air-bladder is divided into two or three compartments, an arrangement which has been supposed to favour sudden changes of the position of the head in swimming, but most probably has some other function.

In addition to the genus Catostomus which gives its name to the family, and to which the Common Sucker (*C. teres*) belongs, four other genera occur in the Lake region, viz.:—*Ictiobus, Erimyzon, Minytrema, Moxostoma.*

The first mentioned, including the Buffalo fishes of the Mississippi Valley and one species from the Great Lakes (*I. Thompsoni*), is at once distinguished by its long dorsal fin of 27 rays, while the others rarely have half as many; of these *Catostomus, Erimyzon, Minytrema*, agree in having the air-bladder divided into two compartments, whereas in *Moxostoma* it has three. Catostomus embraces comparatively small-scaled forms in which 80-100 scales are found in the course of the lateral line, while Erimyzon, Moxostoma and Minytrema have large scales, from 40 to 50 in the lateral line.

Of the numerous species of Catostomus, two, *C. catostomus*, the long-nosed Sucker, and *C. teres*, the common Sucker, are known to occur in Ontario, the former—the larger of the two—being more abundant northward and westward. It is distinguished by the projecting snout which overhangs the mouth, and by the greater number of scales (95-114) in the course of the lateral line as compared with the common species (64-70). Both species indicate their affinity to the next family (*Cyprinidæ*) by the males possessing a special breeding dress in spring, consisting of a rosy lateral band, and numerous excrescences about the head and anal fin.

The Chub Suckers (*Erimyzon sucetta*), are small fish, never exceeding ten inches in length, while the Spotted Sucker (*Minytrema melanops*), which receives its name from each scale having a blackish spot at its base, attains a length of eighteen inches.

Of the large-scaled Suckers the *Redhorses* or *Mullets* are much commoner than the above. The most abundant species is *Moxostoma aureolum*, which reaches the size of two feet and upwards, and is distinguished by a yellowish brown colour and bright red fins, but there is also a silvery form (*M. anisurum*) with a longer dorsal fin (D 15-18 instead of 13).

Closely allied to the Suckers are numerous small fresh-water fish known as Chub, Dace, Shiners, Minnows, etc., belonging to the family CYPRINIDÆ, a family widely represented in the Old World as well, although the Suckers are characteristically North American.

None of them are of any economical importance, except in so far as they furnish food for the larger fishes. Much remains to be learned about the geographical distribution of the family in Ontario, it being a matter of considerable difficulty to distinguish the various species from each other. They differ from the Suckers in that the upper maxillary bone does not contribute to form the border of the mouth. The teeth on the lower pharyngeal bones furnish to naturalists the most convenient way of recognizing the species.

Of the numerous species the following may be noted: *Pimephales notatus*, the fat-head minnow; *Notropis* (*Minnilus*) *megalops*, the Red-fin or Dace, and *N. atherinoides*, the Rosy Minnow; *Hybopsis* (*Ceratichthys*) *dissimilis*, the Spotted Shiner; *Semotilus bullaris*, the Fall-fish or Chub; *Phoxinus elongatus*, the Red-Sided Shiner; *Notemigonus chrysoleucus*, the Golden Shiner, and many others.

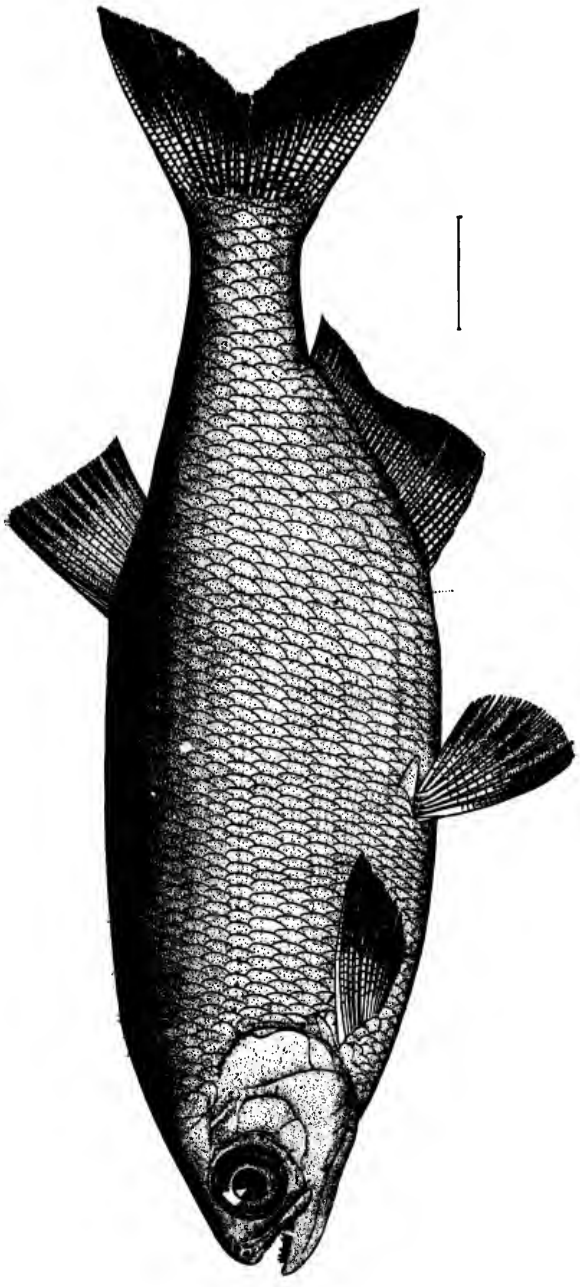
Any description of these forms, sufficient to allow of their correct diagnosis, would transgress the limits of this report. Jordan's Manual of the Vertebrates of North America gives tables facilitating the discrimination of the various species.

In addition to these small Cyprinoids familiar as a group, but less known specifically, are two introduced genera which require some notice. One of these is the gold-fish, *Carassius auratus*, a native of China, and domesticated there for centuries. It is known everywhere as an aquarium fish, and varies very much both in form and colouration. The other is the Carp proper (*Cyprinus carpio*) also an Asiatic fish but valued and cultivated both in Europe and America as a food-fish. Special reference will be made to its peculiarities hereafter, (p. 470).

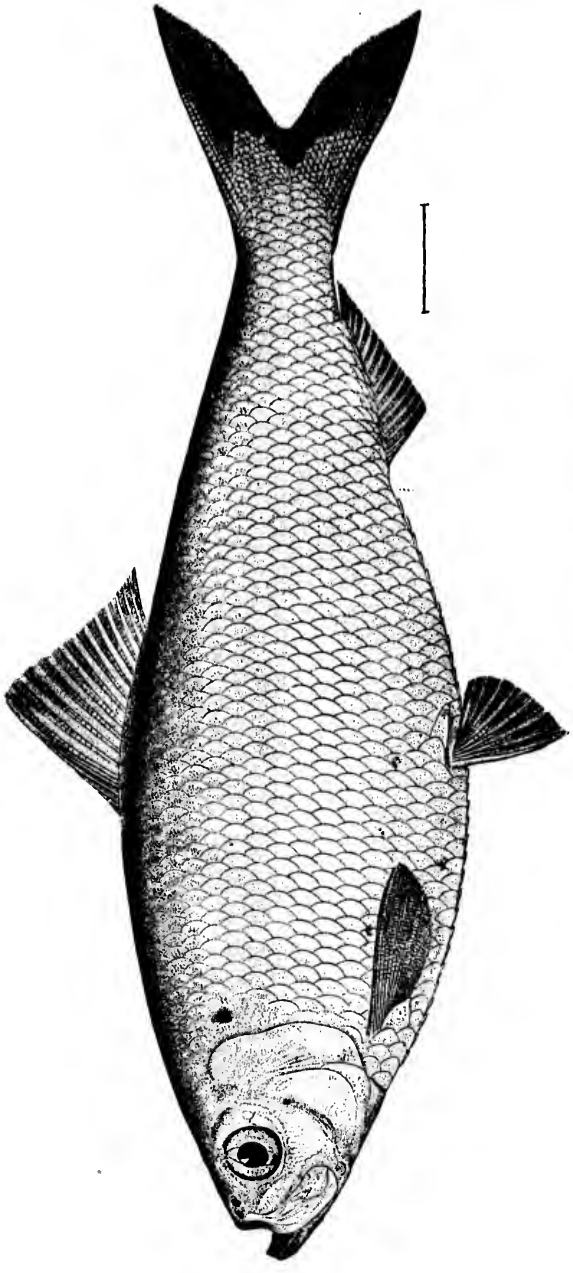
A second natural group of Physostomi is formed of the Moon-eyes, Herring and Shad, which have numerous fresh-water representatives, but are not so exclusively fresh-water in their habits as the preceding families.

In all, the body is compressed and covered with silvery scales usually cycloid and often deciduous. The premaxillaries are not protractile, and the maxillaries contribute to form the edge of the upper jaw. The anal fin is of considerable length although low, and the caudal much forked.

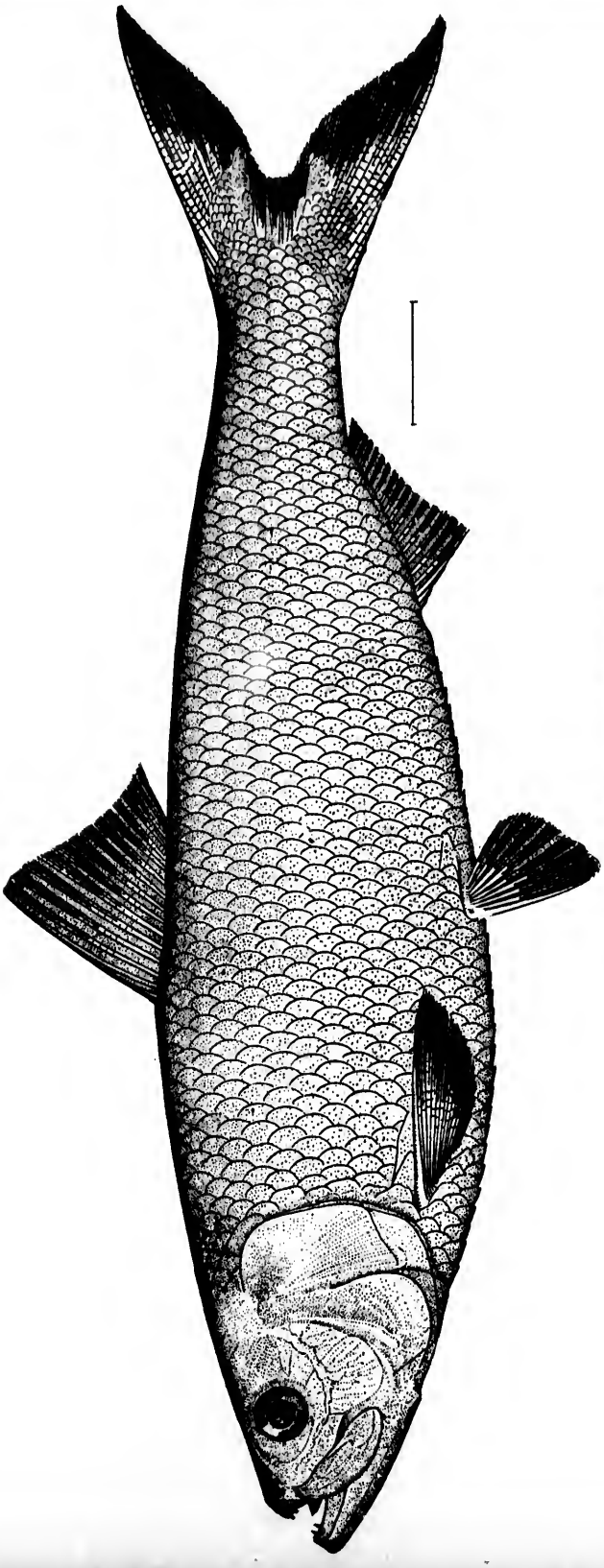
The Moon-eyes are confined to the fresh waters of North America, and belong to a single genus Hyodon which gives its name to the family. The popular name is derived from the very large eyes, the scientific name from the strong teeth with which the tongue is armed. One of the most obvious distinctions from the Herring family is that the teeth are crowded on every available surface of support within the mouth.



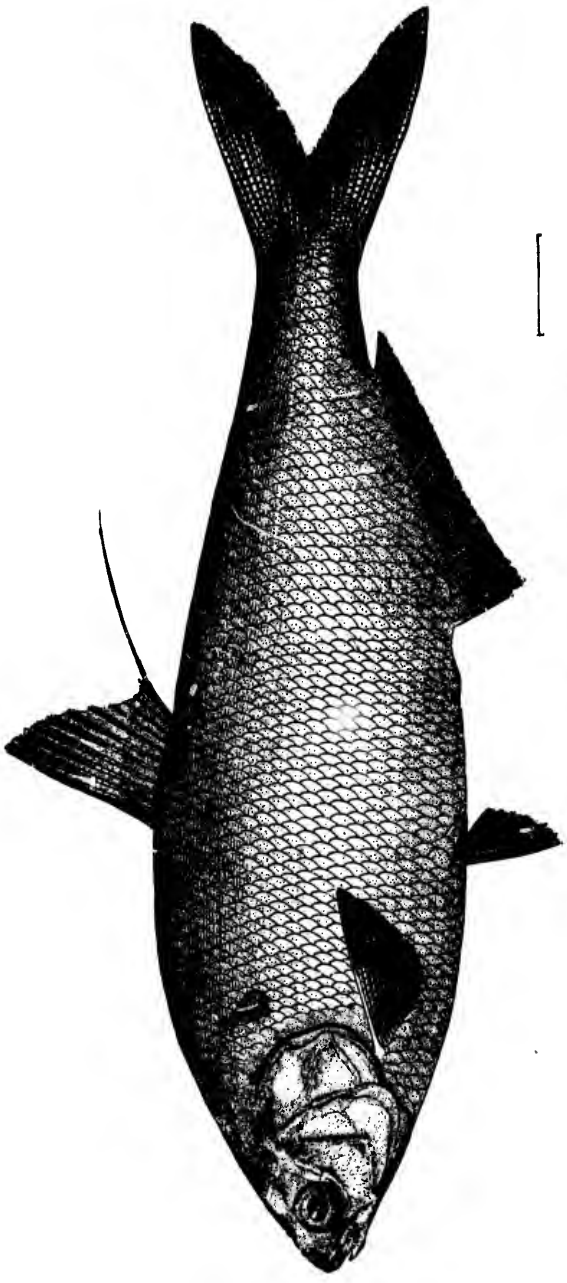
The Moon-Eye (*Hyodon tergisus*).



The Alewife or Branch Herring (*Clupea vernalis*).



The Inland Alewife (*Clupea chrysochloris*).



The Mud-Shad or Gizzard-Shad (*Dorosoma cepedianum*).

The commonest species is the Moon-eye or Toothed Herring of the Lakes (*Hyodon tergisus*): it frequently is taken in pound-nets, but is not regarded as a valuable food-fish. On the other hand the Gold-Eye, *H. alosoides* (so-called on account of the belly coming to a sharp keel as in the Shad) is a fish of some importance in the North-west both commercially and to the sportsman. It is common in the Saskatchewan valley, but is probably confined to that part of Ontario which drains into Lake Winnipeg, p. 428.

The CLUPEIDÆ or Herring family differ from the Moon-eyes in having an almost toothless mouth, but very long gill-rakers; they are all gregarious fish swimming in immense schools, but although many are marine, others, like the salmon, ascend fresh-water streams to spawn, and of these some may become permanently land-locked.

The sea-herring (*Clupea harengus*) is of course one of the most valuable and abundant of food-fish, but it is entirely confined to the sea; the Shad on the other hand (*C. sapidissima*) ascends rivers to spawn and was formerly abundant even in the Lower Ottawa. The only member of the genus, however, which can now be said to be common within the Province is the Gaspereau or Alewife (*C. pseudoharengus* or *vernalis*), introduced into Lake Ontario since 1873 and now very abundant. Another species, the Ohio Shad (*C. chrysochloris*), has been introduced into Lake Erie, but is not valued for food.

One of the marked features of the herrings is the keeled abdomen with its saw-like edge. Teeth may be present on the vomer as in the sea-herring, or on the jaws as in the Shad, or may be absent in the adult as in the Alewife and Shad proper. The latter species is distinguished by the gill-cover being deeper than it is long, also by its finer and more numerous gill-rakers.

The Gaspereau appears to have been accidentally introduced into Lake Ontario when the intention was to plant shad. At least it was formerly very uncommon in the lower St. Lawrence, rarely straggling up higher than Metis. It is still uncertain whether the fish, which appear abundantly every spring toward the end of April, and disappear just as suddenly in September or October, go down to the ocean in the fall and return thence in the spring or whether they merely retire to the deep waters of the lake. The time of their movement is very probably a matter of temperature. They come in towards the shores in immense schools at the spawning season, rising to the surface and rippling it as mackerel do. The schools are composed of adult fish of 8 to 9½ inches in length, and are regarded as a nuisance in the Thousand Island region where they fill the pound and trap nets to the exclusion of other fish. They are, however, valuable from their quantity if not for their quality, and besides furnishing a cheap food the surplus catch can be employed in the manufacture of fertilisers.

Obstacles in the way of river dams, etc., preventing the Alewives reaching their natural spawning grounds and thus diminishing their number, have been regarded by the late Professor Baird as a cause of the decrease of the inshore cod and other fisheries, the Alewives being a favourite food of the carnivorous fish. It is probable that the presence of Alewives in Lake Ontario may re-act favourably on its fisheries by furnishing an abundant food for the larger lake fish. Little is known with regard to the spawning of the Alewife in Lake Ontario: it is said to occur in shoal water in June. The eggs number from 60,000 to 100,000, and are somewhat adhesive; three or four days suffice to hatch them, and the young fish obtain a length of two or three inches before the winter. Immense numbers of dead Alewives are found on the surface of the lake in the early summer; the cause of

their death is obscure, it being hardly possible that the explanation offered as to some of the smaller lakes of New York State—the use of explosives for wholesale killing of food-fish—is the true one.

The shad (*C. sapidissima*) is undoubtedly one of the most important of American food fishes. It used to be abundant in the Lower Ottawa, but the pollution of the river, by sawdust etc., appears to have rendered its former spawning grounds unavailable. Its spawning habits resemble those of the Alewife; the eggs are spun out by the female on to a sandy bar while in rapid motion, and the male scatters the milt at the same time, both sinking slowly to the bottom. Three to eight days suffice for hatching, after which the young escape and are able to swim freely. A ripe shad contains from twenty to forty thousand eggs. The males are smaller (1½-6 lb.) than the females (3½-8) and are earlier mature. The same apparent local instinct is said to be exhibited by the shad as by the salmon; the young hatched in any particular stream returning to it after an interval of two to three years when adult. It is possible that this is to be interpreted by their not going far from the mouths of the rivers in which they have been bred.

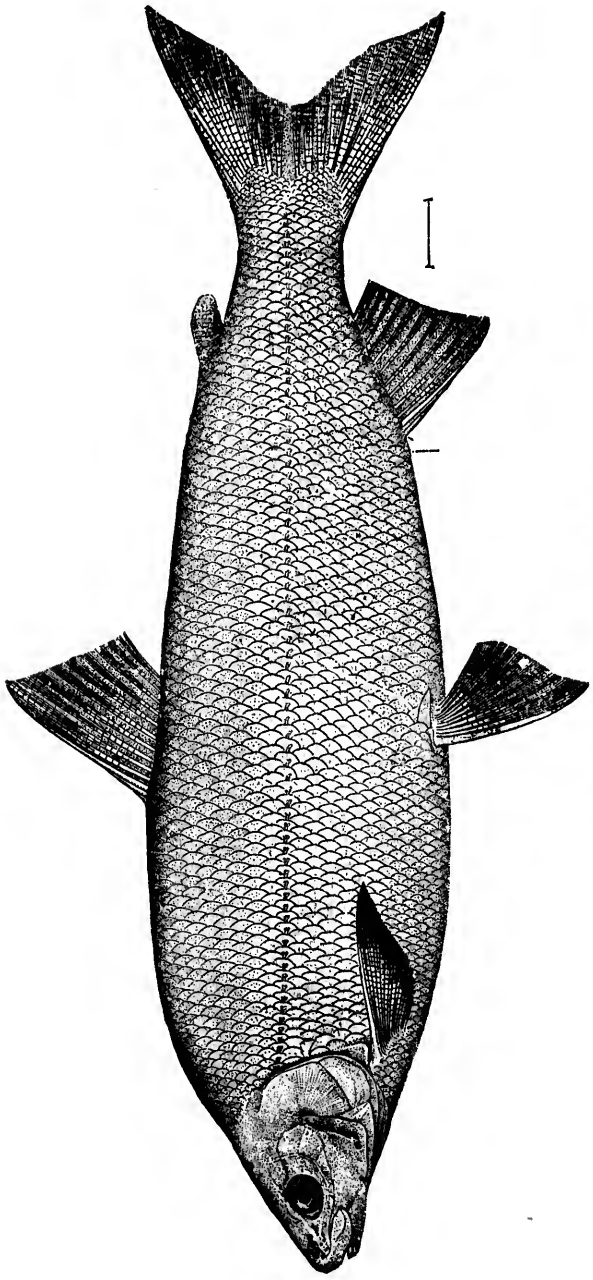
Allied to the shad is a fish of similar form recently introduced into Lake Ontario and Erie, but of no value economically. It is known as the Gizzard-shad (*Dorosoma cepedianum*) on account of its muscular stomach and is further distinguished by the last ray of the dorsal being produced into a long thread. It has occasionally been found dead at the surface in considerable numbers.

By far the most important family of the fresh-water Teleosts, as regards economical value and the number of species, is undoubtedly that of the SALMONIDÆ. Like the foregoing, many of the members are anadromous, living a part of their life in the sea but ascending rivers to spawn. Other forms which are confined to large bodies of fresh water often congregate about the mouths of the rivers falling into them or ascend these for the same purpose. The Capelin (*Mallotus villosus*) and Smelt (*Osmerus eperlanus*) are exclusively marine forms; the Salmon and Trout are found in both salt and fresh water, while the Whitefish, Grayling and Lake Trout are confined to inland waters.

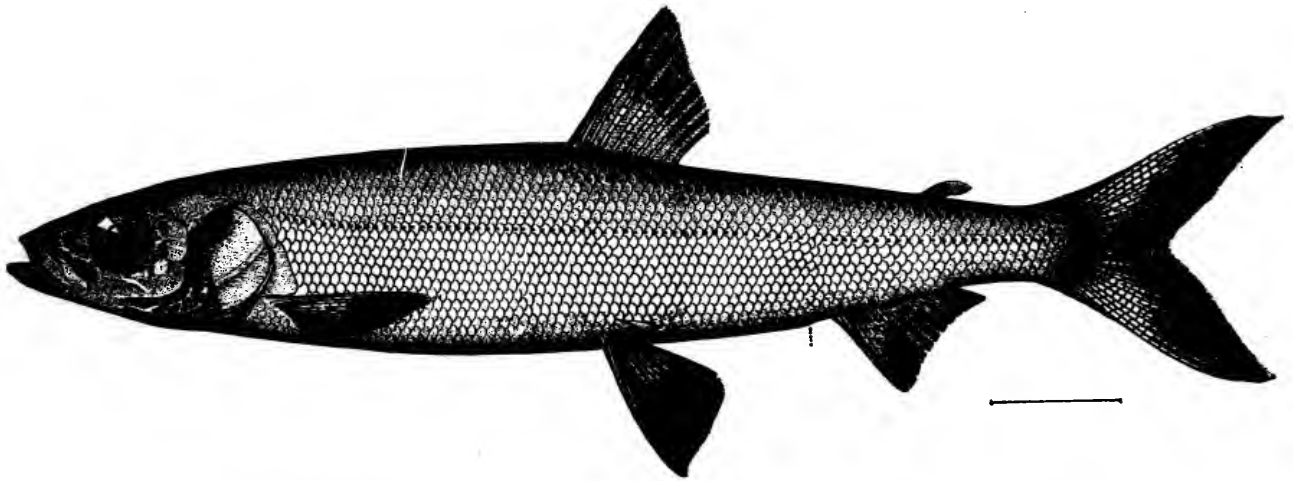
In all of the forms that concern us here, the intestine is furnished with numerous pyloric cœca, which serve to increase its surface. Unlike the shad the abdomen is rounded, and there is present an adipose fin. The Whitefish (*Coregonus*) are distinguished by an entire absence of teeth, and by the large size of the scales. Of the toothed genera, the Grayling (Thymallus) is at once characterized by its long and high dorsal fin, while the Salmon (Salmo) and Brook and Lake Trout (Salvelinus) agree in having teeth on the jaws and tongue, but differ in that the vomer in the latter genus is destitute of teeth.

The genus Coregonus is not confined to North America but is also found in large inland waters—such for example as the Swiss Lakes—in Europe and Asia. The species are somewhat difficult to distinguish, innumerable local varieties being recognized by fishermen, which probably do not deserve to rank as distinct species. The body is compressed in all and the air-bladder very large, the pyloric cœca very numerous, and the eggs numerous and of small size.

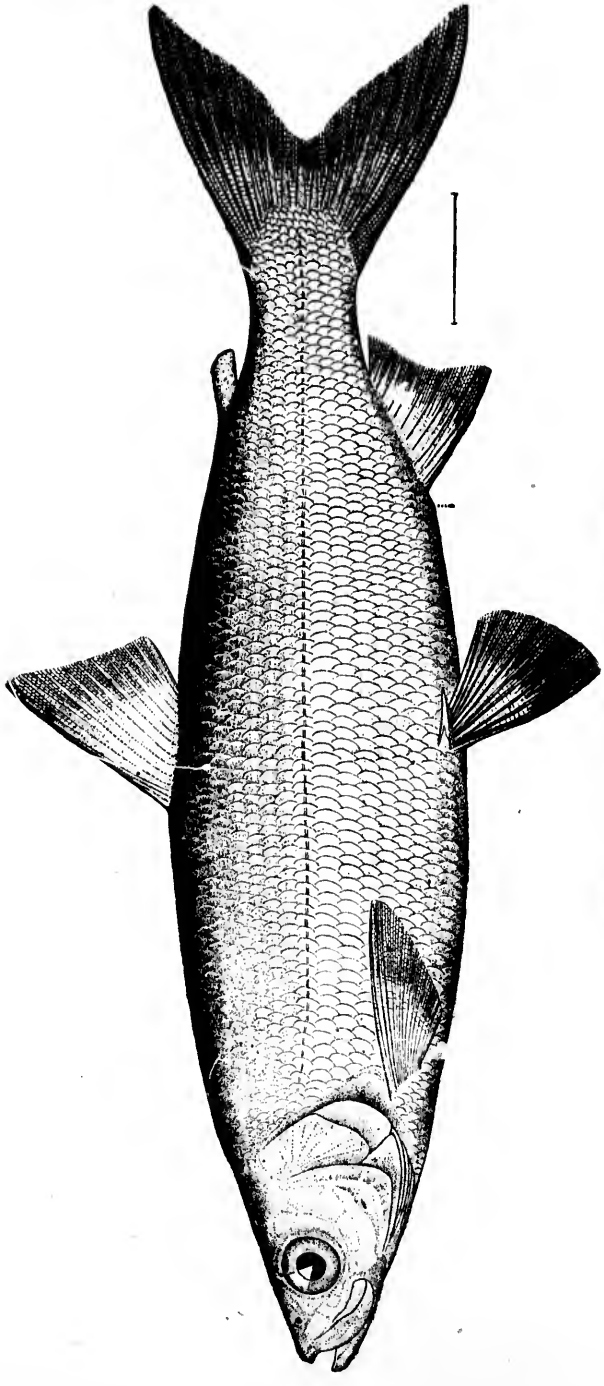
Six species occur within the Province, which may be arranged in two groups according as the lower jaw is included within or projects beyond the upper. To the former belongs the common Whitefish (*C. clupeiformis*), and with it *C. quadrilateralis*, *C. labradoricus* and *C. hoyi*, while to the latter belong the Lake Herring (*C. artedi*) and the Tullibee of Manitoba, (*C. tullibee*).



The Whitefish (*Coregonus clupeiformis*).



THE DEEPWATER CISCO of Lake Michigan, "LONGJAW" of Lake Ontario (*Coregonus hoyi*).



The Lake Herring or Cisco (*Coregonus artedi*).

The common Whitefish is the most important, abundant and widely distributed of these. It is distinguished by its compressed body, its elevated back—a peculiarity especially marked in the adult—and its small short head with obliquely truncated snout.

C. quadrilateralis is rounder in body,(it is the Roundfish of Richardson) and further differs in having a larger head, stouter gill-rakers and a dark-blue colour of the back from the foregoing species, to the size of which it does not reach. It is commoner northward than in the Great Lakes.

C. labradoricus is commoner towards the north-east, as its name suggests, but it is also found in Lake Superior and northward; it has the compressed body of the common whitefish, but the length of head of the Roundfish. It only attains a length of one foot, and has some teeth on the tongue which the whitefish lacks. A whitefish of similar size occurring in the deeper waters of Lakes Michigan and Ontario is known as the Cisco in the former and as the "long-jaw" in the latter; it is distinguished by the bright silvery color of the under parts, but also by the smaller number of fin-rays (D 10, A 10.) and of the scales in a vertical row. In its larger mouth it approaches the Lake Herring (*C. artedi*), which occurs in immense shoals in the lakes and especially in Lakes Erie and Ontario, and is, next to the Whitefish, the most important member of the group. The variety known in commerce as the Cisco of Lake Ontario, is a deep water form, much fatter than the ordinary Lake Herring, and bringing as much as one-third higher price on account of its making better kippers than the other. Lastly the Tullibee, which is commoner in Manitoba than in Ontario, is intermediate to a certain extent between the Lake Herring and Whitefish, but has the deep compressed body of the latter and scales which, being larger in front and peculiarly marked, are characteristic of this species alone.

The Whitefish proper deserves special attention on account of its importance from the economical standpoint. As remarked above it exhibits considerable variation both in size and form. The largest fish are taken in Lake Superior, where they may weigh as much as 20 lb, whereas in Lake Erie they rarely attain to half that weight. The fish are mature when much smaller, the males being conspicuously smaller than the females.

The observed variations in form are associated with a marked preference for adhering to some particular locality even in large bodies of water. This would seem to be incompatible with the migrations of the fish in the lakes, but it is probable that these movements are from deep into shallow water and *vice versa*. Fishermen at least are confident that Whitefish taken in different localities can be easily recognized, that those *e.g.* taken in the upper end of Lake Ontario are different from those in the lower end of Lake Erie; and that the fish *e.g.* taken in Batchewaung Bay, Lake Superior, are peculiar to that bay. Indians at the Sault say that the Whitefish of the lake above never descend the rapids, while those of the river never ascend to the lake.

In Lake Ontario and also in the upper lakes, but not in Lake Erie, where the water is too warm, two shoreward movements are observed; the first occurs in June with the approach of warm weather and its object would appear to be the larvæ of the various aquatic insects which are then abundant. When the shallow water becomes too warm they retreat again into the deeper waters of the lake, where the shrimp-like crustacea of these depths (*Mysis relicta* and *Pontoporeia affinis*) furnish them with abundant food. After a stay of two or three months, that is to say till about the middle of October, there begins the second shoreward movement, this time for the purpose of spawning, the spawning grounds being slowly reached towards the middle of November or the beginning of December. After this function has been successfully accomplished they retreat again into

the deep waters of the lakes. In the fall, and just before the spawning season, various minute shell-fish would appear to constitute the bulk of their food.

The places selected for spawning grounds are honey-combed rocks or gravelly bottoms, in water of 30 to 50 feet depth, the crevices in which afford a safe place of lodgment for the eggs and protect them to a certain extent from the watchful spawn-eaters, the suckers, lake herring and lake lizards or Meno-

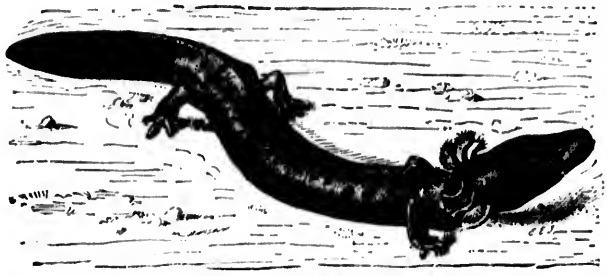


Fig. 12.—Canadian Lake Lizard, or Menobranch. (*Necturus maculatus.*)

branchs (fig. 12). On the north shore of Lake Superior the mouths of the great rivers, like the Michipicoten and Neepigon, are favourite places; possibly a relic of a former anadromous habit, such as characterises other Salmonoids. To cope successfully with the destructive spawn-eaters large numbers of eggs are deposited, although many of them are destined to destruction. It has been calculated that a female Whitefish sheds 10,000 for every pound of her weight

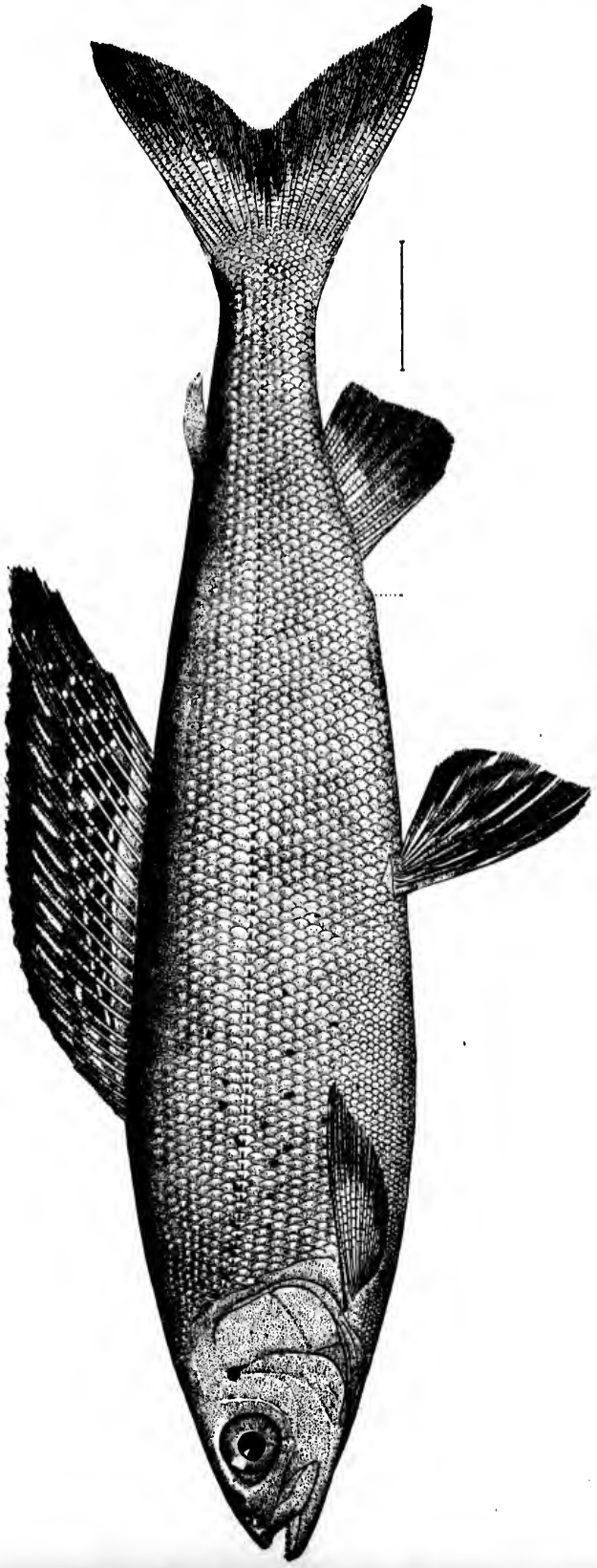
It is possible that the spawning habits in the rivers and lakes differ, the fish exhibiting greater activity in the former than in the latter. In both, however, they pair, the male being uniformly much smaller than the female. In the Detroit River the fish are described as jumping in pairs at night, the male swimming along beside the female with his snout up towards the pectoral fin, and both suddenly leaping from the water, spawn and milt running from them the while. In Lake Ontario, on the other hand, the female has been described as ploughing a nest in the gravelly bottom, where she remains for two or three days until all the eggs are deposited. Possibly the spawning habits of the various species differ, but sufficient attention has not been given to the subject.

In contrast with the short period of development described for the Clupeoids (p 445) the Whitefish eggs require about 100 days to hatch out at the natural temperature of the water. They thus escape from the egg about the beginning of April, and have entirely absorbed the yolk-sac by the end of that month, when they have reached the length of half an inch.

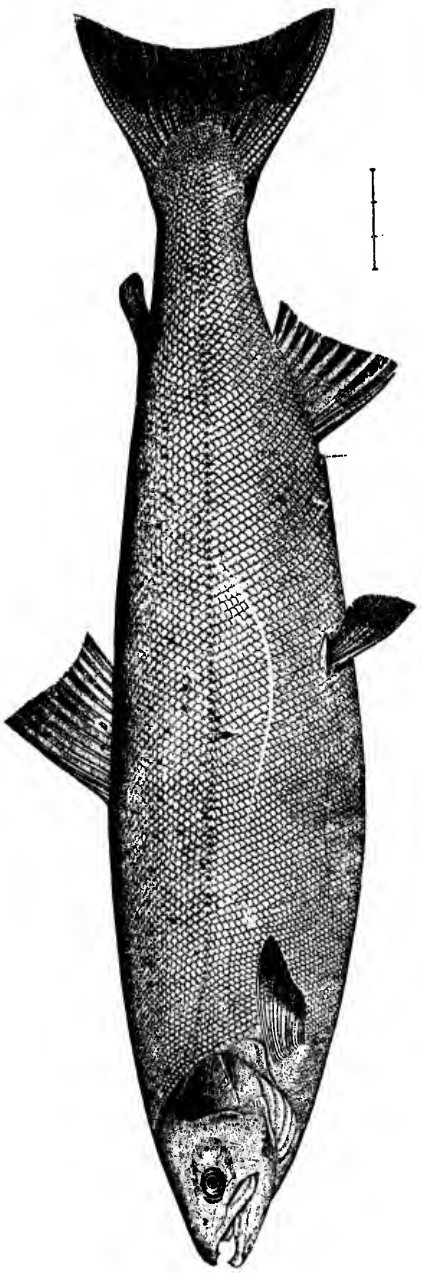
The little minnows thereafter make for deeper water, but it is stated that the fish do not seek the greater depths until they have attained a weight of over a pound; many of these immature fish are therefore caught in pound-nets, while the gill-nets secure no fish under a pound in weight.

The principal enemy of the Whitefish after it has attained maturity is the Lake Trout, but the small fry are undoubtedly eagerly eaten by the Bass and Percoid fishes, as long as they remain within their reach.

Occasionally Whitefish have been observed to die in large numbers. Prof. A. C. Lawson brought me specimens of a parasitic crustacean (*Argulus coregoni* ?) some years ago which was obviously the cause of death of immense numbers of whitefish in the Lake of the Woods, and a similar phenomenon is recorded from lakes in Minnesota. Whether this is a frequent cause of such epidemics remains still to be investigated.



The Grayling (*Thymallus tricolor*).



The Atlantic Salmon (*Salmo salar*).

A passing notice is due to a beautiful and brilliantly coloured fish, the American grayling (*Thymallus signifer*), which is found in streams in the southern peninsula of Michigan and in cold clear streams in suitable places north-westerly from that towards the Arctic ocean. It is possible that this species (which, it has been suggested, is a relic of the glacial period) may yet be found in the north-westerly part of the Province. It attains a length of 12-18 inches, and is marked by its long and high dorsal fin. Unlike the other Salmonoids it spawns in April.

Our remaining Salmonoids are referable either to the genus Salmo, including the Atlantic Salmon (*Salmon salar*), and its landlocked variety the Winninish, and the genus Salvelinus, including the various varieties of Lake Trout (*S. namaycush*) and of Brook Trout (*S. fontinalis*).

The extreme variability of this tribe has always offered great difficulties to the ichthyologist and is attributable to differences of age, sex, breeding habits, and the surroundings of the fish generally. The young, for example, of the Atlantic Salmon are barred, the immature males silvery, while the breeding dress of the male is brilliant and the shape of the jaw different at that time. Again, Brook Trout in rapid streams are brilliantly coloured, in dark lakes, uniformly sombre, while sea-run individuals (Sea-Trout) have a bright silvery coat without any of the ocellated spots generally so characteristic. Similarly, the same species which never attains a pound weight in a small stream may through abundance of food in a large body of water reach a weight of five pounds and upwards. Thus innumerable species have been made out of these local and other variations, which, however, may all be relegated to the three species named above.

Apart from the vomerine teeth which mark out the Salmon proper from the Charrs, the Atlantic Salmon (*Salmo salar*) presents many differences from the Lake Salmon Trout. Among these may be noted the larger scales (there are only 120 to the lateral line instead of 180 to 200), and the black in place of the gray spots.

The Sea Salmon can hardly be said now-a-days to be an Ontario fish. Mr. Samuel Wilmot, of the Dominion Fishery Service, has recorded its disappearance within the last fifteen years from Lake Ontario, the streams and creeks flowing into which used to be crowded at spawning time with salmon. The disappearance is unquestionably due to the drying-up of these streams consequent on the altered conditions of the land drained by them, to obstacles like mill-dams preventing the ascent of the fish toward the head-waters, and to the pollution of the streams by sawdust and other refuse.

It is probable that these salmon visited the sea like the salmon of the Gulf, but it has been suggested, in view of the existence of the land-locked variety in the lakes of Quebec (the Winninish), and of Maine (the Sebago Salmon), that possibly they only retired to the deep waters of the lake.

The Sea-Salmon feeds largely on herring, but fasts for the most part during its fresh-water run. This begins for the earliest arrivals two months before the spawning time (the middle of October for the Gulf Salmon). The fish pair, and both parents assist in ploughing out a series of nests in the gravel of the river-bottom into which the spawn and milt are deposited, and soon covered up by the sand swept down from the nest ploughed out next above.

The eggs of the salmon are of large size, a quarter of an inch in diameter, and a 40 lb. fish produces about 15,000 of these. After impregnation they mature in 100 to 140 days in the Scotch rivers, but here the hatching is postponed by the colder water till May.

When hatched the young Salmon is three-quarters of an inch in length, and still shows its yolk-sac for four to six weeks. After this is absorbed the fry begin

to feed, and measure an inch and a half in two months, when they begin to show the spots and bars of the "Parr." This stage persists till the second or third spring, when the Parr has become seven to eight inches in length, and then it makes its way towards the sea as a "Smolt," exchanging its bright colours for the uniform silvery coat of the new stage. The length of time which the smolt lives in the sea varies from four to twenty-eight months; it returns to its native river as a "Grilse," and in the case of the male has by this time attained sexual maturity. The grilse phase is marked by a slenderer body, smaller head, more forked tail, and bluish spots, while the weight may vary from two to six pounds.

The land-locked Salmon above referred to—the Winninish or Ouananiche of the Indian—so abundant in Lake St. John, probably also occurs in suitable places in Ontario. Hallock in the *Sportsman's Gazetteer* speaks of the so-called Salmon Trout of the Stony Lake region as land-locked salmon and as identical with those of Lake St. John. Mr. H. T. Strickland, writing through Mr. Justice Falconbridge, observes that these fish were first recognized as land-locked Salmon by Seth Green. They live in the deeper parts of the lakes only coming into shallow water at the end of October or the beginning of November to their spawning beds. They frequent swift currents when the ice breaks up in spring and may then be taken by rod and line with live bait. It is possible that in certain instances these larger trout from the inland lakes may be varieties of the next species.

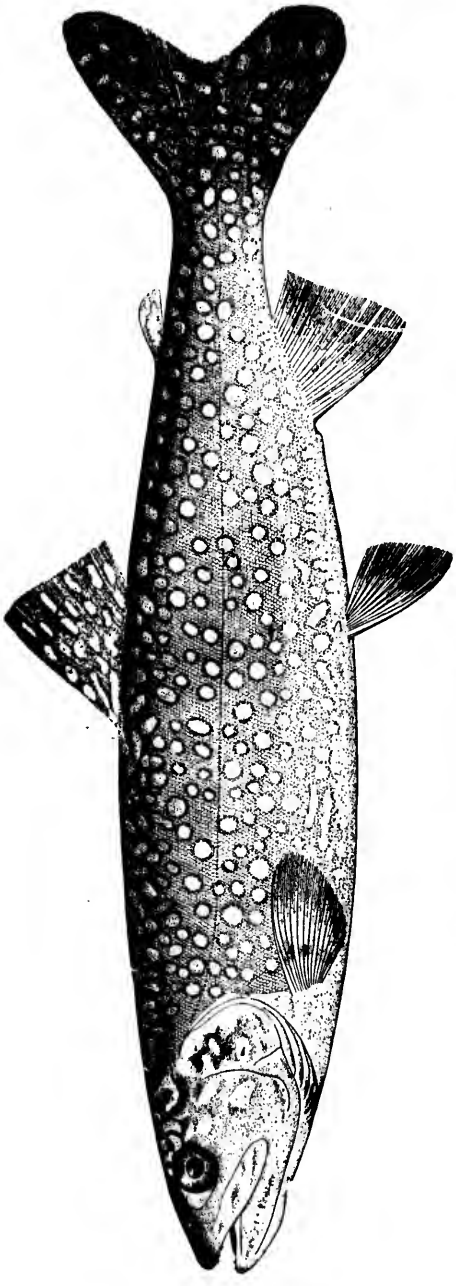
The Lake Trout or Lake Salmon Trout and the Brook Trout both belong to the genus Salvelinus, but the larger species (*S. namaycush*) has a distinct toothed crest on the vomer. Its colouration is for the most part dark grey, with paler grey spots, the dorsal and caudal fins being reticulated with darker markings. There is considerable colour variation recognized by the fishermen: thus the Truites de Grève are those dull coloured ones from muddy bottoms; the Truites des Battures are prettily mottled ones from rocky shores, while the Truites du Large are silvery-coated individuals from deep water.

The Namaycush (its Indian name) attains a length of over three feet and a weight of 20 to 30 lbs. and upwards, which it undoubtedly owes to the succulent whitefish and herring on which it preys. It is by no means confined to the chain of great lakes, but is found in all large bodies of fresh water. A variety from the deeper waters of Lake Superior, the Siscowet, is said to be a very superior food fish, at least in its salted condition, to the Namaycush and differs from it in its smaller size (4½ to 5 lbs.), its less frequency, more silvery colouring, as well as in its shorter and broader head, the eyes being near the end of the nose and further apart than in the Namaycush. The flesh is extremely fat, to which circumstance its Indian name is due.

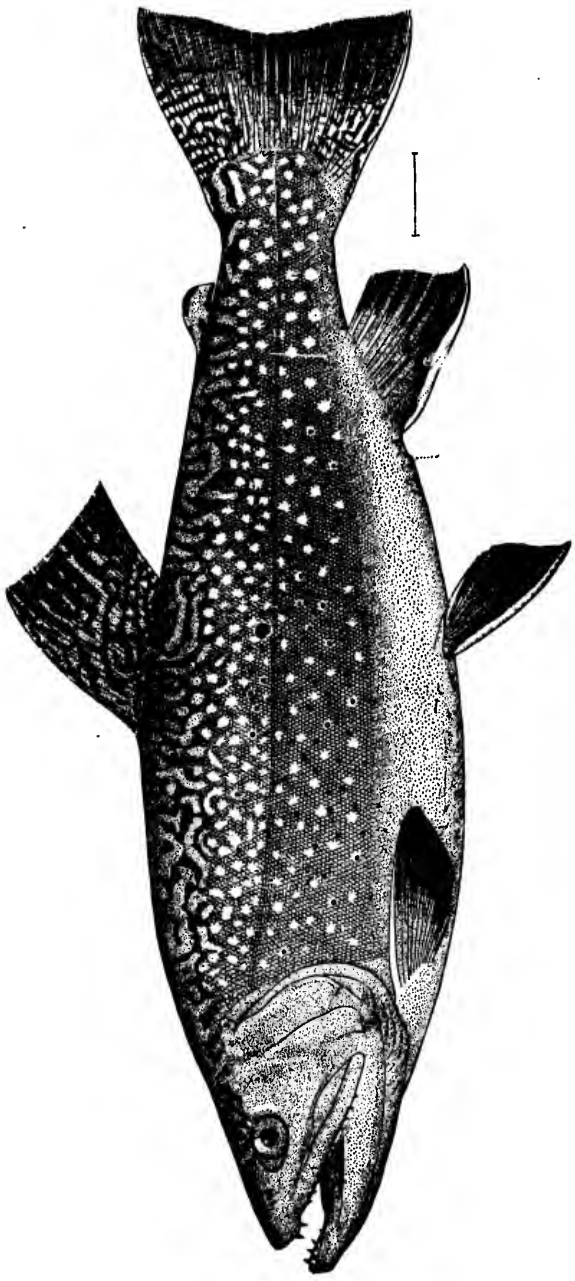
The Lake Trout spawn late in October, before the Whitefish, coming into comparatively shallow water, and depositing their large eggs in the crevices of rocky reefs, where they remain till hatched early in spring.

The average weight of the fish taken in the gill nets is 5 to 15 lbs., but individuals may attain dimensions second only to those of the Sturgeon. A 20 lb. trout has been found with 13 herrings in its stomach, an indication of the voracity to which they owe their rapid growth.

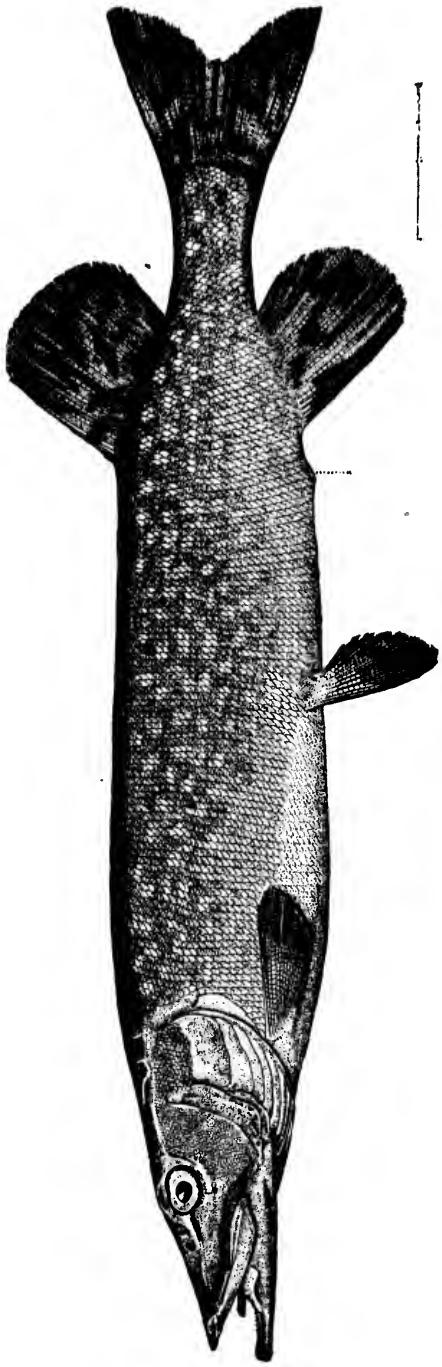
Accessibility to an abundant supply of food appears to have a similar effect on the size of the Brook Trout (*S. fontinalis*), for in the Neepigon, fish up to seventeen pounds in weight have been secured, and sea-run individuals (Sea-Trout) frequently weigh 6 and 8 lbs. Generally speaking, however, in small streams and ponds the trout rarely attain more than a pound in weight.



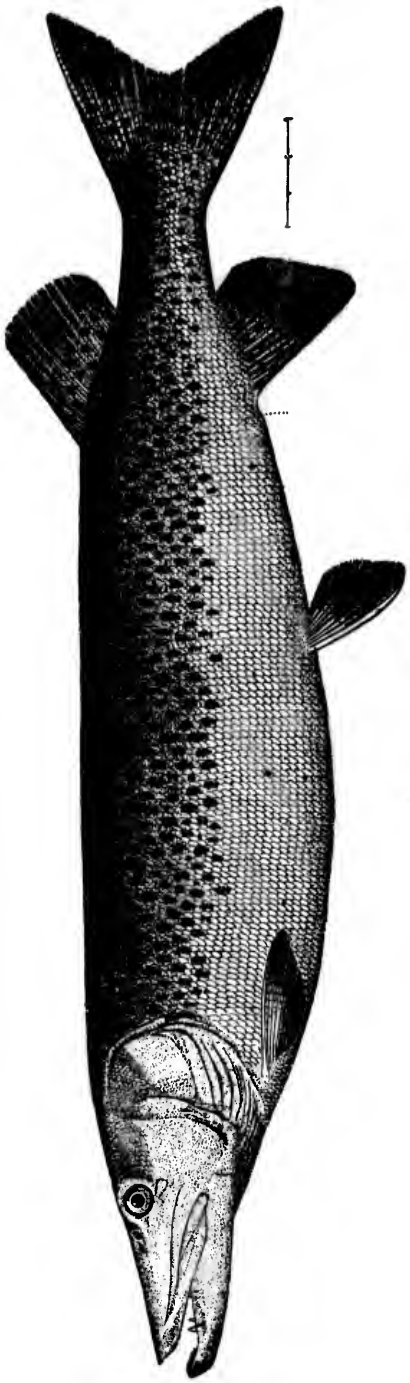
Lake Trout, or Lake Salmon Trout (*Salvelinus namaycush*).



The Brook or Speckled Trout (*Salvelinus fontinalis*).



The Pike (*Esox lucius*).



The Maskinonge (*Esox nobilior*).

Variation in colour and form as well as size is to be observed. From rapid streams the trout are lithe and long-finned, from quiet lakes rounder and short-finned, while from cool brooks the most vividly coloured individuals are obtained, and from dark pools those with sombre hues.

The food of the brook trout is chiefly formed of insects and insect larvæ (mosquito and black-fly larvæ among the number) it is therefore not surprising that, with the cultivation of the country and the consequent reduction of breeding places for flies, the trout should have become scarcer as well as the food.

Like the salmon, the Brook Trout seeks gravelly bottoms in streams to deposit the spawn in the fall of the year, the season lasting from three to six months. The female excavates a nest in the gravel, fans out the sand by means of the anal fin, the male keeping watch while this operation is in progress. The eggs are three-sixteenths of an inch in diameter, varying, however, considerably in size and in number with the weight of the fish. A one pound trout has furnished 1,800, but the numbers are not proportionately large for the bigger fish on account of the larger size of the eggs in these.

The amount of time which the eggs take to hatch is a question of temperature. Fifty days in water of 50°F. is an experiment of the hatching house, but this may be diminished to thirty-two days in water of 54°, and prolonged to one hundred and sixty-five days in water of 37°. The last condition is that which obtains in nature. The yolk-sac is absorbed in another month or two after hatching, when the independent life of the young trout begins.

The only remaining physostomous fishes of economical importance are the members of the pike family (the ESOCIDÆ.) In passing to them, however, reference may be made to certain inconspicuous forms which properly belong here. The first is the trout-perch (*Percopsis guttatus*), a little fish of six inches in length combining the characters of the fish named. It has a small adipose fin, ten pyloric cœca, and its mouth is more like that of a perch than of a salmonoid. It spawns in spring.

A second group is formed by various minnow-like fish such as the spring minnow, *Fundulus diaphanus*, a member of the family Cyprinodontidæ, resembling the minnows in their protractile jaws, but differing from them in their being for the most part brackish water fish, and of ovoviviparous habit. The mud-minnows, (*Umbra limi*) which are everywhere abundant in ditches, resemble the foregoing in their habits, but are more like miniature pike in structure.

The members of the pike family (Esocidæ) are characterized by an elongated body with prolonged and depressed snout. The mouth is adapted by its wide gape and its formidable armature of teeth to the voracious habits of the fish. The dorsal fin is far back over the anal in all, and there is no adipose fin. All belong to the genus Esox, which includes some lesser pike confined to the States (there called pickerel), and the two species that are common in Ontario, *E. lucius*, the common pike—Indian Kenosha (French rendering Kinongé)—and *E. nobilior*, the great pike or maskinongé.

These species may be distinguished from each other by the circumstance that in the pike, *E. lucius*, the cheeks are scaly, the gill-covers bare, while in the maskinongé the lower halves of the cheeks as well as the gill-covers are destitute of scales. The branchiostegal rays also are 14 to 16 in the pike, 17 to 19 in the maskinongé, while the colouration of the former species is light spotted on a dark ground, of the latter, dark spotted on a light ground.

The pike proper is common to both sides of the Atlantic; the maskinongé is confined to the basin of the St. Lawrence. Both species spawn in spring, the

eggs are small and very numerous, as many as 100,000, and are deposited in shallow places or overflowed tracts The hatching process lasts fourteen days. Of the two fish, the maskinongé is the more valuable and is especially common in the smaller lakes such as Lake Simcoe, Rice Lake, Scugog, etc. Further details are desirable with regard to the comparative distribution of the two species in the Province and of their spawning habits.

The only other family of physostomous fishes represented in the Province is that of the eels (ANGUILLIDÆ), distinguished by their elongate snake-like body covered with obscure concealed scales, and possessing well-developed pectoral fins, but no ventrals, while the dorsal and anal are confluent round the tail.

There is only one species, *Anguilla rostrata*, which is common in all rivers of the continent discharging into the Atlantic, but appears to be absent from our Hudson's Bay system. It has been asserted that its introduction into the lakes above Lake Ontario is comparatively recent.

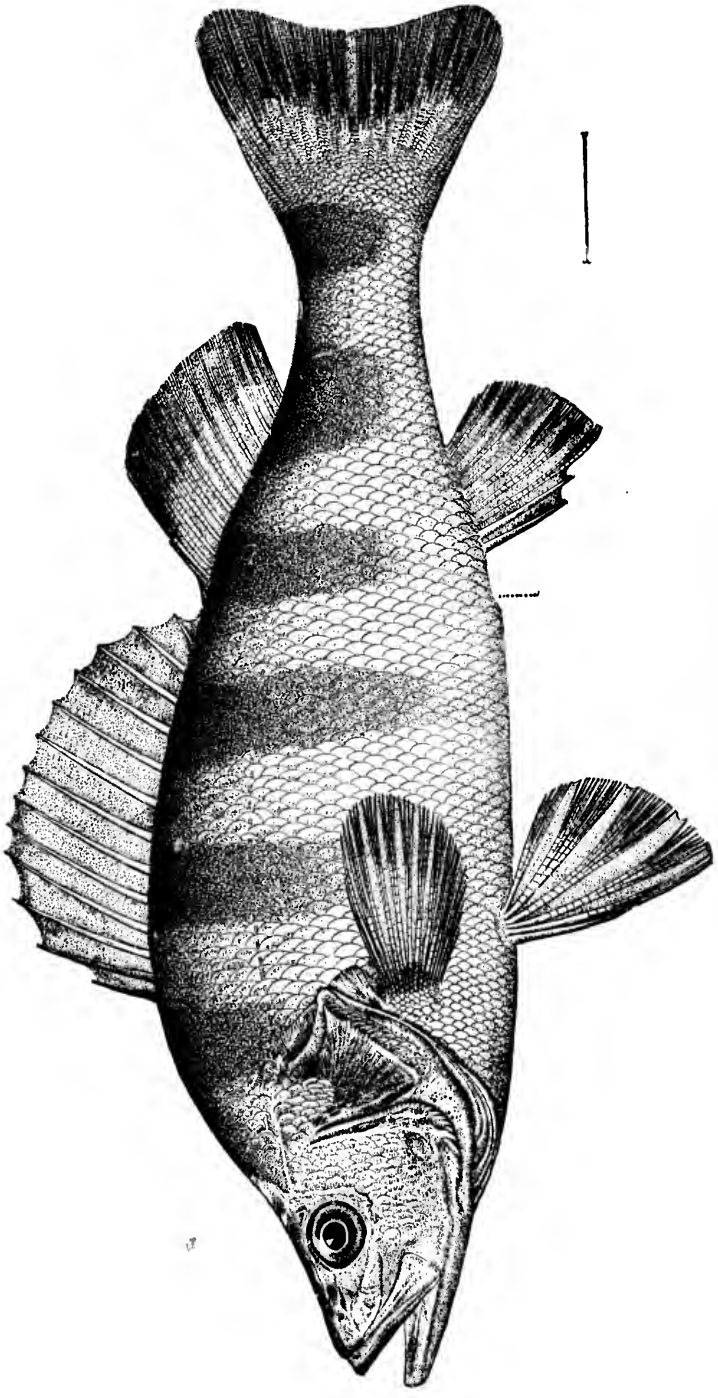
In Europe eels are believed to spawn only in the sea and to die thereafter. The males are small in size (15-16 inches in length) and do not leave the sea for any distance, so that only immature females take part in the spring upward migration and are found high up in the rivers where they remain till they are mature; they then descend to the sea—the downward migration is in October, when immense numbers are captured in V-shaped traps—where they meet the males for the first time. It is probable, however, that the habit of returning to the sea to spawn which is characteristic of the species has been discarded in the case of those which live in large bodies of fresh water like our lakes. Further information on this point is desired.

The eels are found on spawning grounds of other fish, but they are not exclusively spawn-eaters, for they devour nearly all kinds of aquatic animals, and attack even the fish in the gill-nets to the despair of the fisherman. It is considered an excellent food-fish by many, and is taken for this purpose in considerable quantities.

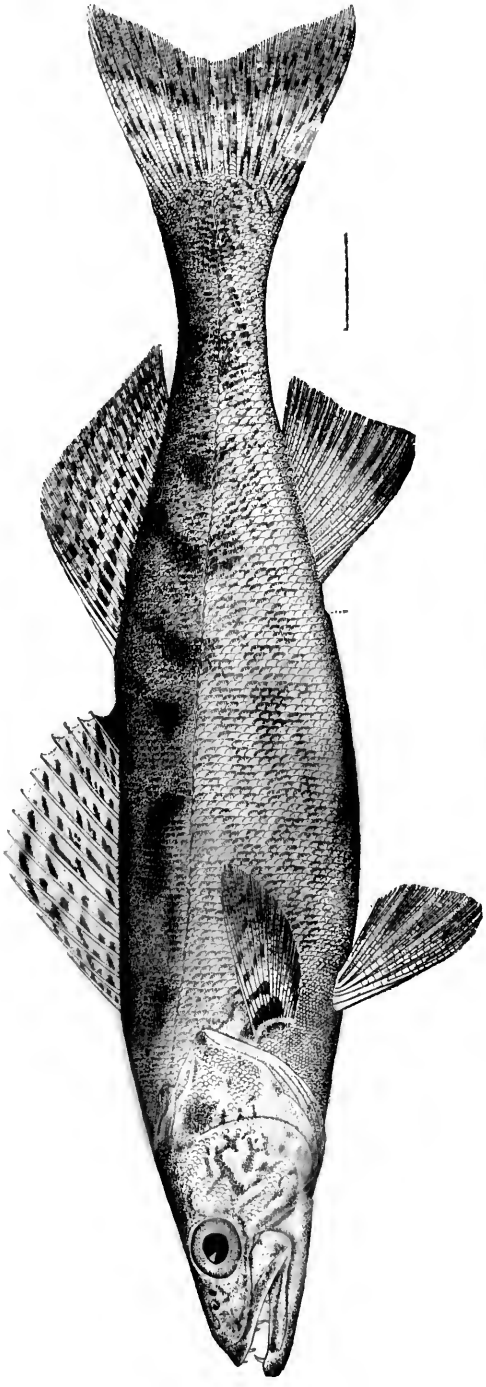
PHYSOCLYSTI.

The Physoclystous fishes, to which we now proceed, are not only marked by the absence of a duct communicating between the air-bladder and the intestine, but by the far forward position of the ventral fins (thoracic or even jugular), and by the spines which largely replace the soft rays of the dorsal and anal fins of the preceding soft-finned fishes.

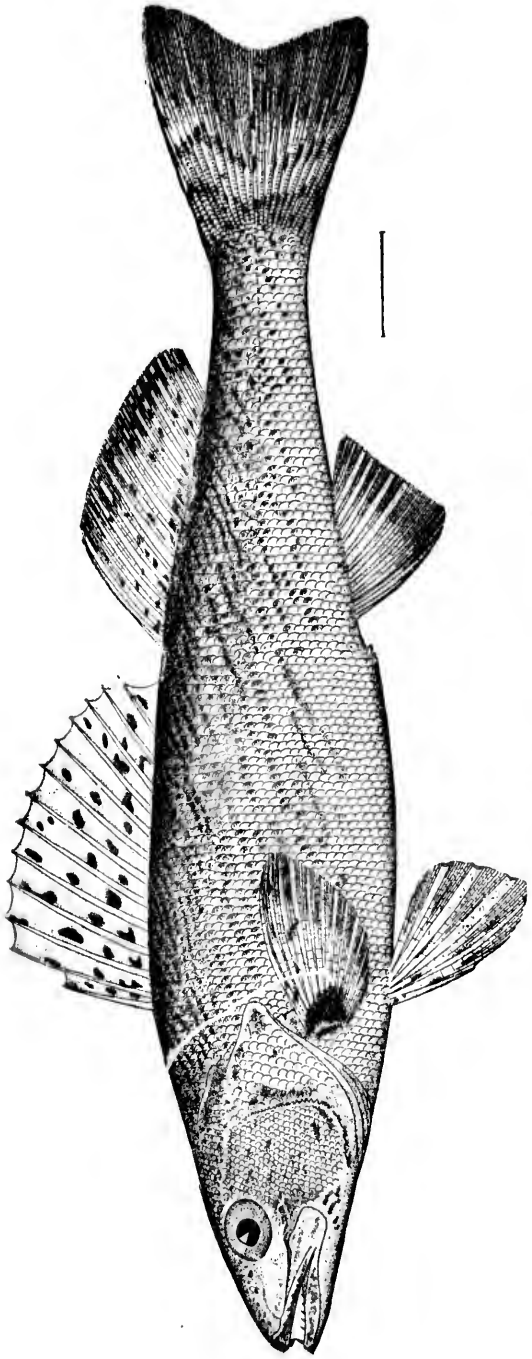
With the exception of the Sandre, (Pickerel as it is called in Ontario, or Doré in Quebec), there is no fish belonging to this group which can be said to be of importance to the Fisheries, but there are numerous forms of interest to the sportsman, and among them the members of three closely allied families, the Percidæ, Centrarchidæ and Serranidæ, of which the perch, black bass and striped bass, may be mentioned as types. The rounded form of the body in the perch family is very different from the deep and compressed form of the two other groups, while the most important difference between these is that the pseudobranch is present in the striped bass and its allies. Again the perch and the striped bass have two separate dorsal fins, while these are confluent in the black bass and sunfishes.



The Yellow Perch (*Perca americana*).



The Pickerel Dore, Wall-Eyed Pike or American Sandre (*Stizostedium vitreum*).



The Sauger or Canadian Sandre (*Stizostedium canadense*).

Apart from a peculiar little group of fishes known as darters (*Etheostomatinæ*), the PERCIDÆ proper include only the common yellow perch (*Perca americana*), and the Sandres, pike-perches or pickerels referred to above—two species forming the genus Stizostedium. The darters have been little studied in Ontario; they may be described as dwarf perches which have taken to live in small and rapid streams, and have acquired in accordance with their surroundings, the very characteristic bright colouring, powerful fins, and rapid movements of the group. The largest is *Etheostoma* (*Percina*) *caprodes*, the log-perch, which may measure six inches or more, but the sand-darter, *E.* (*Ammocrypta*) *pellucida*, and other species which occur in the Province, are rarely more than two or three inches in length. Information with regard to these minute forms would be of scientific interest.

The yellow perch is a familiar fish, very similar in its habits to the European perch. It is common in the shallow waters of the lakes, and finds its way in considerable quantities into the market. It is of fair quality and occasionally weighs as much as 1½ lb., but is not regarded as a valuable food-fish like the following.

Two species of Sandres or pike-perches (so-called as they are carnivorous perch-like fish, attaining the size of a pike) occur in North America, and are abundant in the waters of the Province. They receive widely different names in different localities. The more valuable food-fish of the two, which attains a length of three feet, and a weight of 10 to 20 lb., is *Stizostedium vitreum*, and is commonly known in the Province as the pickerel, (a name which should be reserved for the lesser American pike, p. 451), or among the French as the Doré, from its prevailing yellow colouration. It might be preferable to introduce for it the name which Richardson employs in his Fauna Boreali Americana, the "Sandre," a name which is also used for the European representatives of this group.

The genus differs from Perca chiefly in the shape of the body, which is elongated instead of oblong, and in there being strong canine teeth on the jaws and palatines. The second species, *S. canadense*, known as the "Sauger" in Lake Erie, is much smaller, rarely exceeding fifteen inches in length, and has a rounder body. It has four to seven instead of three pyloric cæca, and a distinctive black blotch at the base of the pectorals, while the larger species has a similar blotch on the hinder part of the spinous dorsal fin. The Sauger also has a rougher head, smaller scales, and a greater number of spines on the gill-cover.

The Pickerel or Sandre is undoubtedly one of the most valuable food-fish we possess, and is only inferior economically to the Lake Trout on account of its inferior numbers. It shares the habit of the other large lacustrine species in retreating to the deep water in the heat of summer. It is, therefore, taken then only in gill-nets; but, when in shallow water, as for example in the spring when it spawns, it not infrequently is taken in considerable numbers from the pounds. In winter many are speared through the ice with the aid of a decoy fish.

Further information is desirable with regard to the distribution in the Province of the two species, as to their spawning habits, and as to the increase or decrease in their numbers. The impression prevails in the lower lakes that the Pickerel have increased of recent years, and this is attributed, in Lake Ontario, to the introduction of alewives into the lake.

To the family CENTRARCHIDÆ belong the various species of Bass and Sunfish—species which, with the exception of the Black Bass, do not attain to any size, but which are all regarded as excellent food-fish. From an economical point of

view the Black Bass must be regarded as among the more valuable fish, as although not swelling the lists of market fish as do the Whitefish, Lake Trout, and Pickerel, it is, nevertheless, as much sought after by sportsmen as the Brook Trout and the Maskinongé.

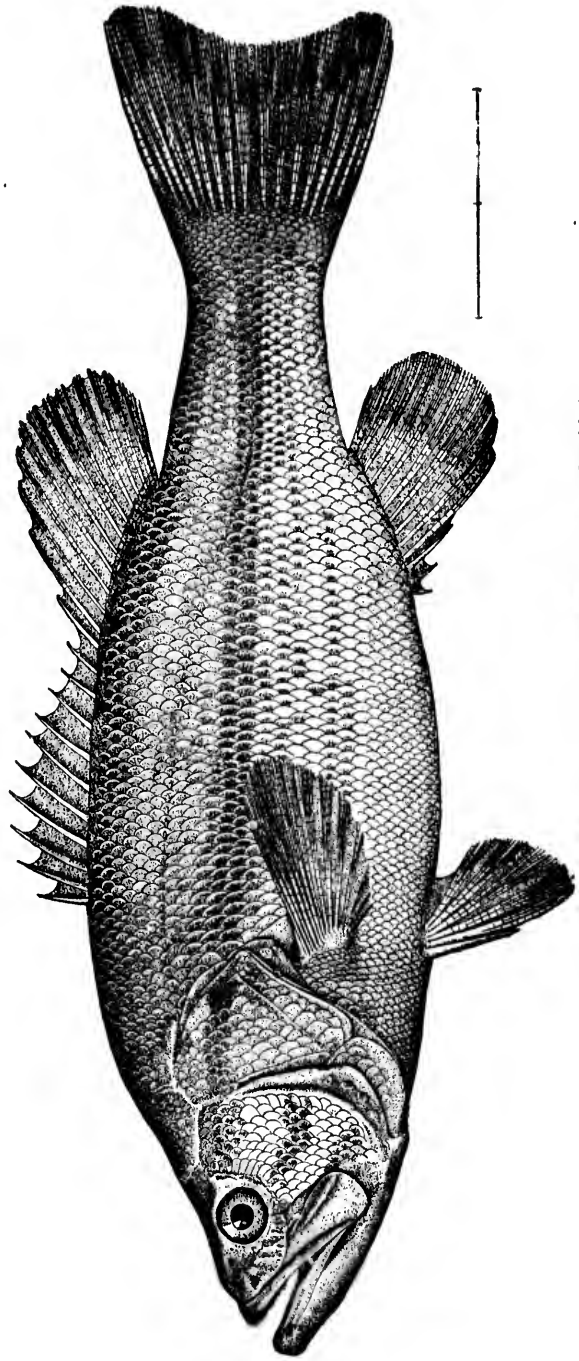
The two species of Black Bass, the small-mouthed and the large-mouthed, both belong to the genus Micropterus, and are distinguished as *M. dolomieu* and *M. salmoides*. Both agree in the elongated oval compressed form of the body, the deep division in the course of the dorsal fin, which is much larger than the anal, and the fin-formula which is D. X, 13; A. III, 11; but the species differ in that the maxillary bone in the small-mouthed species does not extend beyond the orbit, whereas it does in the large-mouthed form. Again, the scales are somewhat larger in the latter, so that they are only 7 to 8 rows above the lateral line and 65 to 70 scales in its course, while in the small-mouthed species 70 to 80 scales occur in the lateral line, and there are 10 to 12 rows above it. Further, the dorsal fin has a deeper notch in the large-mouthed form, which is also thicker through the shoulders, deeper in the body and less agile than the small-mouthed form. No dependence is to be placed on differences of colouration, for the variability in this regard resulting from surroundings is extreme. Mr. Henshaw in his Book of the Black Bass states that it would be possible to recognize from which of twenty small lakes within a radius of eight miles, in a district of Wisconsin known to him, any particular specimen of bass came. Where, however, the species co-exist, the tendency is for the small-mouthed species to incline to sombre hues, the large-mouthed to pale green, although the small-mouthed form is often yellowish in places. In the young, the colouration of the two species is more distinct, *M. salmoides* having a distinct dark lateral band and three dark cheek-stripes, while *M. dolomieu* has interrupted lateral blotches but no band, and three distinct olive cheek-stripes.

The geographical range of both species is very wide, but it is probable that it will be found that *M. salmoides* occurs further to the north than does *M. dolomieu*. They affect different surroundings, the large-mouthed species being especially found in deep pools around sunken logs, while the small-mouthed occurs in rocky streams and about gravelly shores. Their respective vigour and gaminess is said to depend on the water in which they occur. Both species have a musky odour when caught, the source of which is not understood.

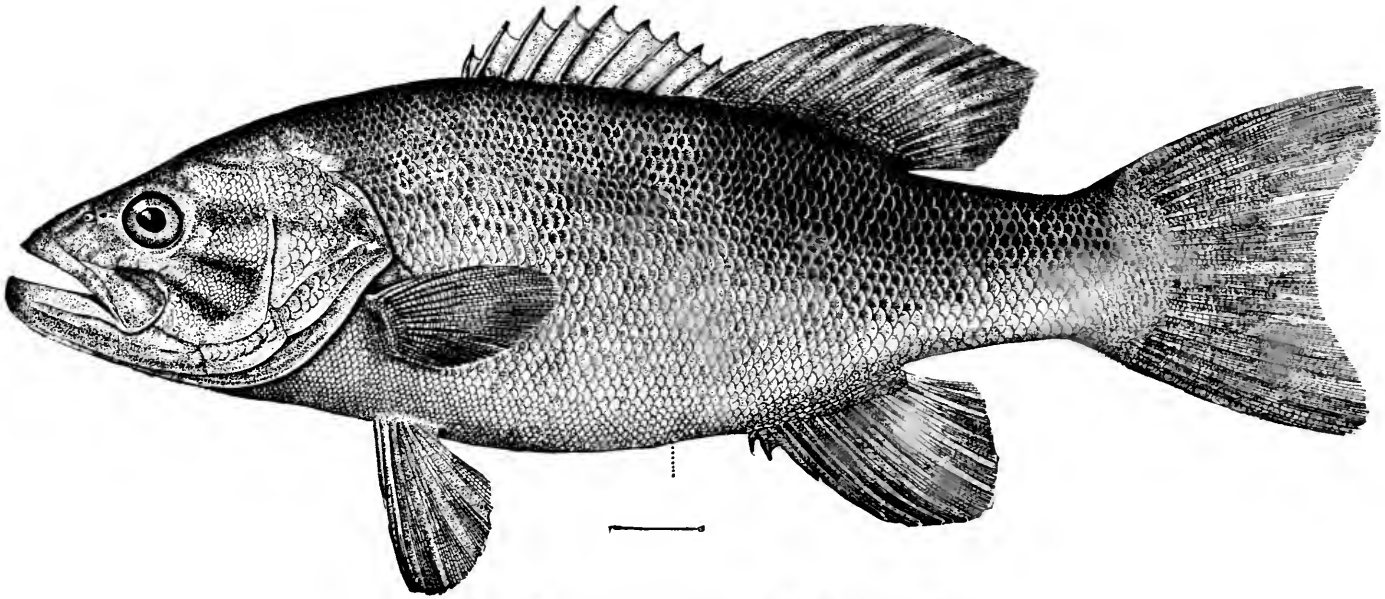
The food of the Black Bass varies with its age, the fry eating various minute larvæ, the young fish, worms and tadpoles, and the adults, crayfish, frogs, mussels and watersnakes.

Unlike Pickerel, Pike and Perch, the Black Bass hibernate (except in the extreme south) burying themselves in mud and weeds, often under the shelter of a sunken log. They leave their winter quarters a month or six weeks before spawning time, when they run in the streams and shallower parts of the lakes, possibly on account of the greater percentage of oxygen in the water there. Thereafter they pair and form their nests on a gravelly or sandy bottom, or on a rocky ledge in from eighteen inches to three feet of water in streams, but in somewhat deeper water in lakes. The nests are circular in form, twice the length of the fish, are often placed quite close to each other, and, where possible, adjacent to deep water or to patches of weeds, to which the parents can retire if disturbed.

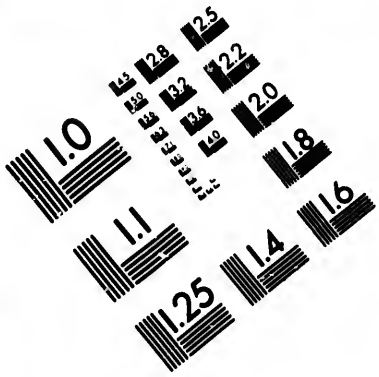
The spawning time varies with the temperature of the region, from early spring to midsummer, but it also varies in the same region from two to three weeks, shallower waters reaching more rapidly the suitable temperature than do deeper waters.



The Large-Mouthed Black Bass (*Micropterus salmoides*).



THE SMALL-MOUTHED BLACK BASS (*Micropterus dolomieu*).



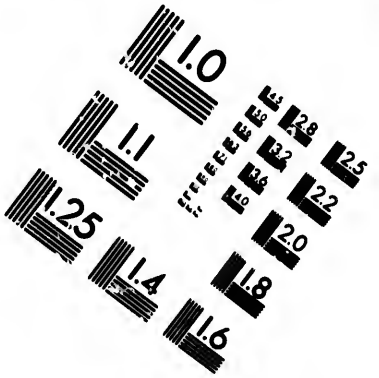
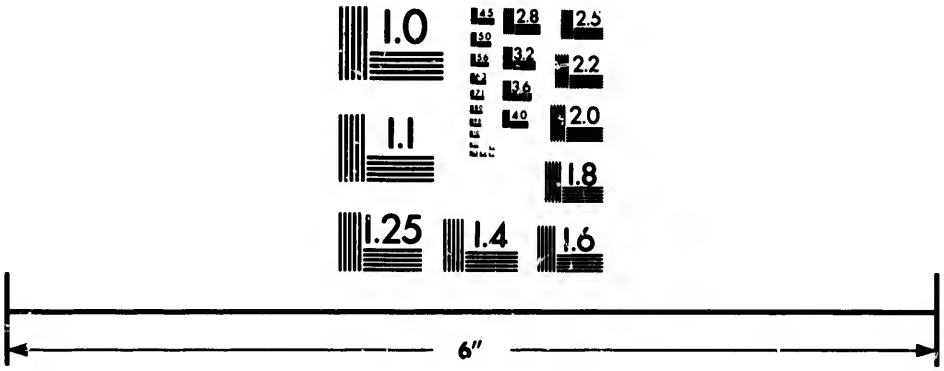
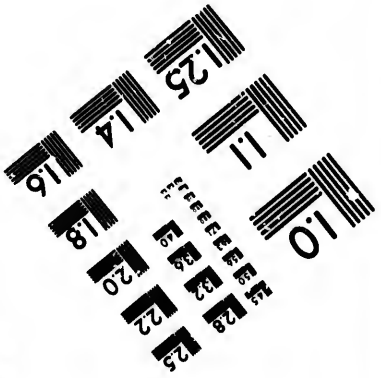


IMAGE EVALUATION TEST TARGET (MT-3)





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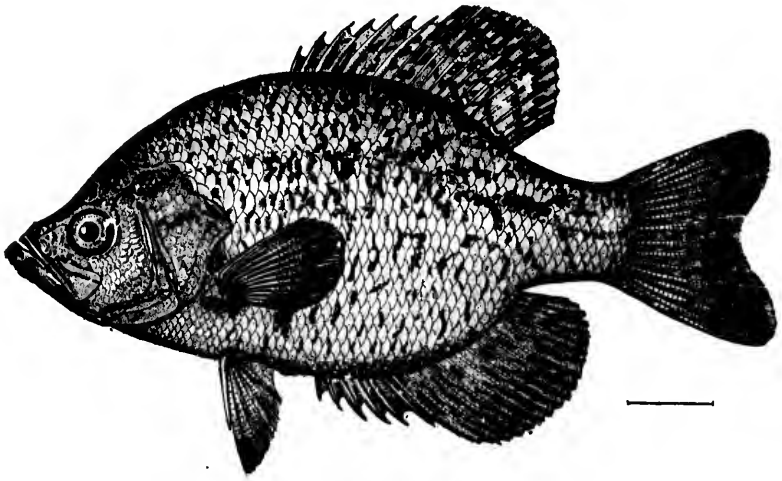
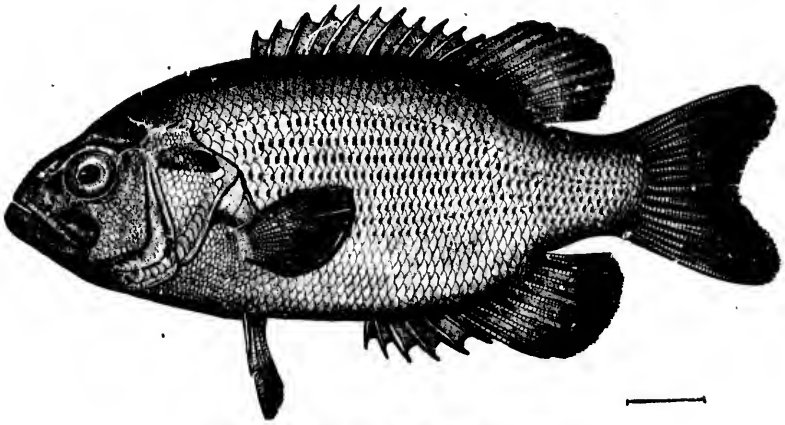
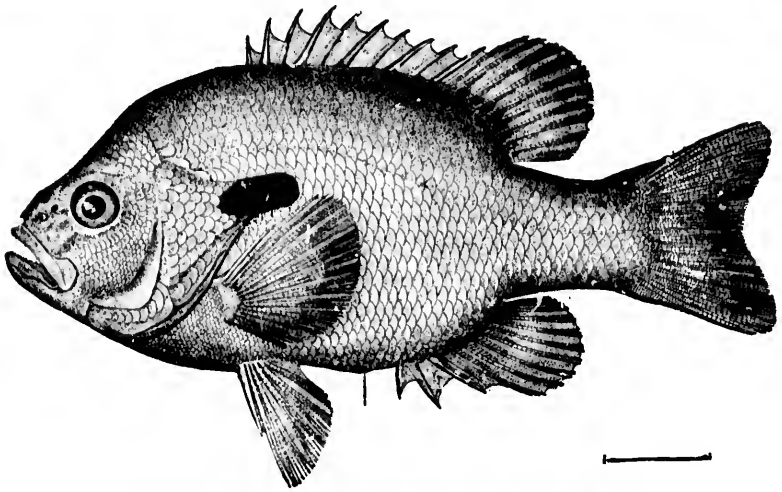


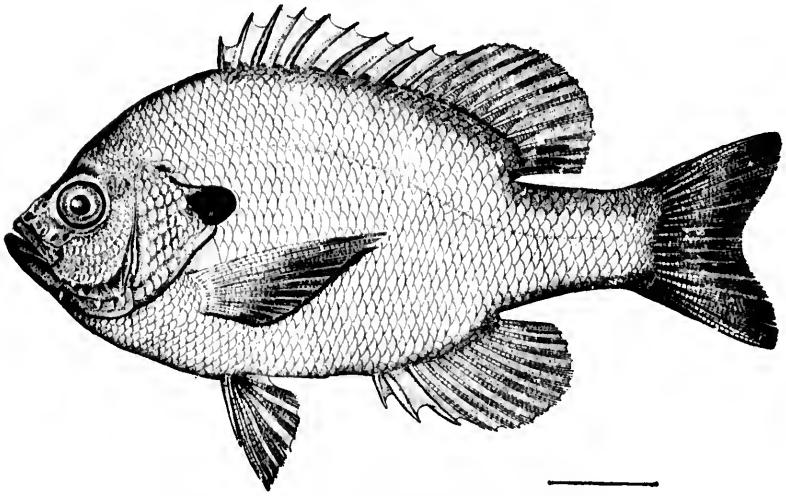
The Grass Bass (*Pomoxys sparoide*).



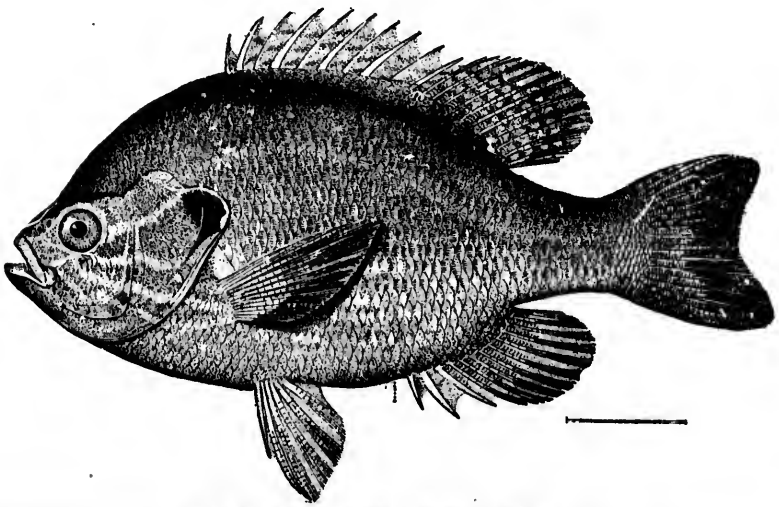
The Rock Bass (*Ambloplites rupestris*).



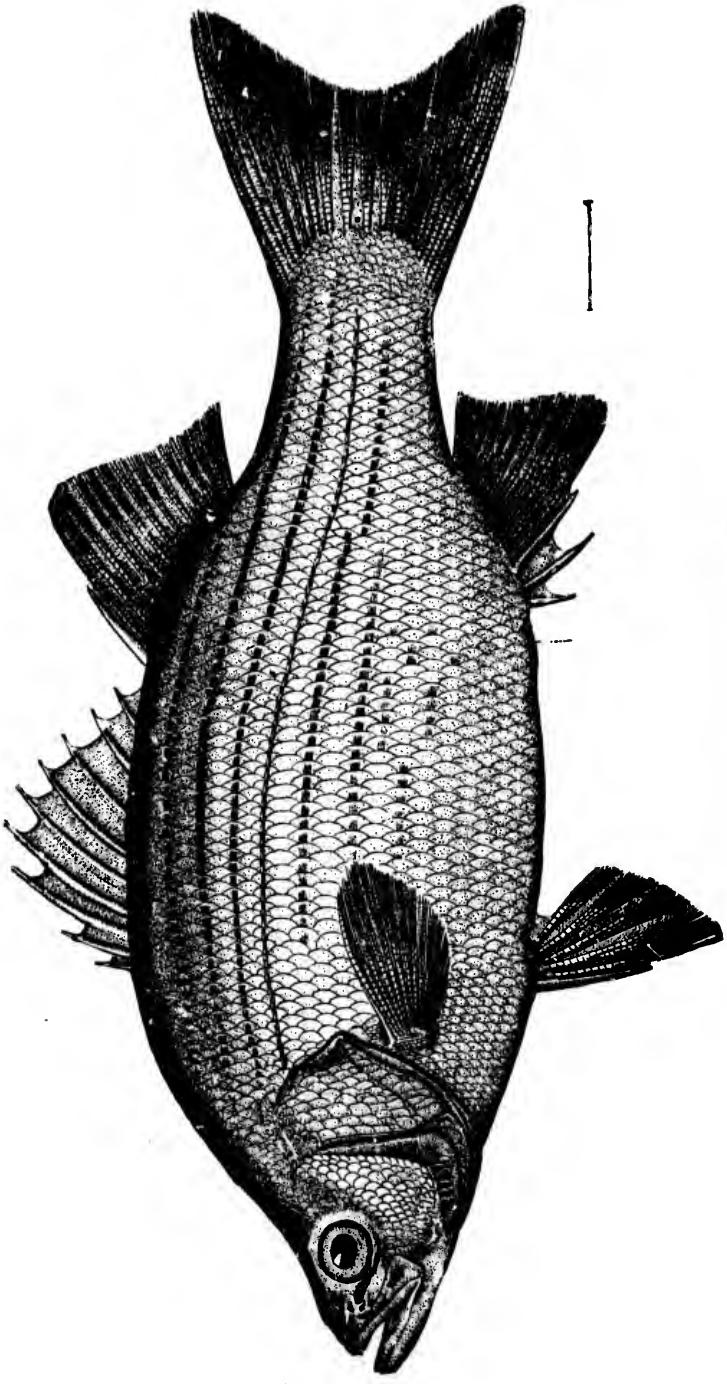
THE PUMPKIN-SEED OR SUNFISH (*Lepomis gibbosus*).



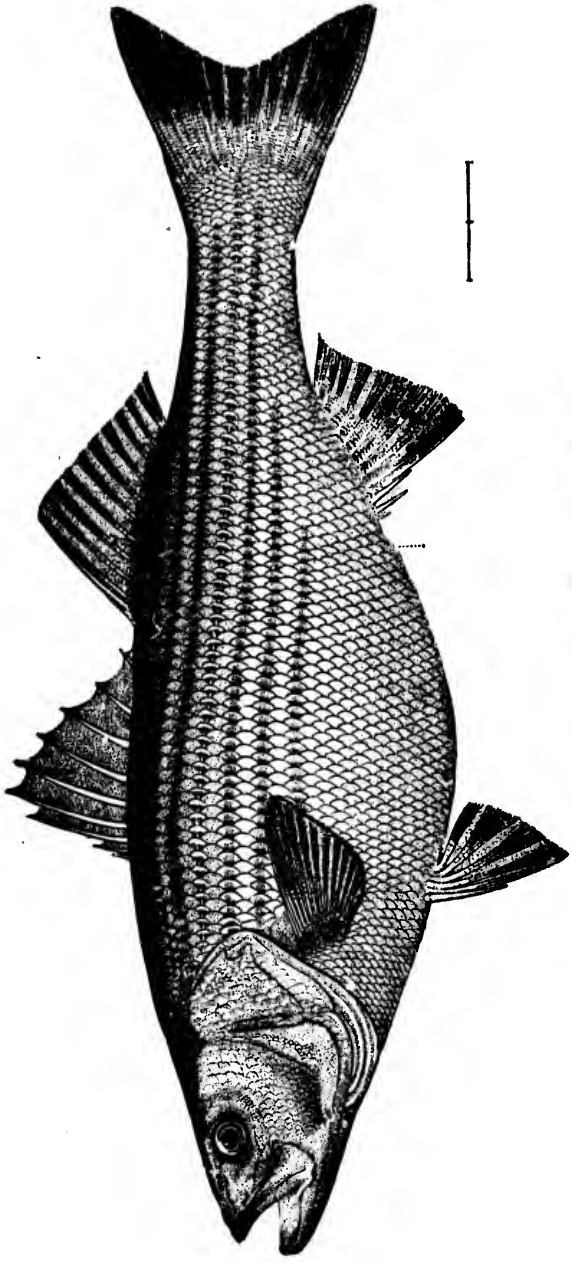
THE LONG-EARED SUNFISH (*Lepomis auritus*).



THE BLUE SUNFISH (*Lepomis pallidus*).



The White Bass (*Roccus chrysops*).



The Striped Bass or Rock-fish (*Roccus lineatus*).

The nests are fashioned with great care by the female, sand and silt being fanned out from between the pebbles by the fins, and other objects removed by the mouth; or if the nests are on muddy ground, as is occasionally the case, they may be paved with sticks and leaves. The male then joins the female, and bites and presses out the roe (which may amount to a quarter of her weight) while she lies on her side, an operation lasting two or three days. Thereafter the male scatters the milt over the eggs, and both parents stay by the nest preventing the approach of spawn-eaters during the eight to ten days required for the hatching process, and subsequently protect the fry, covering the nest and aerating the water in it with their fins for the three or four days during which the young remain in the nest before making off for the deep water. In spite of the vigilance of the parents many depredators, such as frogs and sunfish, get opportunities of making havoc with the fry.

By the end of the first year the fish are four inches long, and are mature at two years, when they measure from eight to twelve inches in length, but spawn much later than older individuals. They gain about a pound a year in weight thereafter, till they reach the limit of weight of the adult, which is from six to eight pounds for the large-mouthed species and four to five for the small-mouthed.

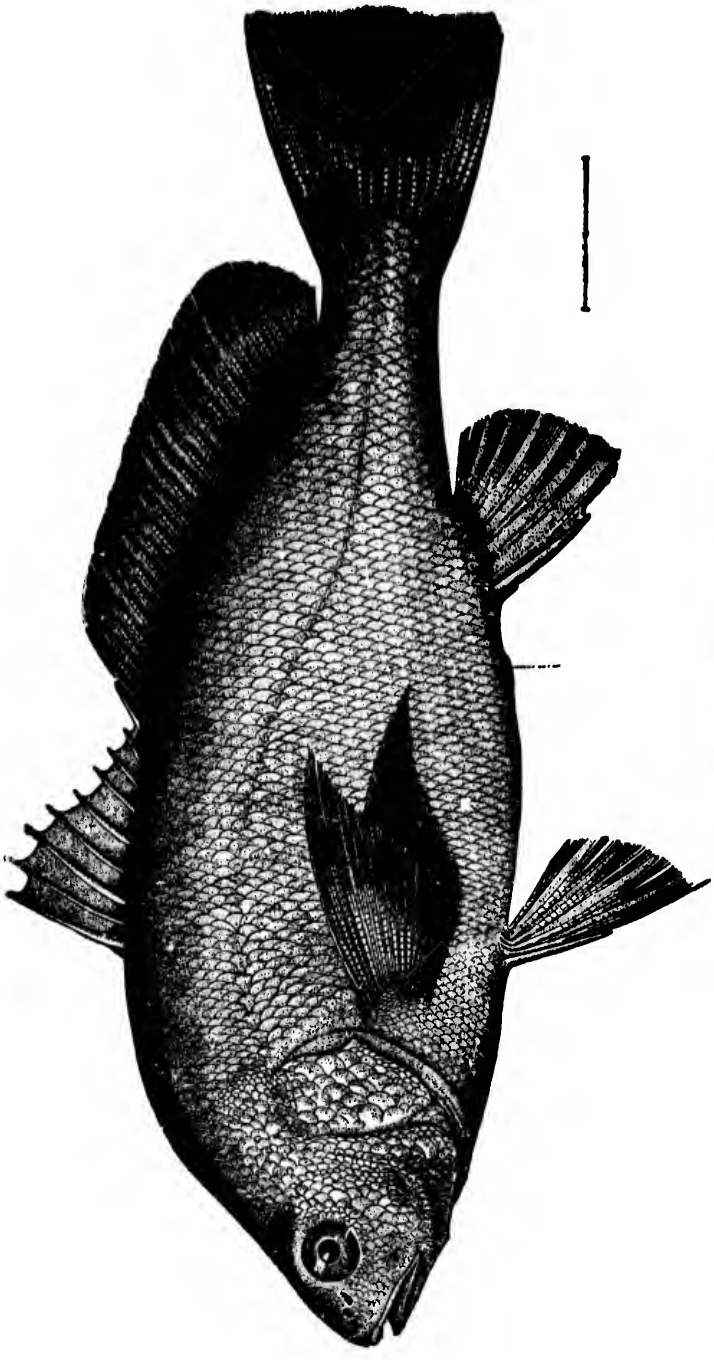
Of the other members of the same family there may be mentioned the Grass or Calico Bass, (*Pomoxys sparoides*), the Rock Bass or Red Eye (*Ambloplites rupestris*), and the common Sunfish, (*Lepomis gibbosus.*)

The first of these is distinguished by its very long anal fin, (the formula is D. VII or VIII, 15; A. VI, 17 or 18,) and occurs in quiet, clear ponds, with grassy bottoms to which its colour is assimilated. It attains occasionally a weight of two pounds, but is not such a game fish as the preceding. The remaining species are of smaller size, the Rock Bass differing from the Sunfish in its larger toothed mouth, and in having six instead of three anal spines.

All the Centrarchidæ spawn in the spring like the Bass, and seem to have the same habits of looking after the fry. There appear to be four or five species of Sunfish (*Lepomis*) within the Province, but their distribution is not well understood.

Unlike the preceding families the SERRANIDÆ constitute a characteristically marine group, and there are only a few forms which live in brackish or fresh water. Both of the species which have been reported from Ontario belong to the genus Roccus, viz., the Striped Bass, (rock-fish of the Atlantic coast) *Roccus lineatus*, and the White Bass, *Roccus chrysops*, an exclusively fresh-water form.

The former can hardly be regarded as a native of the Province; it ascends the St. Lawrence as far as Quebec, and has been taken at the mouth of the Niagara River, but is essentially a brackish water form, and is regarded as the best marine game-fish. The latter is, on the other hand, common in the Great Lake Region, and attains a weight of from one to three pounds. They were formerly still commoner in Lake Erie, so as to be of commercial value and not only of interest to the sportsman; their disappearance is probably due to the multiplication of pound-nets, but is not regretted by fishermen as they were very destructive to whitefish spawn.



The Lake Sheepshead. (*Apidinotus grunniens*).

Another marine family represented in our fresh waters is that of the SCLENIDÆ, fish of compressed and elevated body with a long dorsal fin, thoracic ventrals, and a complicated air-bladder. The Lake Sheepshead (*Aplodinotus grunniens*) is the only fresh-water species; it is sometimes spoken of as the Lake Huron Drum, from a peculiar grunting noise which it produces, and which is attributed by some to movements of the air in the air-bladder, and by others, with more probability, to the crunching up of the crayfish on which it lives, by the broad grinding teeth of the lower pharyngeal bones, which are most characteristic of the species. The fish attains a length of four feet and a weight of fifty to sixty pounds, but is not valued for food, at least not from the Great Lakes.

Before leaving the spiny-rayed fishes reference may be made to two families of minute fishes which differ conspicuously in their appearance and habits, but which have one or two fresh-water species. The first of these is the GASTEROSTEIDÆ (Sticklebacks), distinguished by the absence of scales and the presence of bony plates, which clothe the sides. Two species are common in the Great Lake Region, *G. punyitius*, the nine-spined Stickleback, and *G.* (*Eucalia*) *inconstans*, the five-spined species. Both are spawn-eaters, and are characterized by the elaborate nest built out of glandular secretions of the males, and defended by them with great vigour.

The second family is that of the COTTIDÆ or Sculpins, represented in our fresh waters by several species of Miller's Thumbs, *Cottus richardsoni* and others, and characterized by the high position of the eyes, smooth skin, spiny head, and long dorsal fin, (D. VIII, 17; A. 12.) They are always of small size and appear often to be confined to the deep waters of the lakes.

The only other family of Teleosts represented in the fresh waters of the Province is that of the GADIDÆ or Codfishes, a characteristically marine group embracing some of the most important of food-fishes; but, in as far as the one genus confined to fresh water (Lota) is concerned, entirely unimportant economically. This genus is also representee in Europe by a closely allied species, and is known as the Burbot; it is therefore convenient to use the name American Burbot for our form, *L. maculosa*, which is common in the deep waters of the lakes, although its nomenclature is very varied. It is abundant northward and westward, where it is known as the Mathemeg of the Indians and "La Loche" of the voyageurs. It hardly reaches the markets from the Great Lakes, being considered a very poor fish, but in the fur countries it would appear to be more appreciated, the liver and roe especially being regarded as delicacies. It spawns in March, and is very prolific; as it is a carnivorous and voracious fish it is probably to be regarded as an enemy at least to the young of more edible fishes. It attains a considerable size and weight, up to forty-five pounds, and is heavier in the more northern waters. As in all the Gadidæ, the dorsal and anal fins are long and contain only soft rays. (The formula is D. 14—76, A. 68). The body is long and compressed behind, the head small and broad, provided with barbels, the skin thick and mucous with small imbedded scales and the general colouration dark olive marbled with black, but paler beneath. Like so many fresh-water fish common to rivers and lakes, it attains to comparatively insignificant dimensions in the former.

The Burbot (*Lota americana*).

THE FISHERIES OF ONTARIO.

In the preceding section the natural history of the species of fish which are important from an economical point of view has been treated at considerable length. We must now proceed to consider their absolute and relative economic importance, their relative frequency in different parts of the Province, the nature and value of the apparatus employed in the fisheries, and the number of men who find occupation in connection therewith.

In discussing the subject it is necessary to remember that so far it is only the Great Lakes which have become of great economical importance, and that the possibilities as important sources of a cheap food supply of the inland waters of the Province have not yet attracted public attention.

The following Tables extracted from the last Dominion Fishery Report give valuable information on the points in question.

It appears from Table I. that of 3,045 men employed in the Fisheries of the Province about one-fifth are from Lake Ontario. Lake Erie comes next with 526, Georgian Bay with 436, Lake Huron with 427, Manitoulin division with 387 and Lake Superior with 119.

It also appears that the Georgian Bay heads the list with regard to the number of fathoms of gill-nets in use, Lake and River St. Clair by the seines in use, and the lower part of Lake Ontario by the smaller hoop-nets, while Lake Erie is distinguished by its number of pound-nets.

Table II. informs us of the relative value of the fisheries, the Georgian Bay being at the head of the list with $530,498, out of a total $2,009,637, Lake Erie next, followed by the Manitoulin division, Lake Huron, Lake Superior and Lake Ontario. We also learn from it that the Georgian Bay stands at the head of the list in both Whitefish and Lake Trout fisheries, that Lake Erie on the other hand comes first in the Herring, Sturgeon, Bass, Pickerel and coarse-fish fisheries, that Lake Scugog is the headquarters of the Maskinongé fishery, that the greater proportion of Pike come from the River St. Lawrence, and of Eels from Wellington county, including the Credit River.

From Table III. we learn that the following is the relative economic value of the various species of food-fishes, not classified as miscellaneous or coarse fish:

1. Whitefish.
2. Lake Trout.
3. Lake Herring.
4. Pickerel.
5. Sturgeon.
6. Bass.
7. Maskinongé.
8. Pike.
9. Eels.

TABLE I.

RECAPITULATION of the Number and Value of Vessels, Boats and Fishing Materials, the number of men employed, etc, with the Kinds and Quantites of Fish, in the Province of Ontario, for the year 1890.

NAME OF DIVISIONS.	VESSELS AND BOATS EMPLOYED.							FISHING MATERIALS.							
	Vessels or Tugs.				Boats.			Gill Nets.		Seines.		Pound Nets.		Hoop Nets.	
	No.	Tonnage.	Value.	Men.	No.	Value.	Men.	Fathoms.	Value.	Fathoms.	Value.	No.	Value.	No.	Value.
			$			$			$		$		$		$
Lake Superior Division	6	242	9200	23	42	5160	96	94612	9085			15	5340		
Manitoulin "	13	287	21400	65	104	13400	272	208600	35200	2000	375	29	10650		
Georgian Bay "	15	360	39400	58	152	29040	378	733600	116205	465	550				
Lake Huron "	10	502	17300	51	131	18110	367	152200	35200	2414	9185	37	7356		
River and Lake St. Clair Division					57	1159	221			8205	9235				
Detroit River Division					25	724	106			720	1400	4	1000	3	105
Lake Erie "	12	163	16700	52	264	18775	474	24600	12349	6675	4275	197	56810		
Lake Ontario "	1	15	1200	2	106	8680	239	92000	15890	2350	1557	3	450	11	220
Prince Edward and Bay of Quinté Division	3	30	8000	9	114	2130	315	45500	3566	4700	3900			117	2350
Lennox, Addington and Frontenac "					46	1170	89	10500	980	25	35			23	650
Wolfe Island and Kingston "					24	589	29	4576	577					45	463
Rockport, Brockville and Cornwall "														40	350
Prescott, Russell and Carleton "															
Leeds and Lanark Division					8	107	38							34	600
Renfrew County "								350	150						
Lake Nipissing "					4	96	9	3800	266						
Parry Sound and Muskoka Division															
Wellington County Division															
Lake Simcoe Division															
Lake Scugog and River Division	1	15	1800	3	200	3000	150								
Victoria County Division															
Peterboro' "															
Totals	61	1614	115000	263	1277	102131	2782	1369738	229462	27554	30512	285	81600	283	4738

RECAPITULATION of the Number and Value of Vessels, Boats and Fishing Materials, etc., Province of Ontario.—*Concluded.*

NAME OF DIVISIONS.	KINDS OF FISH.														VALUE.
	Whitefish, barrels.	Whitefish, lbs.	Trout, lbs.	Trout, barrels.	Herring, barrels.	Herring, Fresh, lbs.	Eels, lbs.	Sturgeon, lbs.	Maskinongé, lbs.	Bass, lbs.	Pickerel, lbs.	Pike, lbs.	Coarse Fish, lbs.	Home Consumption, lbs.	$ c.
Lake Superior Division	432	892000	530800	807	....	4000	.....	97400	.....	.....	90000	.....	45000	36300	150713 00
Manitoulin "	1482	2236100	731840	842	.....	.....	...	106050	.....	.....	170850	7100	22200	16800	293475 00
Georgian Bay "	540	2858000	2441000	760	332	12000	...	21000	5000	114000	464300	31000	26 00	131000	530198 00
Lake Huron "	1511	139820	1100650	1550	4660	414700	....	223750	.....	9200	182100	300	39900	213400	223752 60
River and Lake St. Clair Division	.....	20800	41000	....	812	139500	. ...	12000	5910	17670	142120	10580	18140	34150	33641 50
Detroit River Division	.....	38600	.....	....	....	59850	.....	34100	1040	600	15050	5500	54900	1000	11199 90
Lake Erie "	.....	204322	1500	....	....	5394000	.....	580610	400	134650	961350	62820	552240	533000	422464 56
Lake Ontario "	.....	8050	20760	...	351	2087200	15400	34100	195000	128855	51500	57020	373400	... ..	148046 30
Prince Edward and Bay of Quinté Division	102	218400	80000	....	270	269500	5400	900	956	2890	31700	49350	330000	.....	55925 26
Lennox, Addington and Frontenac "	.....	158500	35200	...	....	6000	5200	.....	1000	5500	55250	22800	32100	.....	23620 00
Wolfe Island and Kingston "	.....	.....	2600	...	....	.....	6700	6390	1500	5200	.....	88700	52000	.....	7313 00
Rockport, Brockville and Cornwall "	...	.....	....	....	....	.....	12900	4000	4500	74200	3900	214800	361800	.....	27564 00
Prescott, Russell and Carleton "	.....	800	.....	....	..	.....	6400	4000	7400	8000	9500	10000	90800	.....	5406 00
Leeds and Lanark Division	.....	1500	1600	....	....	1200	400	.....	.....	4000	2000	2600	56350	.....	2544 50
Renfrew County "	.....	1600	1800	....	....	.....	835	460	1990	2130	290	3450	15025	.....	1424 75
Lake Nipissing "	.....	.....	.....	....	....	.....	.....	6000	.....	.....	16500	24900	46000	.....	3975 00
Parry Sound and Muskoka Division	.....	....	23400	....	....	.....	.....	.....	500	4000	5500	500	24000	.... ..	3685 00
Wellington County Division	.....	.....	6000	....	....	30000	55000	.....	.....	2500	.....	3000	42000	.....	6960 00
Lake Simcoe Division	.....	1500	32500	....	....	10000	...	.....	26300	45400	7000	43000	25000	.....	11492 00
Lake Scugog and River Division	.....	.....	.....	.	....	.....	4000	.....	250000	100000	.....	....	150000	.....	25740 00
Victoria County Division	....	.....	1000	....	....	4000	1000	.....	30000	20000	5000	....	6000	.....	3840 00
Peterboro' "	.....	2000	20000	....	....	5000	1400	.... ..	120000	100000	.....	.....	30000	.....	17350 00
Totals	4067	6782292	5074650	3959	6425	8435950	125235	1132970	651406	778795	2216520	637420	2556515	965650	2009637 37

RECAPITULATION

Of the Yield and Value of the Fisheries in the Province of Ontario, during the year 1890.

Kinds of Fish.		Quantity.	Prices.	Value.
			$ c.	$ c.
Whitefish	brls.	4,067	10 00	40,670 00
"	lbs.	6,782,292	0 08	542,583 36
Trout	"	5,074,650	0 10	507,465 00
"	brls.	3,959	10 00	39,590 00
Herring, salted	"	6,425	4 00	25,700 00
" fresh	lbs.	8,435,950	0 05	421,797 50
Eels	"	125,2[illegible]	0 06	7,514 10
Sturgeon	"	1,132,970	0 06	67,978 20
Maskinongé	"	651,406	0 06	39,084 36
Bass	"	778,795	0 06	46,727 70
Pickerel	"	2,216,520	0 06	132,991 20
Pike	"	637,420	0 05	31,871 00
Coarse fish	"	2,556,515	0 03	76,695 45
Home consumption, not included in the above	"	965,650	0 03	28,969 50
Total for 1890				2,009,637 37
" 1889				1,963,122 80
Increase				46,514 57

STATEMENT showing the Number and Value of Vessels, Tugs, and Boats, etc. in Ontario, during the year, 1890.

Articles.	Value.
	$ c.
61 vessels or tugs (tonnage, 1,614)	115,000 00
1,277 boats	102,131 00
1,369,738 fathoms of nets	229,462 00
27,554 " seines	30,512 00
285 pound nets	81,600 00
283 hoop nets	4,738 00
Number of Men employed, 3,045.	563,443 00

On the other hand the relative value per pound is:

1. Lake Trout, 10c.
2. Whitefish, 8c.
3. Eels, Sturgeon, Maskinongé, Bass, Pickerel, 6c.
4. Herring, Pike, 5c.
5. Coarse fish, 3c.

While these tables give some information as to the geographical distribution of the principal food-fishes, further details are required in regard to the more remote bodies of water.

It is known that the Lake-of-the-Woods is chiefly characterized by its abundant Sturgeon, the principal food of the numerous Canadian Indians (1,000) living near its borders, and the proposition has recently been made that these waters should be closed to commercial enterprise and be reserved for the Indians, as has been done by the United States Government for the portion under its control, pound-nets being prohibited to prevent wasteful fishing. In one year 46 tons of Sturgeon, 29 of Whitefish, 12 of Pickerel and 1 of Trout have been taken from these waters, which, therefore, if properly taken care of, should form a neverfailing source of food-supply for the population on their borders.

FISHERY LEGISLATION.

The following are the chief provisions of the Dominion Fishery Laws which affect this Province:

CLOSE SEASONS.

Brook Trout (*Salvelinus fontinalis*)	Sept. 15 to May 1, inclusive.
Pickerel	April 15 to May 15, "
Bass and Maskinongé	April 15 to June 15, "
Whitefish	Nov. 1 to Nov. 30, "
Lake Trout	Oct. 15 to Nov. 30, "

There is no close season for Sturgeon or for Lake Herring.

Net fishing is prohibited in public waters, except to holders of a purchasable license. The size of the nets is submissible to regulation, and the nets must not be set nor seines used so as to intercept channels or bays.

Explosives and poisons for killing fish are illegal, mill-dams must have passes, and mill-refuse must be destroyed.

It is desirable that enquiry should be made as to the adequacy of the protection afforded by the close seasons at present prescribed. It is possible that in certain waters an extension is required. In Lake Megantic, *e.g.*, it is reported that the Lake Trout have finished spawning by the 1st of October, while Mr. John H. Willmott, of Beaumaris, Ontario, Fishery Overseer for the Muskoka District, reports in 1890 their spawning season as from October 8th to 20th for this region. Again in the North-west it is reported that the Whitefish spawn earlier than is the case in the Georgian Bay, so that if the close season were assimilated to that of Lake Trout, the change would have more to recommend it than the mere simplification of the law and its efficient carrying-out. It is even reported that the run of Whitefish may occur within our waters after the 30th of November, so that an extension in the other direction might also be considered.* Such differences indicate that further information is required as to the spawning habits of our food-fish from all parts of the Province, so that future legislation may provide for the protection of waters lying at a distance from the present commercial centres.

Although the absence of a close season for Lake Herring does not appear to have so far affected the results of the Fisheries in Lake Ontario, complaints are being made that the Lake is being depleted of the more valued Cisco (p. 447), and that consequently some measure should be taken to protect this variety. A close season during July and August has been suggested.

* Brook Trout have been observed to spawn in Central Ontario three weeks earlier than the beginning of the close season.

Again, the increasing commercial value of the Sturgeon is likely to lead to a more systematic pursuit of this fish, and it appears to be advisable that it should be spared during its spawning season (May 1st to June 15th), and possibly that efforts should be made to increase the numbers by breeding.

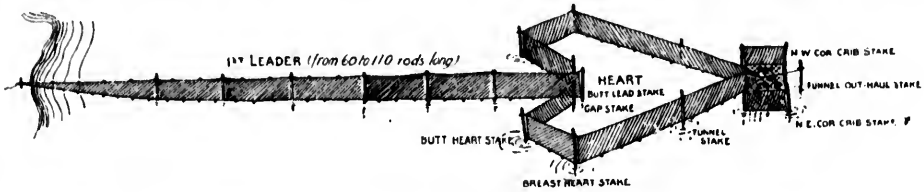
The revenue derived by the Dominion Government, under the laws at present in force, from rents, license-fees and fines within the Province amounts to $23,666 out of a total $56,976, while the expenditure within the Province on Inspection amounts to $14,539 out of a total $65,873, and on Fish-breeding (to which reference is made hereafter) to $11,492, out of a total $39,126.

Ninety-five Fishery Overseers and six Wardens are employed by the Dominion Government for purposes of protection. As pay is often merely nominal, the inspection can hardly be regarded as satisfactory, especially in view of the enormous length of coast line to be protected. The overseers therefore complain that poachers with fyke-nets or spears are at work as soon as their backs are turned.

APPARATUS EMPLOYED IN CATCHING FISH.

Of these there are two important modifications:—"Pound-nets" (in various forms) for shallow-water fisheries, and "gill-nets" for deep-water.

The pound-net essentially consists of a long net, the so-called "leader" projecting at right angles to the shore for from 300 to 600 yards, and supported by strong stakes of the necessary length, 30 to 60 feet, driven at an interval of 5 or 6 feet. The rim-line of the leader is secured to these at the water-level, while the bottom line is weighted with stone-sinkers. Fish swimming towards the leader are diverted by it into the "heart," a Λ-shaped chamber, the funnel-shaped narrow end of which projects into a "pot" or "crib" some 30 feet square, the floor and walls of which are formed of net, the walls projecting two feet above the water-level. The mesh of the leader is 6½ to 7½ inches, of the heart 3 to 5 inches, of the funnel 3, and of the pot frequently only 2 to 2½, to the destruction of immense numbers of immature Whitefish. Beyond the first crib a second leader, terminating in the same way, and a third—indeed, as many as twenty have been arranged in "strings," if the shallowness of the water admit of it. Lake Erie obviously permits of such destructive use of this kind of apparatus more extensively than any of the other lakes, so that as many as 900 pounds exist on its American side. The average value of a pound-net is from



POUND-NET.

$250 to $500, and five men are required to work three nets. A boat of peculiar form is generally used, schooner-rigged with wide square stern, and plenty of beam so as to permit of lifting the pockets or cribs of the pound. They must be able to take a large load of fish and yet have little draught. A special scow is used for driving and pulling stakes, in the spring and winter respectively.

The Fyke-net is essentially a miniature pound, the crib being replaced by two funnels of netting, one opening into the other, and the heart by wings leading to the door of the outer funnel at an angle of 45 degrees. They are used for catching Perch, Catfish, etc. A similar device is the trap-net which is simply a miniature movable pound, the crib of which is held in position by weights and floats.

Pound-nets have largely superseded seines for inshore fishing, but in some favorable places with sandy bottom the latter are still used, as in the Detroit and St. Clair Rivers. They may be 1,000 feet long by 12 feet deep in the middle, where the mesh is narrowest, but shallower and with larger mesh in the wings. Horse-power is sometimes used for hauling the seines.

The second important variety of net used is the gill-net, so-called as the mesh is arranged of such a size (4½ to 4¾ inches for Whitefish—3⅜ for Herring) as to catch fish striking the net behind the gill-covers. These nets are set vertically at different depths in deep water, often at right angles to the shore, the lower borders being weighted with stones or leads or iron rings (according to the kind

of bottom), the upper being floated with cedar blocks or with corks. Each net is some 300 or 400 feet long, 4½—5½ feet deep, and of 4¼ to 4¾ inch mesh for Whitefish, and sometimes an inch more for Lake Trout. Ten to twenty or more such nets arranged in a row form a "gang," and four gangs constitute an outfit for four men, two gangs being in the water at one time, and one of these hauled daily.

Certain objections are urged against the use of gill-nets; the catch is often so large as to be unmanageable, and is therefore wasteful, the fish spoil in a few hours, especially if there is much current, and decomposition sets in with great rapidity after death, so that when the nets are hauled many of the fish are not in proper condition for the market, requiring to be punctured and salted before they can be sold. This is especially the case in summer, more particularly so if the lifting of the nets has been delayed a day or so by bad weather. In such a case the fish are all decayed, and too often the net is stripped on the spot, and the decayed fish thrown out to the great injury of the fishing grounds. Again, gill-nets may drift in stormy weather, and be thrown with their contents on some reef, perhaps to the destruction of some good spawning ground. The gill-net fishermen using a comparatively small number of nets to a gang, "a light rig," employ Mackinaw boats, which, unlike the pound-boats, are sharp-sterned to prevent shipping water aft when running with the sea. Larger boats are necessary with "heavy rigs."

Of other varieties of nets, the Trammel net, Dip-net and Beam-trawl may be mentioned. The first is a 3-ply net-work of varied mesh, generally set across the current of a stream during the run of suckers or for catching inshore fish. The Dip-net varies in size, and may be used for catching bait or for emptying the cribs of pounds. The Beam-trawl, so extensively used in British sea-fishing, cannot be employed successfully except on a smooth sandy bottom, and is therefore unavailable in the lakes.

In addition to net-fishing reference may be made incidentally to two other methods:—set-line fishing on a commercial scale, and fishing through the ice. The former is practiced in Lake Michigan successfully for Trout, several gangs of 200 to 500 hooks, strung six feet apart on a line, buoyed by cedar floats, being set in 25 to 50 fathoms water, the hooks being baited with herring attached in as natural an attitude as possible. The "trawl" lines are visited every two or three days, and have in some places proved so successful as to have displaced gill-nets.

Ice-fishing may be effected either by seines or by spearing or by bait-fishing, but hardly attains to sufficient commercial importance to require further notice here.

METHODS OF PREPARATION OF FISH FOR THE MARKET.

Fish are classified for the market as "hard" and "soft," the latter embracing the miscellaneous coarse fish separately enumerated on p. 455. Some fish are dressed; catfish, *e. g.*—which have been classified in the Report of the U. S. Fish Commission as the most important food-fish of Lake Ontario—being always decapitated, cleaned and skinned before being shipped. Again other fish are shipped "round" without any preliminary cleaning. Various methods have been suggested for arresting and preventing the decomposition which fish more than all other classes of food materials so rapidly undergoes.

These are reducible to two:—the use of antiseptic chemicals and the use of a low temperature. The former method has been chiefly adopted in Norway for preserving herring and consists in laying the fish in a mixture of two parts of salt and one of boracic acid (for a barrel of herring, 5 lbs. salt, 2½ lbs. boracic acid) and filling up with a weak solution of the acid. It is said to have the disadvantage of communicating a slight taste to the fish which injures their market value. With an abundant ice-supply at command the second method is preferable, and is sufficient if the fish are not already in bad order before being preserved (p. 465). In the States large refrigerators are employed in which fish may be frozen during any period of the year and preserved till demand arises for them. Sturgeon may thus remain a year in the refrigerator, being stacked there like cord wood. Trout are dressed before being frozen, but pickerel are frozen "round."

Whitefish are occasionally smoked in small quantities for local markets. This is effected in small huts seven feet square, the fish being first cleaned, then placed in brine for three to five hours, impaled in strings of five on sticks and hung up in the smoke of a hardwood fire, the door of the hut being first left open for half-an-hour and then closed for three or four hours. Substantially the same plan is used for kippering Herrings. After the fish are split they are placed for thirty-five minutes in pickle, spitted on fine rods carrying 12 to 20 herrings each and then smoked for five to six hours, the fuel used being the waste sawdust from birch. If a strong colour is required they are afterwards subjected to a shorter or longer exposure to the smoke of other wood—oak, *e. g.*

A passing reference may be made to the ingenious conversion of Lake Erie herring by the use of a suitable stain into canned salmon, an industry which has its headquarters in Cleveland. One of the methods of preserving whitefish employed by the Indians of the North-West is not likely to be adopted generally but is worthy of being noted. The abundant fish caught in spring are dried, smoked, pounded to powder and mixed into a cake with oil from the liver. This with ordinary smoked fish furnishes an important element of food-supply.

A large proportion of the Sturgeon caught on the north shore of Lake Erie are sent to Toledo and Sandusky, where they are further prepared for the market (partly by being converted into smoked Halibut), and where the roes are extracted for the preparation of caviare. Although the American demand for caviare is not great, yet large quantities are shipped to Germany, and it commands good prices—as much as 10 cents a pound. Toledo alone packs 75,000 lbs. in cases of 130 to 150 lbs. each. The method of preparation is as follows: A large fish yields as much as three to five pails of roe, the eggs, which measure about one-ninth of an inch in diameter, varying in number from 800,000 to 2,500,000. The masses of roe, preferably not yet ripe and therefore hard, are taken quite fresh and

placed on a wire screen over a zinc-lined trough four feet long, two feet wide and eighteen inches deep. The meshes of the wire netting are just of sufficient width to allow the eggs to fall through. These are then placed in clean kegs, and the best German (Lüneburg) salt is rubbed in by hand. This extracts in a short time (ten to fifteen minutes) fluid from the eggs, which are then placed in quantities of 8 to 10 lbs. in sieves and drained. The caviare is therefore ready for the market in a few hours. That from the Lake Sturgeon is said to be of superior quality to that of the marine species and there is therefore a constantly increasing demand for it.

Certain economic uses of fish, other than as food, require now to be noticed. One of these is the manufacture of isinglass which has been carried on to a certain extent in the States, and the important source of which is the sounds or air-bladders of Sturgeon. The method employed is to remove from the vertebral column by means of a knife the absolutely fresh sounds, to place them in clean water, and in strong brine on the following day after the thin lining has been scraped off. They are then dried on frames covered with network and finally exposed to the sun for four or five weeks to bleach the isinglass. Such isinglass manufactured at Sandusky, Ohio, to the amount of 3,000 lbs. per annum is worth $1 a lb.

Sturgeon oil obtained by pressure from the livers brings 40 cents a gallon, and at Sandusky about 25 barrels of oil per annum are secured in this manner. The Sturgeon therefore which was formerly regarded as of no economic importance is destined to be one of the most valuable fish, especially of Lake Erie.

The recent abundance of the Alewife in Lake Ontario has been taken advantage of for the manufacture of fish-oil and guano. After the fish have been cooked twenty minutes they are subjected to hydraulic pressure; a million fish yield 500 gallons of oil and 63 tons of fertiliser.

DECREASE IN NUMBER OF FISH—ITS CAUSES AND REMEDIES.

Apart from such well-known instances of the almost total disappearance of valuable food fishes where they were previously abundant, such as the disappearance of Salmon from Lake Ontario and of the Shad from the lower Ottawa, other cases of waters being "fished out," or of the yield of certain species being on the decline are only too common.

It has been impossible so far to collect evidence showing to what extent waters within the Province previously rich have been depleted; such statistics however, are much required.

The causes of depletion are twofold: Such as are outside our control, and such as can by proper remedies be mitigated or avoided.

Among the former are the changes in the conditions of life incident to the opening up of the country for agricultural purposes, the removal of forests, the reclaiming of swamps, the resulting changes in rainfall, or at least in the extent to which surplus rainfall is held back by forest land and underbrush, and thus delivered only gradually and not in torrents through the streams. It is probably to such changes, aided by other causes adverted to below, that we must attribute the disappearance of Salmon from Lake Ontario.

Not only do such changes directly affecting the surroundings of the fish react upon its abundance, but they also have an indirect effect through the food-supply. Brook Trout, as was before observed, have for their natural food the larvæ of various species of gnats and flies, the elimination of which from a cultivated country is looked on as one of the blessings of civilization. There is, however, the reverse side to this advantage, the diminution of the favorable conditions for insect life leading to a disturbance of the food-supply of the insectivorous fish.

Various other obscure causes may interfere with the balance of life in any particular body of water, resulting in the wholesale destruction of one or more forms.

These may be of the nature of epidemic diseases like the Salmon Saprolegnia due to the attack of a parasitic fungus, or in some way animal parasites, causing usually comparatively little injury, may gain the upper hand and be the cause of widespread destruction. For example, Prof. A. C. Lawson brought to me some years ago specimens of an Argulus which he had taken from Whitefish dying wholesale in the Lake of the Woods, and shortly thereafter Mr. Washburn published in the *American Naturalist* an account of similar epidemics in inland lakes of Wisconsin. It has been suggested that the increase of the parasite is only possible when the fish are already weakened by some other cause.

Investigations into such cases are much required, and would be of much interest even although it might be impossible to obviate the cause when discovered.

Other causes more immediately under our control are (1) illegitimate and destructive methods of fishing, including the capture of immature fish in immense quantities by the prodigal use of narrow-meshed nets and the use of illegitimate methods of fishing especially at the spawning time, when the habits of most fish expose them far more to destruction than at others; (2) the destruction of spawning and feeding grounds by sawdust or other mill-refuse, or by the decayed contents of gill-nets or offal from fishing boats; (3) the prevention of access to spawning grounds by obstacles placed in streams.

Reference has been made through the body of this Report to wasteful and destructive methods of securing fish either at ordinary times or at the spawning season. It is very encouraging to learn that in certain inland lakes, such as Scugog, Rice Lake and Lake Simcoe, where illegal fishing has been strictly put down, the improvement in Bass and Maskinongé, for which these waters were formerly distinguished, is very great. Large quantities of Bass are peddled by Indians in the country surrounding Rice Lake in exchange for flour and pork.

Explosives have been frequently employed in American waters—and their use is not unknown in Ontario—for killing fish in a wholesale fashion. It is said that the air-bladder is ruptured in fish killed in this way : obviously only a very small proportion of the fish killed or fatally injured are brought to market.

Again the use of pound-nets with a small 1½ or 2 inch mesh in the pot secures countless immature fish of little or no market value, and the same may be said of the use of seines for herring, many immature Whitefish being captured, the surplus catch being used as manure when the market is glutted.

Sturgeon were formerly looked upon in Lake Erie as of so little value and were considered to such an extent as intruders in the pounds, that the fishermen were in the habit of bleeding them and allowing them to escape, the object being to keep the species off the fishing grounds. Spearing and grappling for them at spawning time and indeed spearing of any fish under such circumstances is properly regarded as one of the most destructive methods of fishing.

The respecting of a close season has done much to counteract depletion due to taking advantage of the comparatively helpless condition of fish at the spawning seasons.

The extent to which the various species expose themselves to capture is different, but the accounts we read of Ontario streams formerly blocked by Salmon at this time, and carted away in immense quantities convince us that the changes in the conditions of the streams are not entirely to blame for their total disappearance.

With regard to the destruction of spawning and feeding grounds by sawdust etc., and by decayed fish or offal, it is obvious that this source of injury to our fisheries is largely preventable. The enactments of the Dominion have already done much in putting an end to the former condition of affairs by which a fine river like the Ottonabee River, formerly celebrated for its Bass and Maskinongé, had its depth reduced from twelve feet to a few inches by accumulated sawdust, which is further distributed by spring freshets. It is not only in rivers that damage is done. Deposits of blackened and decomposing sawdust have been found miles out on the floor of the Great Lakes opposite rivers on which there are many saw mills, to the great detriment of favourite spawning and feeding beds of Whitefish.

This water-logged sawdust is also objectionable as forming a nucleus for sand-bars, interfering with navigation, but from the fisheries point of view the danger already noted, and the injuries to adult fish by the development of the gases of decomposition and by the floating sawdust getting into the gills of the fish cannot be exaggerated.

The consumption of mill-refuse is such an easily accomplished remedy that there is no excuse for the failure to carry it out. The Dominion law appears to be sufficiently explicit on the subject, but, as may be inferred from complaints from various parts of the country, requires to be better enforced.

Nor is there any excuse for the short-sighted policy of fishermen throwing overboard decayed fish or the offal of fish on the grounds; the occasional damage done by drifted nets and their putrid contents might probably be guarded against by more careful inspection of the nets, and attention to precautions against the floats becoming water-logged.

No doubt the presence of obstacles in streams preventing anadromous fish from reaching their spawning grounds has done much to divert fish elsewhere, or to prevent them accomplishing the function of reproduction at all. It is known that many fish are extremely sensitive in this way, the Sturgeon, for example, although ready to spawn, retaining its eggs after captivity.

The construction and maintaining of proper fish-ways is therefore absolutely necessary, and this can be effected so cheaply that there is no excuse for neglecting it when a dam is built. Various forms are in use, a recent one which promises well, being fed from the bottom instead of the top of the dam, and consisting of a series of vertical compartments communicating with each other and with the dam above and the stream below, by comparatively narrow apertures in a line with each other, the result being the gradual reduction of the height of the water in each compartment, and a continuous passage from stream to dam, the velocity of the current in which is easily overcome by the fish.

Close supervision of these various factors that favour the decrease of our food-fish will unquestionably have a most marked beneficial influence on the yield of our fisheries.

Apart from such remedies, aiming at preventing decrease of our food-fish supplies, there are others which aim at directly increasing them by artificial pond-culture and by fish-breeding. Both have given admirable results where they have been consistently prosecuted.

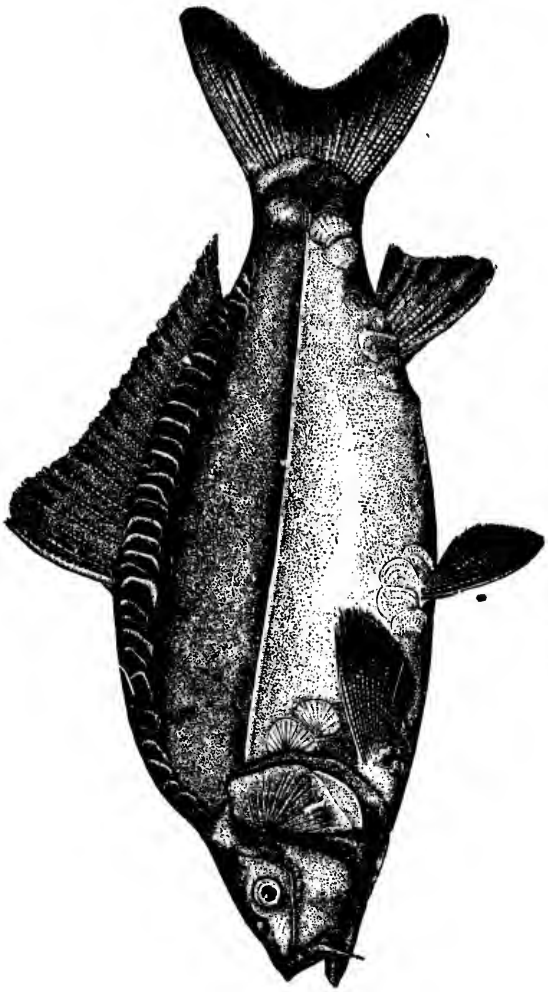
POND-CULTURE.

Under the above heading may be considered the artificial culture of Carp which has been conducted successfully for centuries in Europe, and has met with some favour in the United States.

The Carp is originally a native of Asia Minor and Persia, and has been for centuries before its introduction into Europe (1258 A.D.) a domestic fish, occupying somewhat the position that the pig does among mammals, at least in regard to its capacity for absorbing scraps.

Like all animals in a state of domestication it is extremely variable, and three well-marked races occur :—the full-scaled Carp, the Mirror Carp with scattered scales of large size, and the Leather Carp destitute of scales. The first mentioned may be regarded as approaching most nearly the original stock and are the most prolific; the last are the furthest removed from the original as to their coat, they are least prolific, but attain the largest size and fatten most rapidly. The Mirror Carp occupy an intermediate position in both respects.

They are very prolific, the females of the third and fourth year depositing from one to five hundred thousand eggs, when the water of the pond in which they have hibernated reaches a temperature of 63° F.



The Mirror Carp (*Cyprinus Carpio*).

While specially adapted for warm climates (they do not grow in weight materially in water of less than 48° F.) on account of their ability to stand warmer water than most fish, their culture is nevertheless prosecuted successfully in climates (Sweden for example) not very different from our own.

Special shallow ponds are arranged for the fry in which vegetable food is supplied for them by previously sowing clover; the larger fish, however, are fed on mixed animal and vegetable food, for example, chopped straw mixed with dried blood, etc. The winter pond is made seven feet deep, and in this no food requires to be provided as the fish neither feed nor grow there. They are in season from October till May, and they are always placed for a week before sale in a pond traversed by a current of running water to remove the muddy taste which all such bottom-feeding fish have when taken from the water. As they bring high prices in Europe, 16 to 20 cents a lb., their culture is attended with considerable profit; but the usual verdict of English speaking people on the subject of the Carp is that it is a tasteless fish, only fit to be a vehicle for sauces.

Various other foreign fish have been successfully introduced into North America, *e.g.* the European Brook Trout or Brown Trout, a fish which in some respects deserves more attention for culture purposes than our own Brook Trout, and again the California Mountain or Rainbow Trout (*Salmo irideus*), an exceedingly handsome species, is successfully hatched and introduced in the east.

One of the native fishes most adapted for pond culture is the Catfish (p. 442) which is not only prolific, but looks well after its young, all of which are hatched; it grows comparatively rapidly, is an omnivorous feeder, and fetches (where properly appreciated) high prices. One experimenter writes from the States that the culture of Catfish pays better than farming land and that peaty soil is very well fitted for it which would be unsuitable for agricultural purposes.

The merits of the Catfish as a pond fish have been recognized in California, where it has been introduced, also in various parts of Europe where societies interested have experimented with it.

FISH BREEDING.

Although pond-culture may prove a remedy for a deficient supply of food-fish in places distant from natural sources, and although it may also greatly improve the yield of small natural lakes, yet the only efficient method for preventing the exhaustion of the food-supply from our inland waters is Fish-breeding on a large scale commensurate with the rate of artificial depletion due to the fisheries.

It has been noted above that great differences are observable between different species of fish as to the number of eggs deposited by them. It might be supposed that those species which are characterized by great fertility would eventually crowd out the less fertile species, but observation teaches that the latter are able to hold their own, a greater proportion of eggs arriving at maturity, generally because the young are exposed to fewer dangers. In fact in any body of water there is a certain natural balance of life, liable to slow natural changes, to which the rate of reproduction is in the case of each species closely adjusted. Artificial interference with this balance on a grand scale of the character of our fisheries must inevitably lead to depletion of the species sought after, for the rate of reproduction being already adjusted to natural conditions cannot at once alter to suit the new artificial condition. If, however, the proportion of eggs arriving at maturity can be artificially increased on a scale commensurate with the rate of depletion, then the danger of exhausting the fish-supply will be thereby obviated. This is the object of the artificial breeding of fish; it is evidently only possible with those species where the natural conditions of the development of the eggs are such that only a small proportion of them attain maturity and it consists in the artificial hatching out of such eggs, and the care of the fry till such time as they may be safely introduced into the waters to be stocked.

Many of the earliest experiments in this direction are due to the energy of Mr. Samuel Wilmott, of Newcastle, Ont., who, stimulated by the rapid disappearance of the Atlantic Salmon from Lake Ontario, endeavoured thus to prevent it. Much of the apparatus employed is also due to this gentleman's ingenuity, and has, during his official connection with the Fish-culture operations of the Dominion Government, undergone improvements which have led to highly successful results.

The earlier apparatus consisted of shallow hatching trays, over which a steady current of water was allowed to flow; these permitted readily the extraction of the dead eggs, the decomposition of which interfered with the development of their neighbours. Now glass incubating jars are in use which allow of an easy inspection of the progress of development, with better aeration by a constant current of water running through them. These are employed successfully for Whitefish, Lake Trout and other Salmonidæ, and are also used for the propagation of Shad by the U. S. Government. The jars are cylindrical with a hemispherical bottom; a metal cover, with two holes $\frac{5}{8}$-inch in diameter for in-and out-flow tubes, is screwed water-tight on the mouth by means of a rubber collar. Half-inch rubber tubing connects the inflow tubes with the constant water-supply, the pressure of which may vary with different kinds of eggs, but for the Salmonidæ a fall of six feet from a tank provided with a ball-cock (in the event of the water-pressure being high) suffices. The amount required per diem varies; for Whitefish eggs 4,000 gallons a day is ample.

The number of eggs which can be accommodated in a jar varies with the particular species—with recently gathered Whitefish eggs 3 quarts (108,000 eggs) are regarded as sufficient for a jar, but four or five quarts may be accommodated in the same jar when the eggs have become "eyed."

The amount of movement of the contained eggs can be readily controlled in such a jar by pushing the inlet tube further out or in; Whitefish eggs, *e.g.*, when first taken, are glutinous and require to be worked rapidly under a full current with the inlet tube pushed down. Dead eggs, on the other hand, can be removed by pushing the outlet tube down into the superficial layer of eggs. When the hatching time arrives and the embryos are freed from the egg-membranes, they pass out from the outlet tube into a glass receiving tank, the current outward being barely sufficient to induce the fish to swim out.

Whitefish embryos when first hatched are light gray in colour; they are dormant for two hours but then become quite active, more so than Salmon or Trout fry. The young may be fed on a paste made of 2½ parts meal, ½ blood, 6 water. Experiments are at present in progress on this phase of fish-breeding operations.

It is now very generally conceded that it would be advantageous to reserve the fry of Salmonidæ till they have attained to some considerable strength and size before being turned out. The trouble is to find suitable food as nearly related as possible to their ordinary food. An effort has been made in the South of France to overcome this difficulty by raising water fleas (Daphnia p. 437) in basins intended for the purpose. It has been possible by allowing such basins to dry up to kill out noxious insects; this desiccation, however, appears to be favourable to the winter-eggs of the Daphnias, which hatch out in enormous numbers on the ponds being subsequently flooded.

From the last report of Fish-breeding operations in Canada the following statistics relating to Ontario are extracted:—

There exist three hatcheries, the oldest one at Newcastle, where Mr. Samuel Wilmott made the first experiments and researches on this subject; the second at Sandwich; and a third recently erected at Ottawa as an experimental and educational station. The Newcastle hatchery is chiefly devoted to Lake and Brook Trout. The Lake Trout are secured in two pounds at Wiarton during November; and in 1890, 11,125,000 eggs were obtained from 3,222 female fish taken in the pounds.

It is interesting to note that there were captured at the same time 1,396 males—an indication of the relative abundance of the two sexes. Of the eggs thus obtained 4,700,000 were put out as fry; 1,500,000 in the Georgian Bay, 2,300,000 in Lake Ontario, and 450,000 in Lake Simcoe, while of the remainder 5,500,000 were sent elsewhere in the Dominion as semi-hatched or eyed eggs.

About 400,000 eggs of Brook Trout were secured, one-fourth of which were distributed as eyed eggs, the remainder placed in various streams and ponds as fry.

Of 2,750,000 Whitefish fry hatched out from eggs received from the Sandwich hatchery there were distributed to Lake Ontario (1,650,000), Georgian Bay (1,000,000), and Lake Simcoe (100,000).

The Sandwich hatchery deals chiefly with Whitefish and Pickerel eggs, the latter being hatched out in the spring after the Whitefish fry have been disposed of. Ninety million Whitefish eggs were obtained in the Detroit River, which is

exclusively reserved during the close season by the Government, and of these one-half were successfully hatched in 600 automatic glass incubators, thirty million being put out as fry, as follows:—

Lake Huron	2	million.
River and Lake St. Clair	5	"
Detroit River	10	"
Lake Erie	10	"
Lake Ontario	3	"

Of Pickerel eggs (*Stizostedium vitreum*) 32,000,000 were secured from Lake Huron and 22,000,000 fry placed out as follows:—

Lake Huron	2	million.
River and Lake St. Clair	4	"
Detroit River	10	"
Lake Erie	5	"

Reports amply show that these operations are already meeting with their reward, and indicate that a similar policy pursued by the Ontario Government with regard to the smaller inland waters would be followed by a rapid improvement of these as valuable sources of food.

CONCLUDING REMARKS.

It is obvious from many passages throughout this Report that there is abundant work for a permanent Fish Commission appointed under the Ontario Government.

Not only must our knowledge of the geographical distribution, habits, foods and enemies of our food-fishes be extended by a systematic survey of our waters, but a rigid and effective inspection of the fisheries must be introduced, and measures taken to counteract the decline in yield which is otherwise inevitable. The establishment of a Provincial Fish Hatchery is one of the most easily arranged of these measures, but there are problems of greater difficulty confronting the Commission connected with the control of the fisheries themselves.

While there is no difference of opinion as to the desirability of enforcing the laws against spearing and other illegal methods of fishing, there is considerable divergence as to the respective merits and demerits of pound-nets and gill-nets. These have been referred to on p. 464, but it is needless to say that the pound-net fishermen exaggerate the faults of the apparatus employed by the gill-net fishermen and *vice versa*. Unquestionably the multiplication of pounds has done much harm in interfering with the inshore migrations of the fish, an altered habit in this regard being noted since pounds were common; the use of small-meshed pots is also destructive, on account of the habit of immature Whitefish remaining in comparatively shallow water.

On the other hand drifted or unlifted nets with decaying fish must inevitably prove harmful to the fishing grounds, and while on the whole larger fish are secured by the gill-nets their condition is not so good as those taken from pounds.

It must be noted that the same size of mesh in a pound-net and a gill-net will secure very different sizes of fish, the meshes in the former being taut, in the latter loose, so that escape from the former is much easier than from the latter. An impartial consideration of the advantages and disadvantages of both methods of fishing will probably lead to the conclusion that both methods of fishing may under certain restrictions continue to be prosecuted without danger to the Fisheries.

Apart from rigidly limiting the number of pounds to be permitted, the leaders should be controlled in length, a considerable gap left between them and the shore, and only a single pot allowed. Above all the mesh of the pot should be such that immature whitefish may be able to escape. The general opinion is that this may be secured by employing netting for the pot, the mesh of which, after the tarring process, stretches to three and a-half inches. Experts announce that the number of whitefish to a barrel has been steadily on the increase of late years. If measures such as the above are adopted an improvement in this respect would inevitably follow.

Finally a strict inspection of pounds is necessary, especially during the close season, to prevent fish being pounded until after the season has expired.

Again, regulations with regard to the renewal of the seaming and of the stretching lines of gill-nets would go far to prevent damage done by drifted nets. It is probable that an increase in the size of the mesh of the pound-nets might be advantageously accompanied by the use of a five-inch mesh for whitefish gill-nets, and the imposition of a penalty for possessing or selling nets of illegal size would asssist the objects of the Commission.

The latter regulation would not be complete without a similar penalty for possessing or selling immature fish, such as whitefish under two pounds or of black bass under one pound.

At present there is no doubt that large quantities of our game fish are netted or secured by other illegal means and shipped to the States. This is true of the magnificent Nepigon trout on the north shore of Lake Superior. It is asserted also with regard to bass which are caught by poachers in fyke-nets, and shipped covered over by less valuable fish.

It would not be a difficult task for the Commission to devise means to check such shipments. The outlay for adequate inspection to enforce the carrying out of the rules adopted would no doubt be considerable, but would speedily be repaid by the increase of the value of the Fisheries.

TREATISE ON THE GAME AND FUR-BEARING ANIMALS OF ONTARIO.

TREATISE ON THE GAME BIRDS OF ONTARIO.

REPORT ON FISH.