Age	Mean FL					
	N Sask. R., Sask. (Reed 1962)		Gt. Slave L., N.W.T. (northern part) (Harris 1962)		Pyramid L., Alta. (Rawson & Elsey 1950)	
	(*inches*)	(*mm*)	(*inches*)	(*mm*)	(*inches*)	(*mm*)
1	–	–	–	–	2.0	51
2	–	–	6.0	152	3.3	84
3	12.7	323	6.7	170	4.2	107
4	15.1	384	10.0	253	5.2	132
5	16.8	427	11.4	290	6.0	152
6	17.3	439	12.3	314	7.0	178
7	–	–	13.0	330	8.0	203
8	–	–	14.6	372	8.8	224
9	–	–	15.8	403	9.6	244
10	–	–	17.0	433	10.4	264
12	–	–	19.6	499	12.4	315
15	–	–	21.5	547	–	–
19	–	–	25.2	642	–	–

These figures illustrate the extreme variability in growth from place to place. Size at the same estimated age can be as much as 40 mm greater in a population in southern Great Slave Lake than one in northern Great Slave Lake. The Pyramid Lake population shown was the one described by Bajkov (1927) as a dwarf, under the name *C. c. lacustris*, saying they grew to no more than 4.5 inches (114 mm). Specimens up to 16 inches (406 mm) were found later and no evidence was found to separate this population as a subspecies (Rawson and Elsey 1950). Lacking more reliable ages by pectoral fin sections, it is impossible to assess how much of this variation is attributable to error in aging. Some reports stated there is no difference in growth rate between males and females taken in the lake; others, that in the spawning run, males are always smaller than females. Females live longer and achieve a greater maximum size.

Age at first sexual maturity is equally variable and equally subject to the aging error. In British Columbia, spawners were 5.1–15.7 inches (130–400 mm) fork length, mostly 10–12 years of age. First spawning was estimated to occur at 5–7 years of age. In Great Slave Lake, no spawners younger than an estimated 9 years of age were seen. Longnose suckers live to spawn more than once and in southern areas in successive years; 20–50% of them twice, 10–30% a third time, and smaller numbers through to a sixth time.

The individual often quoted as the North American size record is from Great Slave Lake, 25.2 inches (642 mm) fork length, 7.3 pounds in weight, and estimated to be 19 years old (Keleher 1961). They may, however, be as old as 22–24 years of age.

The longnose sucker is the most successful and widespread cypriniform in the north occurring almost everywhere in clear, cold water in moderately large numbers. It occurs in the south more sporadically, in more restricted environments (the deeper areas only of lakes), and in fewer numbers. Generally restricted to freshwater lake bottoms or tributary streams, it is, however, reported from brackish water about the mouths of arctic streams. It is reported from as deep as 600 feet in Lake Superior but not below 80 feet in Great Slave Lake. The latter might be the maximum depth at which nets were set rather than a true depth stratification of the longnose sucker.

Upper lethal temperature was calculated as 79.8° F (26.5° C) when acclimated at 57.2° F (14° C), and as 80.6° F (27° C) when acclimated at 52.7° F (11.5° C) (Black 1953).

The food of this sucker is variable from place to place, season to season, and by size. It is, however, totally invertebrates taken from the bottom and no vertebrates have been reported. A typical food list in order of frequency of occurrence is as follows: Amphipods (*Hyalella*), Trichoptera, chironomid

larvae and pupae, Ephemeroptera, ostracods, gastropods, Coleoptera, pelecypods, copepods (*Cyclops*), cladocerans (*Bosmina*), and plants. There are older records of the food being largely algae. As with the white sucker, this species would appear to be largely erroneously considered a serious egg predator of more valuable fish. However, one record indicated that longnose suckers 14–16 inches (356–406 mm) in length had 0–98 brook trout eggs in the gut. It was known that these eggs had been exposed by superimposition of nests on limited spawning grounds and may have been dead when eaten (Stenton 1951).

The young of this species probably fall prey to a wide variety of predaceous fishes and fish-eating birds. Even larger longnose suckers are taken by northern pike. Adults in the spawning streams are probably taken by bears, other mammals, and by osprey and eagles.

As bottom feeders, longnose suckers are competitors for food with all other bottom feeders except those from whom they are spatially separated in the deeper water.

In Saskatchewan the fluke *Metorchis conjunctis* infects this species and accumulates by the thousands in the livers of dogs fed raw suckers. There is a record of the death of 10 sleigh dogs in northern Saskatchewan as a result of this parasite (Rawson 1960).

Hoffman (1967) listed the parasites of this species as follows: Trematoda (10), Cestoda (7), Nematoda (4), Acanthocephala (9), leeches (1), Crustacea (1). Parasites were also given in Bangham (1955) and Bangham (1941).

Dechtiar (1969) described a new monogenetic trematode *Pellucidhaptor catostomi* from the nasal cavity of this species.

Relation to man The utilization of this fish as food by native peoples in northern Canada ranges from nil to extensive. It is used everywhere as food for dogs, but even they prefer lake whitefish. The flesh is firm, white, flaky, and sweet. Other than the numerous bones, the flesh is edible and more palatable than that of white suckers. Those taken in the Great Lakes are often marketed as frozen fillets, called "mullet," and said to be received with some favour. This species made up 7% of the summer commercial catch in Great Slave Lake in 1945. It is entered in the commercial records in Ontario with all other suckers, which in 1966 totaled slightly more than 1.3 million pounds, valued at $22,456.

Nomenclature

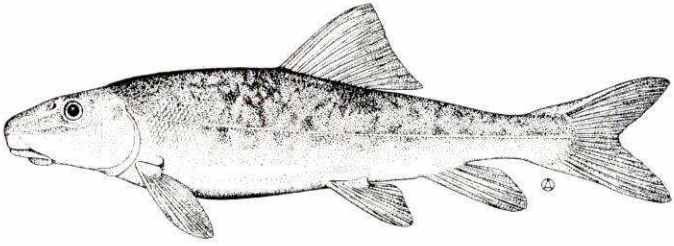
Cyprinus Catostomus	— Forster 1773: 158 (type locality tributaries of Hudson Bay)
Catastomus Forsterianus	— Richardson 1823: 720
Cyprinus (Catastomus) Forsterianus (Rich.)	— Richardson 1836: 116
Cyprinus (Catastomus) reticulatus (Cuvier)	— Richardson 1836: 303
Catostomus aurora	— Agassiz 1850: 360
Catostomus communis	— Fortin 1864: 64
Cyprinus catostomus	— Fortin 1866: 72
Catostomus forsterianus	— Fortin 1866: 72
Catostomus hudsonius	— Günther 1868: 13
Catostomus longirostris	— Adams 1873: 253
Catostomus griseus (Girard)	— Eigenmann 1895: 108
Catostomus catostomus (Forster)	— Jordan and Evermann 1896–1900: 176
Catostomus catostomus lacustris	— Bajkov 1927: 380
Catostomus c. catostomus (Forster)	— Bangham 1955: 187
Catostomus catostomus rostratus (Tilesius)	— Walters 1955: 295

Etymology *Catostomus* — inferior mouth alluding to the ventral position of the mouth.

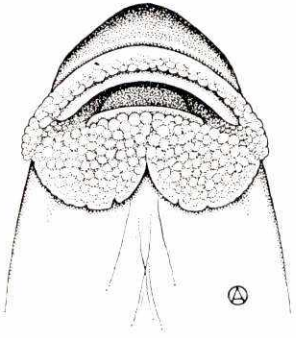
Common names Longnose sucker, sturgeon sucker, northern sucker, finescale sucker, red sucker, red-sided sucker, black sucker. French common name: *meunier rouge*.

BRIDGELIP SUCKER

Catostomus columbianus (Eigenmann and Eigenmann)



Description A very rounded, torpedo-shaped fish, usually 8–12 inches (203–305 mm) in length. Body cylindrical, not laterally compressed, greatest depth ahead of origin of dorsal fin, 18.5–19.8% of total length; caudal peduncle shallow, depth 5.7–7.2% of total length. Head moderately long, about 20% of total length, wide, interorbital width 40.0–45.8% of head length, not deep; eye high on head at midlength and moderately large, diameter 38.4–45.4% of snout length; snout long, 47.6–50.0% of head length,



rounded; mouth ventral, little overhung by snout, protrusible and suctorial, gape reaching to nostril, cartilagineous edge of jaws visible in open mouth; lips thick, papillae large, round, lobes of lower lip rounded, not completely cleft, 2–5 rows of papillae crossing base, papillae on anterior edge of upper lip, sometimes a slight notch at lateral point of connection of upper and lower lips; no teeth in mouth, pharyngeal teeth in single row, flat, comblike. Gill rakers short and fleshy, about 24–42 + 34–55 (Smith 1966). Branchiostegal rays 3. Fins: dorsal 1, soft rayed, base 13.0–14.6% of total length, more than twice depth of caudal peduncle, height greater than base, edge only slightly emarginate, rays 11 or 12 in material examined, but 11–14 over whole range (Carl et al. 1967); caudal rather long, deeply forked, tips rounded points; anal not markedly long, length about equal to height of dorsal, tip a rounded point, 7 rays; pelvics abdominal, low, origin at midpoint of dorsal fin, wide base with fleshy pad, but no axillary process, and obvious membranous stays, 10 or 11 rays, tip a rounded point; pectoral low, long, pointed, 17 rays. Scales cycloid, small, crowded anteriorly, larger on caudal peduncle, lateral line scales 87–99 in material examined, 88–124 over British Columbia (Carl et al. 1967); lateral line at midpoint of body, pale, complete but often with breaks and branches. Peritoneum black; intestine long, 6–14 loops anterior to liver, little differentiated; no pyloric caeca, swim bladder of 2 chambers, not reduced, reaches at least to origin of pelvic fins. Vertebrae, including Weberian ossicles, 43–51.

Nuptial tubercles on anal fin, lower lobe of caudal fin, and on scales of posterior half of the body on males.

Colour Back and top of head dark brown to olive, upper sides often somewhat mottled and paler brown, lower sides, head below eye, and ventral surface white to pale yellow. Lateral line prominent near head, and paler than background. Breeding males

with prominent, orange lateral band. Young with black peritoneum obvious in abdominal region, and often with 3 dark lateral blotches.

Systematic notes Miller and Miller (1948) discovered that *Pantosteus columbianus* of Eigenmann and Eigenmann (1893a) and *Catostomus syncheilus* Hubbs and Schultz (1932), applied, in part, to the same species, that it was not a synonym of *Pantosteus jordani* (= *C. platyrhynchus*) as suggested by Eigenmann in 1895, and that it should not be put in the genus *Pantosteus* but in the genus *Catostomus*. The discussion concerning *Pantosteus* versus *Catostomus* was given by Smith (1966). Smith recognized 3 subspecies *C. c. columbianus*, *C. c. palouseanus*, *C. c. hubbsi*.

Hybrids between the bridgelip sucker and the largescale sucker are known.

Distribution Restricted to the fresh waters of northwestern North America. It occurs in the Columbia River drainage from British Columbia to Nevada, below the great falls of the Snake River, from Idaho west to at least central Oregon and Washington, and north in the Fraser River to central British Columbia (*see* Smith 1966).

In Canada, it is limited to British Columbia where it occurs in Erie and Lower Arrow lakes, East Kootenay District (Columbia River), in Osoyoos Lake and the Similkameen River, south-central British Columbia (Columbia River), Nicola Lake, North Thompson River, Quesnel River (Fraser River), and tributaries of the Fraser River from Australian Creek to Prince George, including Wright Creek, Salmon River, Beaverley Creek and the West Road River (Carl et al. 1967).

Biology Virtually nothing is known of the biology of this species in Canada or elsewhere. It probably spawns in late spring in British Columbia as ripe females were taken on June 9 near Prince George, but earlier to the south. Eggs are as large as 2.8 mm in diameter. Young were 7 mm on July 10 in Idaho and 2.5–3.1 inches (40–80 mm) by the end of the first summer. Sexual maturity is first reached when individuals are about 5 inches (127 mm) in length. Adult maximum size was 10 inches (250 mm), according to Smith, and to 15 inches (381 mm) according to Carl et al.

The habitat of this species is usually colder water of small, swift rivers with gravel to rocky bottoms, but it is also found in rivers where current is more moderate and the bottom of sand and mud. It is only infrequently found in lakes.

Carl et al. noted that the cartilagineous edges of the jaws and the black peritoneum of this species suggested its food might be obtained by scraping algae from rocks. The food would include invertebrates taken while feeding on the bottom.

This species occurs in an area where large predaceous fishes are not abundant After it reaches adult size it may escape predation by other fishes. It may be preyed on by mammals and birds.

The parasites of this species were listed by Hoffman (1967) as follows: Trematoda (1), Cestoda (1), Acanthocephala (4), Crustacea (1).

Relation to man This species is of very little, if any, direct or indirect relation to man. It is edible and may have constituted food for native peoples and their dogs but it is not eaten today. It may constitute food, when small, for economically important salmonids. It may, in turn, compete with such salmonids for food. It is not presently a fish pursued by anglers.

Nomenclature

Pantosteus columbianus — Eigenmann and Eigenmann 1893a: 151 (type locality, Boise River, Caldwell, Ore. (= Idaho)

Pantosteus jordani Evermann — Eigenmann 1895: 107

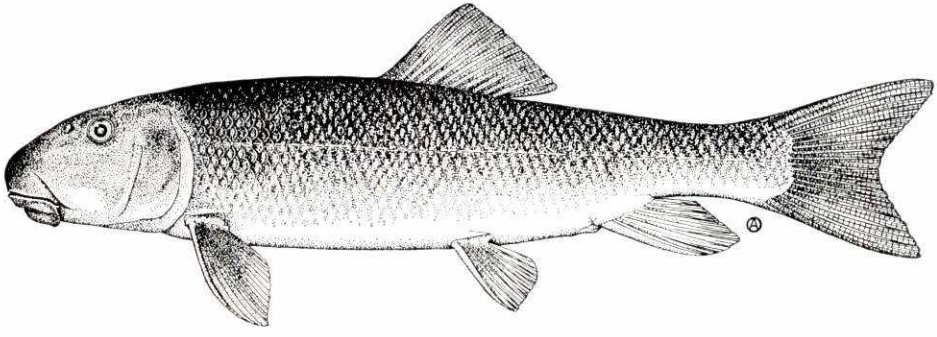
Catostomus syncheilus — Hubbs and Schultz 1932: 6
Catostomus columbianus
(Eigenmann and Eigenmann) — Miller and Miller 1948: 177

Etymology *Catostomus* — inferior mouth; *columbianus* — of the Columbia River.

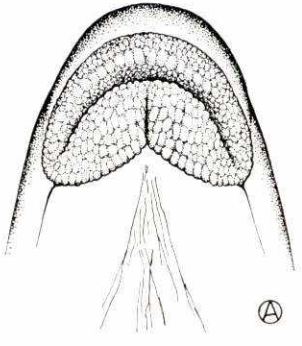
Common names Bridgelip sucker, Columbia small scaled sucker. French common name: *meunier de l'ouest.*

WHITE SUCKER

Catostomus commersoni (Lacépède)



Description A robust, cylindrical, torpedo-shaped fish, usually 12–20 inches (305–508 mm) in length; round to oval in cross section forward, little compressed laterally, greatest depth at origin of dorsal fin 14.1–20.0% of total length; caudal peduncle moderately long and slender, depth 6.5–8.6% of total length. Head moderately long, about 20% of total length, naked, bluntly pointed, rounded on top, moderately wide, interorbital width 35.2–49.5% of head length; eye small, 41.3–66.6% of snout length, high but at centre of head length; snout rounded, sometimes square, fleshy, overhanging upper lip, 35.7–50.0% of head length; mouth ventral



(terminal until 2 mm total length), toothless, suctorial, moderately small, maxillary extend-

ing half the snout length; lips fleshy, thick, papillate, papillae small and oval; pharyngeal teeth in single row, comblike (*see* p. 25), 40–42+39–43 according to McPhail and Lindsey (1970). Gill rakers approximately 20–23, short to long, somewhat knobbed, on both surfaces of the arch. Branchiostegal rays 3. Fins: dorsal 1, soft rayed, almost at midpoint of total length, origin ahead of pelvics, base short 10.7–15.0% of total length, slightly emarginate, 10–13 principal rays; caudal deeply forked, tips roundly pointed, usually 18 rays; anal long, height at least 2 times base, more or less pointed, 6–8 large, principal rays; pelvics abdominal, low, under middle of dorsal, short, square, with moderately broad base, small axillary process, 10 or 11 rays; pectorals low, long, almost equal to head length, pointed, 16–18 prominent rays. Scales moderately small, larger on peduncle than near operculum, 53–74 in lateral series, scales on peduncle visible to naked eye on 3-inch (76-mm) fish; lateral line complete, straight, at midpoint of body. Peritoneum pale or lightly speckled; intestine long, about 4 or 5 coils, simple, no area differentiated as stomach; no pyloric caeca; swim bladder of 2 chambers. Vertebrae 45–48, including Weberian ossicles.

Nuptial tubercles on males, well developed on rays of anal fin, lower lobe of caudal fin and on some caudal peduncle scales, minute tubercles on undersurface of head between the bases of the pectoral fins and the posterior margin of the operculum. There is a smaller number of poorly defined tubercles on some females. External characters for sexing white suckers were described by Spoor (1935).

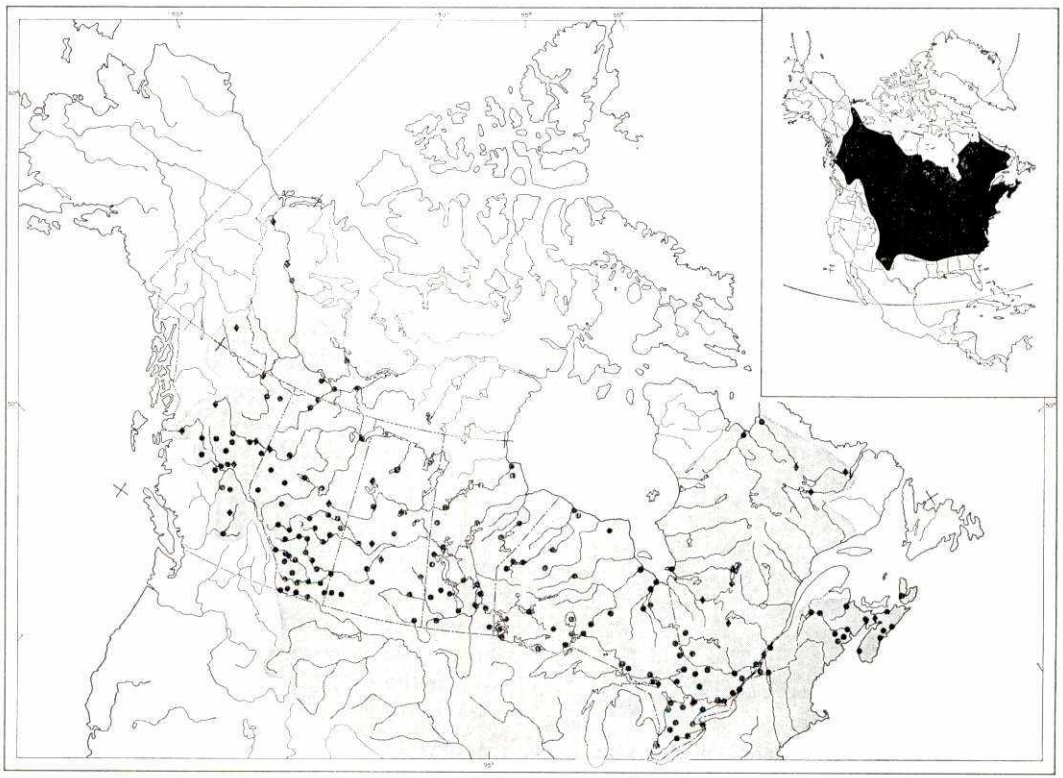
Colour In adults, the back, top of head, upper sides, and sides of head to below the eye are grey, coppery brown through brown, to almost black, lower sides and ventral surface of head and body cream to white; anal fin whitish, other fins dusky. Young 2–6 inches (51–152 mm) in length usually with 3 large, prominent, black spots on sides of body. In spawning individuals, the body is more golden in colour and the dark of the upper parts deeper and more intense. Males east of the Rocky Mountains and south of the Territories have a pronounced rose to nearly scarlet, wide, lateral band. In Saskatchewan, this is replaced by a pale, cream-coloured band and no band was noticed west or north of the mountains. In Ontario, this band varies in intensity from population to population and is often almost black in colour.

Systematic notes The white sucker seems to be a rather plastic animal and characters vary from area to area. There would appear to be a very slight north–south cline in some meristics and body proportions but many of these are effected by differing growth rates. Differences in general appearance, counts, and a tendency to develop dwarf populations, led to many separate names for different populations, including *teres*, *communis*, *flexuosus*, *reticulatus*, *gracilis*, *pallidus*, *chloropteron*, *commersoni suckleyi*, and *commersonnii utawana* (McPhail and Lindsey 1970). The possibility that there were, in the past, three geographically separated forms, from eastern, Plains, and Hudson Bay drainages, has been suggested by Metcalfe (1966) on the basis of body thickness, eye size, scale count, and number of lip papillae.

Kendall (1909) interpreted Low's (1896) *C. Forsterianus* Richardson, as *C. commersoni*, and Low's *C. longirostris*, LeSueur, as *C. catostomus*. Backus (1957) felt the reverse was true. Both names used by Low are usually considered synonyms of *C. catostomus*. On the basis of spawning time given by Low (*C. Forsterianus* 2 weeks later than *C. longirostris*) it would seem that Kendall's interpretation was correct.

Distribution Restricted to North America. Occurs from central Ungava, Labrador, Nova Scotia, south near the coast to western Georgia, extreme north of the Gulf states to northern Oklahoma, north through the eastern portions of the states from Colorado to Montana, through Alberta and British Columbia to the Mackenzie River delta.

In Canada, it is generally distributed from



central Ungava, Labrador, sporadically in Nova Scotia, generally in New Brunswick, in Quebec north only to near Fort Chimo where it is uncommon, generally distributed in southern Quebec and over all the provinces west to Alberta, north-central British Columbia (upper Fraser, Skeena, and Peace rivers), southeastern Yukon Territory, and across the Northwest Territories, at the level of the north shore of Great Slave Lake or within the tree line, from Hudson Bay to the Mackenzie River. Downstream in the Mackenzie River to the delta.

Biology As a result of the abundance and widespread distribution of this species, its capture during studies of economically important fishes, and its minor importance as a commercial fish, much is known of its biology in Canada. Special studies of its biology were made by Campbell (1935) and Geen et al. (1966) from which the following is largely taken.

White suckers spawn in the spring, usually from early May to early June. Adults usually migrate from lakes into gravelly streams when stream temperatures first reach 50° F (10° C), but they are also known to spawn on lake margins, or quiet areas in the mouths of blocked streams. Spawning sites are usually in shallow water with a gravel bottom but they may spawn even in rapids. Adults home to certain spawning streams. Thousands may ascend a suitable stream, as many as 500 passing a point in 5 minutes. In certain lakes a segment of the population spawns in the lake and another in tributary streams. At times white suckers move into tributaries at spawning time but actually spawn in the lake rather than in the stream. The bulk of spawning at one Ontario locality took place at dusk and dawn. Spawning did take place during daylight hours but to a much more limited extent and usually only at the peak of spawning activity.

On the spawning grounds two to four

males often crowd around one female, pressing her with their tuberculate fins during irregularly spaced spawning acts lasting 3–4 seconds, and occurring 6–40 times an hour. Egg number in Minnesota varied from 36,000 to 139,000 in females 7–20 inches (178–510 mm) total length. The usual number is probably 20,000–50,000. In Waskesiu Lake, Sask., there were approximately 11,160 eggs per pound of body weight. Eggs are yellow. No nest is built, eggs are scattered, they adhere to the gravel or drift downstream and adhere to the substrate in quieter areas. Adults begin moving off the spawning grounds to the lake 10–14 days after spawning begins. Eggs hatch in about 2 weeks (8–11 days at 50°–59° F or 10°–15° C in the laboratory), the young remain in the gravel 1–2 weeks and fry start to migrate to the lake about a month after spawning begins. They are at this time 12–17 mm in length. There may be as little as 3% survival from egg to migrant fry.

For details and illustrations of egg and early development of the young, *see* Fish (1932) and Mansueti and Hardy (1967).

Growth of young white suckers is extremely variable from lake to lake. Daily increment in Waskesiu Lake was calculated at 0.1 mm and 0.4 mm in early and late June. Fry grew from an average length of 9.25 mm on May 26 to 55.2 mm on September 5. Growth in length in subsequent years is slower, variable from place to place, probably never more than 10–20 mm per year, and difficult to interpret. Growth may cease after sexual maturity is attained. Records from the literature are now suspect as most ages have been calculated from scales, and Beamish and Harvey (1969) stated that, whereas pectoral fin ray sections provide a reliable age interpretation over the whole life, ages by scales are reliable only to the fifth year. Over age 8, ages determined from scales could be as much as 5 years in error. Some published age–length relations for Canadian populations, including a recent fin ray determination in George Lake, Ont., are shown below.

Growth rates are extremely variable from one location to another but these figures demonstrate the difficulty, expressed by most authors, in aging white suckers by their scales. Females appear universally to grow faster than males, achieve larger sizes, and to live longer. Age at first attainment of sexual maturity varies over the range from 5 to 8 years (usually 3–4 years in Ontario), with males spawning first a year earlier than females. Spawning mortality in the north and west is usually 15–20% but is lower in the east. At least 20% spawn a second time, 10% a third time, and a few individuals

	Gibson L., N.B. Smith (1952) (age determination by scales)		Lake of the Woods, Ont. Chambers (1963) (age determination by scales)		Waskesiu L., Sask. Campbell (1953) (age determination by scales)		George L., Ont. Beamish (1970) (age determination by pectoral fin rays)	
Age	Mean FL		Mean FL		FL		Mean FL	
	(*inches*)	(*mm*)	(*inches*)	(*mm*)	(*inches*)	(*mm*)	(*inches*)	(*mm*)
1	–	–	–	–	–	–	7.0	179
2	–	–	8.8	224	–	–	10.8	274
3	–	–	11.2	284	3.9–5.5	100–140	13.2	336
4	8.5	217	11.9	302	5.9–7.8	150–200	15.2	387
5	9.3	236	15.1	384	8.2–10.2	210–260	16.7	424
6	10.0	254	15.6	396	10.6–13.0	270–330	17.8	452
7	10.6	269	16.9	429	13.4–15.3	340–390	18.6	472
8	11.2	284	17.4	442	15.7–17.3	400–440	19.1	487
9	–	–	18.4	467	17.7–19.7	450–500	19.6	499
10	–	–	19.3	490	–	–	20.0	509
11	–	–	19.8	503	–	–	20.3	517
12	–	–	20.7	526	–	–	20.6	524
13	–	–	20.9	531	–	–	20.8	529
14	–	–	22.8	579	–	–	21.0	533
15	–	–	–	–	–	–	21.1	536

spawn four or more times. Campbell (1935) gave weight at ages 4, 6, and 9 as 3 ounces, 1.1 pounds, and 4.3 pounds. Maximum size records are rarely maintained for other than sport fishes but Keleher (1961) quoted a 6.9-pound fish from East Twin Lake, Conn., in 1939, and Chambers (1963) listed one of 7 pounds and 22.8 inches (579 mm) fork length, from Lake of the Woods, Ont. McPhail and Lindsey (1970) gave maximum length as 25 inches (635 mm). Maximum age would appear to be about 17 years.

White suckers are usually fish of warmer, shallow lakes or warm, shallow bays, and tributary rivers of larger lakes. They are usually taken from the top 20–30 feet of lakes but have been recorded below 151 feet in Great Slave Lake. In addition to spawning migrations, movements, other than a general tendency to move offshore with increase in age, are random, probably in response to temperature. White suckers are moderately active during the daytime but active feeding is usually restricted to near sunrise and sunset when they move into shallower water.

In Waskesiu Lake, the young were associated with the young of spottail shiner, blacknose shiner, yellow perch, and sticklebacks. The larger white suckers were taken with cisco, lake whitefish, northern pike, longnose sucker, yellow perch, walleye, and burbot.

For a detailed study of the food of the young by size and season *see* Bigelow (1923).

The fry at about 12 mm length begin feeding near the surface on plankton and other small invertebrates. At 16–18 mm, the period when the mouth moves from terminal to ventral, there is a shift to bottom feeding. There is a shift in the type of invertebrate food consumed with increasing size, and season. Campbell (1935) cited the range of percentage composition of the gut content of individual white suckers 4.6–9.6 inches (118–245 mm) fork length, over the period June to September as: Chironomidae 5–90%, Trichoptera 2–70%, Mollusca 5–85%, Entomostraca 5–98%, *Chaoborus* 50% (one individual). In total, chironomid larvae and pupae constituted 48% of the food taken and molluscs were next in importance. In Ontario, cladocerans constitute 60–90% of the food of many individuals in summer, the number in a single specimen is sometimes in the tens of thousands.

When less than 12 inches (305 mm) in length, white suckers which are often very abundant in warm lakes, constitute a major food item of a wide variety of predatory fishes such as northern pike, muskellunge, basses, walleye, and burbot. The smaller ones are eaten by predaceous birds; the fry are at times gorged on by Atlantic salmon and brook trout, and spawners in streams fall prey to bears and other mammals. Sea lampreys attack white suckers, particularly when the number of lake trout available is low, and have seriously reduced the number of larger white suckers in South Bay, Lake Huron.

They are bottom feeders, but do not apparently constitute serious competition for other browsing, shallow-water, bottom feeders such as trouts, basses, and sturgeons. They were often condemned as egg feeders and considered to do great damage on the spawning grounds of more desired species. The evidence for this is variable and nonconclusive. Ellis and Roe (1917) reported that egg predation by white suckers on logperch nests was as high as an average of 500 logperch eggs per sucker. Campbell (1935) found no eggs in 100 stomachs of white suckers taken on the lake whitefish spawning ground at spawning time. Stewart (1962) reported no eggs in a detailed study of the food of this species.

White suckers are subject to a wide variety of parasites and diseases, including bacterial furunculosis *(Aeromonas salmonicida)*. Hoffman (1967) listed the following parasites for this species over the whole of its range: Protozoa (11), Trematoda (28), Cestoda (16), Nematoda (14), Acanthocephala (13), leeches (4), Mollusca (1), Crustacea (7). Dechtiar (1969) described a new monogenetic trematode *Pellucidhaptor nasalis* from the nasal cavity of this species.

There are hybrids reported for the white sucker and the largescale sucker in Canada and the form referred to as *C. commersoni suckleyi* has been shown in the United States to hybridize with the mountain sucker, longnose sucker, and the bluehead sucker. There

are puzzling, distinct, dwarf populations over most of its range. Often these dwarfs cohabit a lake with a normal population. Important studies of this form are those of Dence (1948) who worked with a population long known as *C. commersonnii utawana* (Mather), and of Beamish (1970).

Relation to man The flesh of the white sucker is edible and under many circumstances highly palatable. It is white, flaky, and sweet but somewhat bony. It makes good soups and chowders and if the upper muscle masses only are used almost all of the bones are avoided. When taken in cold water in the spring it is said to be tasty if fried in butter. It is as good as so-called prime fishes when hot-smoked. It is not, however, highly favoured commercially, forms only a small part of the commercial catch, and when marketed it and other suckers are usually called mullet. In 1921–1927 this species constituted 5% of the commercial catch in Waskesiu Lake, Sask. In 1966 the Ontario catch marketed as suckers (several species) was just over 1.3 million pounds with a value of almost $22,500. Much of it may have gone into pet food.

It is rarely angled for in Canada but anglers fish for it in the United States. Numbers of white suckers are netted for food during the spring spawning runs or when dipnetting smelt. It has a real and presently unutilized potential as a sport fish in Canada. They can be taken still fishing with a small hook and a variety of baits including doughballs. They will also strike small spinners and wet flies and provide good sport.

Considerable numbers of young suckers are sold annually, as bait, to anglers in the east, usually for basses, northern pike, and muskellunge, at a price of 75¢ to $1 a dozen. They are reared for bait in the United States (*see* Dobie et al. 1948) and reared and captured there and in Canada as the main food for hatchery rearing of game fishes.

Nomenclature

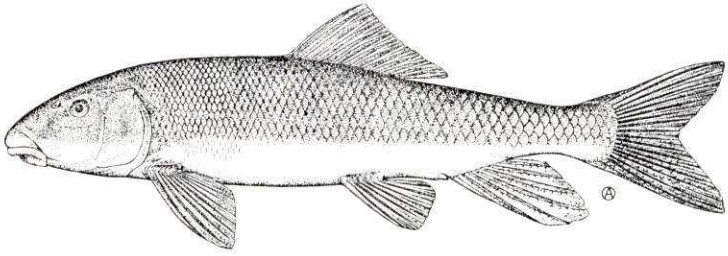
Cyprinus Commersonnii	— La Cepède 1803: 503 (no type locality given)
Catastomus Hudsonius	— Richardson 1823: 717
Cyprinus (Catastomus) Hudsonius (LeSueur)	— Richardson 1836: 112
Cyprinus (Catastomus) reticulatus (Cuvier)	— Richardson 1836: 303
Catostomus communis	— Perley 1852: 192
Catastomus communis	— Forelle 1857: 281
Catostomus Bostoniensis	— Gill 1865: 261
Catostomus teres	— Günther 1868: 15
Catostomus commersoni (Lacépède)	— Eigenmann 1895: 108
Catostomus Forsterianus Richardson	— Low 1896: 329
Catostomus commersoni Jordan	— Cox 1896b: 64
Catostomus commersonii	— Bean 1903b: 101
Catostomus richardsoni	— Harper and Nichols 1919: 263
Catostomus commersonnii Lacépède	— Hubbs 1926: 21
Catostomus commersonnii commersonnii (Lacépède)	— Hubbs and Brown 1929: 20

Etymology *Catostomus* — inferior mouth; *commersoni* — after P. Commerson, an early French naturalist.

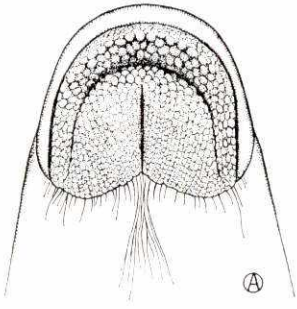
Common names White sucker, common sucker, common white sucker, coarse scaled sucker, fine scaled sucker, eastern sucker, grey sucker, black sucker, sucker, mullet, black mullet, carp. French common name: *meunier noir*.

LARGESCALE SUCKER

Catostomus macrocheilus Girard



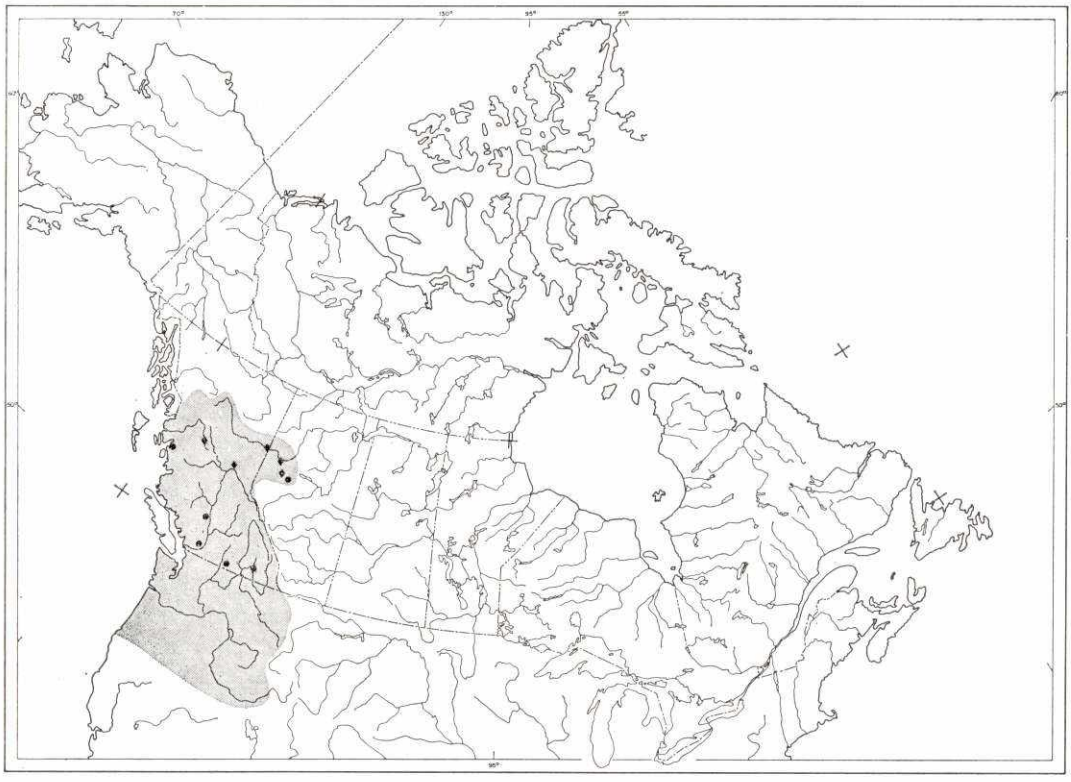
Description Body long, moderately deep, greatest depth at dorsal origin 15.0–18.7% of total length, more laterally compressed than longnose and white suckers, cross section of body at dorsal origin a deeper oval; caudal peduncle shallow, 5–7% of total length; body tapers rapidly behind dorsal fin; individuals usually 13–17 inches (330–432 mm) in length. Head moderately long, 20–23% of total length, deep, wide, interorbital width 35.0–42.5% of head length; eye high on head, a little ahead of centre of head, diameter 39.1–47.0% of snout length; snout bluntly rounded, with depression ahead of nostrils, moderately long, 35.0–47.5% of head length; mouth ventral but little, if at



all, overhung by snout, protrusible, suctorial, moderately small, gape reaching only to nostrils, lips large, lower lip deeply incised, with coarse, oval papillae, no papillae crossing cleft at midline of lower lip, although sometimes 1 and rarely 2 irregular rows cross the base (Carl et al. 1967); no teeth in mouth; pharyngeal teeth in a single row, flattened, comblike, 43–46+43–48. Gill rakers short and fleshy, 25–37 (McPhail and Lindsey 1970). Branchiostegal rays 3. Fins: dorsal 1, soft rayed, large, a little ahead of midpoint of body, base 13.4–17.7% of total length, base equal to height, slightly emarginate, 12–17 principal rays; caudal moderately long, well forked, tips rounded points; anal long, pointed, with 7 prominent principal rays; pelvics abdominal, low, moderately long, somewhat pointed, broad, with small axillary process and weak fleshy stays, 9–12 rays; pectorals low, long, more or less pointed, 16–18 rays. Scales cycloid, large, somewhat crowded anteriorly, increasing in size from head to tail, 62–83 in lateral series; lateral line complete, at midpoint of side beyond dorsal fin. Peritoneum dark; intestine long, coiled, stomach little differentiated; no pyloric caeca. Vertebrae, including Weberian ossicles, 47–49.

Nuptial tubercles white, horny, well developed on spawning males, on anal fin and lower lobe of caudal fin, absent or weakly developed on females.

Colour Adults dark and pronouncedly countershaded; back, upper sides to just below lateral line and head to just below eye, blue-grey to olive, lower sides, lower part of head and ventral surface, cream to white. A dark lateral band, below the lateral line, from snout to base of caudal fin. Fins immaculate to dusky, dark leading edge, or white edge



with dark behind it, on dorsal and paired fins. Young (to 6 inches or 152 mm length) with three or four diffuse dark spots on sides. Countershading and lateral band darker, more pronounced on breeding males. Above the lateral line in both sexes of breeding individuals, there is an iridescent olive-green to ochre band and a narrow, yellowish stripe between the black lateral band and the white of the ventral surface (Nelson 1968c).

Systematic notes This sucker would appear to be the Pacific slope counterpart of *Catostomus commersoni*, the large-scaled sucker of the plains and eastern Canada. These two species occur together and hybridize in a limited area of the upper Fraser and Skeena rivers in British Columbia. (Nelson 1968c).

Distribution Restricted to western North America. It occurs mostly west of the Rocky Mountains from the Peace River in Alberta and British Columbia, the Nass River in British Columbia, through most of the river drainages from western Montana to the coast, south to the Sixes River in Oregon and in western Utah and northern Nevada.

In Canada, it occurs in Alberta in the Peace River drainage downstream to the junction of the Smoky River, west through the Peace River in British Columbia, throughout British Columbia from the Nass River south, including the Fraser and Columbia rivers, except for streams which flow into the Strait of Georgia.

Biology The largescale sucker spawns in the spring, usually in deeper sandy areas of streams, but at times on gravelly or sandy shoals in lakes. Spawning takes place in British Columbia from late April to late June but usually mid-May to late June, depending on stream temperatures. They enter spawning streams when stream temperature is 46°–48° F (7.8°–8.9° C), and spawn during the

day or night, a week or more later than white suckers using the same streams. A female may deposit as many as 20,000 eggs, which are adhesive, demersal, yellow, and average 2.5 mm in diameter before fertilization. Eggs hatch in about 2 weeks. Fry remain in the gravel or on the surface of the sand for the first few weeks until the elongate yolk is absorbed. At this point, the mouth is terminal and they become pelagic. They remain so until the mouth moves to the ventral position (at about 16–18 mm in length) and they then become associated with the bottom.

Growth is generally slow; fry grow to about 20–25 mm by July. Average fork length at various ages, from scale interpretation, was given by Clemens et al. (1939) for Okanagan Lake, as follows:

Age	Avg FL	
	(inches)	*(mm)*
1	1.8	46
2	3.0	76
3	4.9	124
4	6.7	170
5	7.5	190
6	9.0	229
7	11.2	284
8	12.0	305
9	13.4	340
10	14.0	356
11	14.8	376

They also calculated that a largescale sucker from Woods Lake 21.2 inches (540 mm) in length was 15 years of age. These authors expressed the usual concern about the accuracy of age determination by scales for suckers over 5 years of age. McPhail and Lindsey (1970) gave maximum size as 24 inches (610 mm) and maximum known weight as 7 pounds.

This sucker lives in lakes and in large rivers. The young are pelagic until they are about 18 mm in length. As they grow larger, they move toward the bottom and into deeper water. Adults are usually found at depths of only a few feet but have been taken as deep as 80 feet. They are often in large numbers in the weedy shore areas of lakes, in backwaters, and in stream mouths. According to McPhail and Lindsey (1970), fry move inshore into very shallow water to feed in daylight hours, and off into deeper water at night.

The upper lethal temperature has been calculated at 85° F (29.4° C) for fish acclimated at 66° F (18.9° C) (Black 1953).

The most detailed analysis of food of this species in Canada is that of Carl (1936). Composition varies with size of individual, time, and habitat but in adults is almost exclusively bottom invertebrates. The following data represent the percentage of lake-dwelling individuals examined which had eaten the various items from June to December: ostracods, 0–19%, copepods, 0–60%, amphipods 5–50%, Trichoptera, 33–50%, Chironomidae 56–100%, larvae of other aquatic insects, 15–40%, molluscs, 10–67%, fish eggs, 0–58%, diatoms, 0–22%, algae, 5–25%, detritus, 75–87%. The food of immature fish before and after the mouth migrates is planktonic cladocerans, copepods, ostracods, and mites; small amounts of chironomid, trichopteran and ephemeropteran larvae, and small quantities of bottom ooze. Stream fish eat more algae, diatoms, and insects other than chironomids and fewer amphipods and molluscs. A high percentage of fish eggs was present only during the fall spawning period of the kokanee and Pacific salmons.

The young of this species may be eaten by a number of species of fish such as squawfish, and by birds such as mergansers. Adults in shallow spawning streams are doubtless eaten by bears, other mammals, osprey, and eagles. This species occurs in areas where it is relatively free of predation by larger fishes.

Largescale suckers in large numbers could constitute serious food competitors with the young and adults of salmonid fishes.

The parasites of this species listed by Hoffman (1967) were as follows: Protozoa (1), Trematoda (6), Cestoda (5), Nematoda (6), Acanthocephala (6), leeches (1), Crustacea (2). Bangham and Adams (1954) listed parasites of this species in British Columbia by locality. Lynch (1936) and Becker (1962) published original descriptions of parasites found in this species.

This sucker is known to hybridize with the white sucker (Nelson 1968c) and with the bridgelip sucker.

Relation to man As with the other suckers, this species is of little direct or indirect importance to man. The flesh is firm, white, flaky, and edible but bony and not highly favoured. It undoubtedly served as food for interior British Columbia Indians and their dogs. McPhail and Lindsey (1970) suggested it may sometimes be sold in fish and chip shops today.

Like the other suckers, its indirect effect as competitor and egg eater of highly valued salmonids may be exaggerated. Eggs eaten by this species may only be those exposed by superimposition of salmonid nests.

Nomenclature

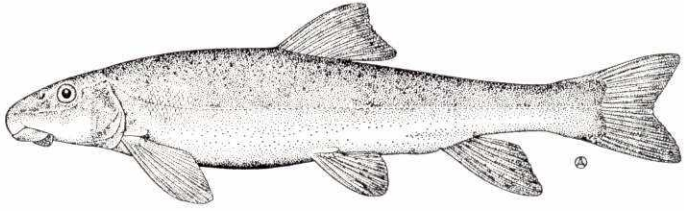
Catostomus macrocheilus — Girard 1857a: 175 (type locality Astoria, Ore.)

Etymology *Catostomus* — inferior mouth; *macrocheilus* — large lip.

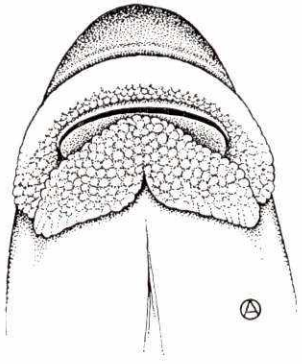
Common names Largescale sucker, coarsescale sucker, Columbia River sucker. French common name: *meunier à grandes écailles.*

MOUNTAIN SUCKER

Catostomus platyrhynchus (Cope)



Description A small, shallow, cylindrical sucker, body torpedo shaped, cross section at dorsal fin almost round, length usually 6–8 inches (152–203 mm); little compressed laterally anterior to dorsal fin, greatest depth near origin of dorsal fin 15.4–20.9% of total length, caudal peduncle long and only moderately deep, depth 6.3–8.0% of total length. Head short, about 16% of total length, not deep but moderately wide, interorbital width 38.4–47.3% of head length; eye diameter 38.8–66.6% of snout length, high on head, at midpoint of head length; snout fleshy, broad and heavy, rounded, length 42.8–50.0% of head length; mouth ventral, large,



lips often exceed width of head, overhung by snout, protrusible, suctorial; gape reaching to

between nostril and eye; cartilagineous sheath of lower jaw obvious even when mouth closed, less rounded than in bridgelip sucker, lower lip the shape of paired wings, anterior edge markedly convex, covered with large, round papillae, cleft shallow, incomplete, with 3–5 rows of papillae crossing base, pronounced notch at point of lateral connection of upper and lower lips, upper lip large, its anterior edge a thick fold with no papillae visible from front; no teeth in mouth, pharyngeal teeth flat and comblike. Gill rakers 23–37 + 31–51. Branchiostegal rays 3. Fins: dorsal 1, soft rayed, height greater than base length which is 10.5–14.5% of total length, edge slightly emarginate, 9–11 principal rays in material examined, 8–13 over whole range; caudal not long, not deeply forked, tips rounded points; anal long, height almost 3 times base length, 7 prominent rays; pelvics abdominal, under middle of dorsal fin base, broad, membranous stays and axillary process obvious, tip rounded, 9 or 10 rays; pectorals long, tips pointed, 15 rays. Scales small, cycloid, crowded towards head, 79–89 in lateral series in British Columbia, 60–108 over the whole range; lateral line complete, straight and at midpoint of body beyond pectoral fins. Peritoneum black or dusky; intestine long (6 times standard length), 6–10 coils anterior to liver, little differentiated; no pyloric caeca; swim bladder of 2 chambers, posterior chamber slender, extending to origin of pelvic fins. Vertebrae, including Weberian ossicles, 42–46.

Nuptial tubercles in both sexes, larger and more abundant in males. Present on males on anal fin, lower lobe of caudal fin, caudal peduncle, dorsal surface of paired fins, entire surface of body (minute). Present on females on anal fin, lower lobe of caudal fin (minute), caudal peduncle, dorsal surface of paired fins, dorsal and lateral parts only of head and body (minute). *See* Smith (1966) and Hauser (1969) for more details, size, and location.

Colour Back, head above eyes, and sides to lateral line green, grey, or brown, speckled with black, lateral line not prominent, ventral surface of head and body pale yellow to white, a dark green to black lateral band and/or five dorsal blotches of fine black pigment, fins colourless or faintly red. Breeding individuals more highly coloured, an orange to deep red lateral band, fin rays darker.

Young markedly countershaded dark green above, white below, three dark vertical bars and black peritoneum obvious.

Systematic notes This species was long known as *Pantosteus jordani* Evermann. *See* Smith (1966) for detailed discussion of problems associated with original description, relationship to *P. platyrhynchus* Cope, and reasons for reducing *Pantosteus* to a subgenus of *Catostomus*.

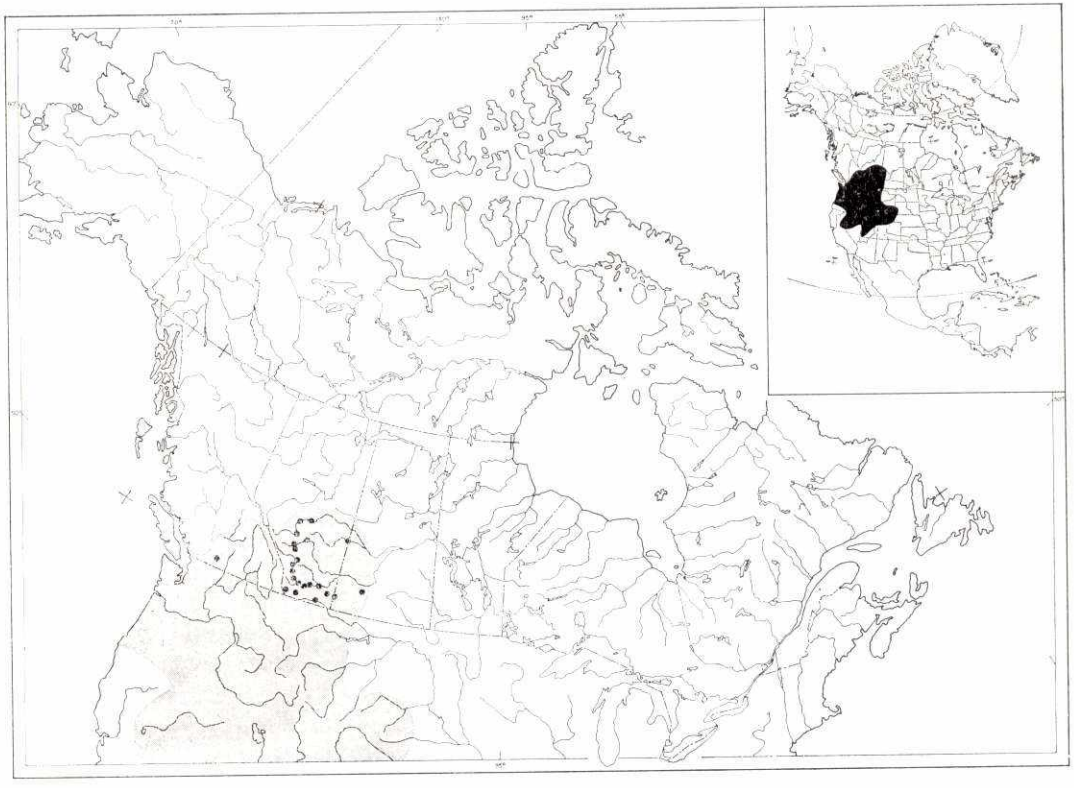
After the combination of mountain sucker populations under *C. platyrhynchus*, the old common name prefix northern, used for *P. jordani*, was no longer applicable.

Distribution The mountain sucker is restricted to the fresh waters of the mountainous regions of western North America. It occurs from western Saskatchewan south through Montana, western South Dakota, Wyoming, west through Utah, northern Nevada to east-central California, north through Oregon and Washington (less abundant) to southern British Columbia.

In Canada, it occurs in the South Saskatchewan and Milk rivers in Saskatchewan and Alberta, and in the Similkameen (Columbia River) and North Thompson (Fraser River) rivers of British Columbia. This species was first recorded in British Columbia in 1955, and Alberta in 1957 (Scott 1957a), and nowhere is it abundant or widely distributed.

Biology Virtually nothing is known of the biology of this sucker in Canada and little from elsewhere. Most of the following was taken from Smith (1966) and Hauser (1969).

Mountain suckers spawn in riffles adjacent to pools of swift mountain streams, for a short period in late spring to early summer (last week in June and first 2 weeks in July), when



water temperature is 51°–66° F (10.5°–18.8° C). Females 5.1–7.2 inches (131–184 mm) total length, bear 990–3710 eggs. Even in fully mature females there is a direct relation between length and egg number. Probably no nest is built; the ripe eggs, which are demersal and probably adhesive, are, depending on size of female, 1.5–2.2 mm in diameter, yellow and translucent. There are smaller, recruitment eggs in the ovary as well.

Growth is slow in this environment and some fry reach 9 mm in July, and 1.2–1.4 inches (29.5–36.0 mm) total length by mid-September. Most fish have formed an annulus on the scales by mid-June of the following year. Ages by scales corresponded to those by otoliths and although difficult to interpret, seemed reliable. The suckers at time of first annulus formation were 2.9–3.8 inches (49–73 mm) total length. The mean total length at capture for various ages for specimens from Flathead Creek, Mont., was given by Hauser as follows:

Age	Mean TL	
	(*inches*)	(*mm*)
1	3.6	93.0
2	4.5	116.8
3	5.1	131.0
4	5.9	151.0
5	6.6	168.2
6	7.2	183.0
7	8.0	204.4
8	8.4	215.2
9	8.9	226.5

The smallest mature female was 5 inches (127 mm), and all females over 5.7 inches (145 mm) total length were mature. Corresponding figures for males were 4.7 inches (122 mm) and 5.1 inches (130 mm). All Montana specimens became mature between 3 and 5 years of age, males often a year earlier than females. Smith (1966) said maturity came by the second year and sometimes the first year for males.

The largest individual seen by Hauser was apparently 8.9 inches (226 mm). Smith

(1966) gave maximum size as 6.9 inches (175 mm) standard length.

Small mountain suckers are usually found in cover in shallow water of moderate current. Larger young were associated with weedy, intermittent side channels or deep pools. During late winter and spring, adults were found adjacent to pools in 3–8 feet of water, usually with rubble bottoms, from sea level to 8400 feet altitude. After spawning, the habitat was associated with bank cover in deep pools, often in small isolated schools. They occur in lakes only rarely. Summer stream temperatures usually vary from 60° to 74° F (15.5°–23.3° C).

Food in Montana was diatoms, other algae, higher plants, dipterous larvae and pupae. Diatoms, *Closterium*, and filamentous algae were the most important parts of the diet. Turbellaria, Ephemeroptera, Rotifera, and Plecoptera were infrequently eaten. This more or less bears out the statement by Carl et al. (1967) that the horny edges of the jaws would suggest that this species scrapes algae off rocks.

Small mountain suckers may be preyed on by stream salmonids and spawning adults by birds and mammals, but adults probably have few fish predators. Their algae-eating diet probably precludes any important competition with salmonids.

The only parasite listed by Hoffman (1967) for the mountain sucker was the trematode *Posthodiplostomum minimum*. This probably indicates the degree to which parasite determination has been carried out for this species rather than freedom from parasites.

This species is known to hybridize with the white sucker, longnose sucker, Tahoe sucker (*Catostomus tahoensis*), the Utah sucker (*C. ardens*), and *C. discobolus* (Smith 1966).

Relation to man This species, although edible, is so small and so scarce in Canada as to suggest it has never been an important item of food for man or beast. Its algae diet even precludes it being of indirect relation to man as a competitor of, or predator on, other fishes which he values. So, it has virtually no direct or indirect relation to man. It is used and reared for use as a bait fish in the United States and used as food for fur-bearing mammals.

Nomenclature

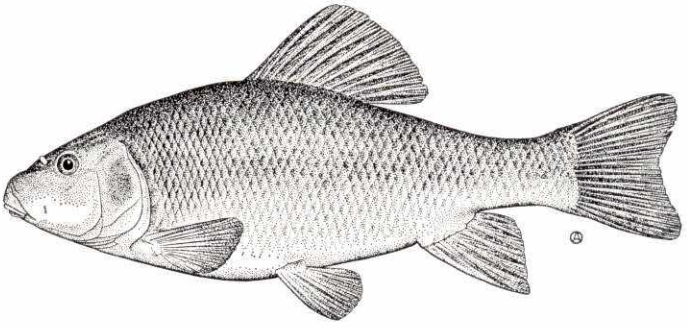
Minomus delphinus	— Cope 1872: 435 (type locality tributary of Green River, Wyo.)
Pantosteus jordani Evermann	— Jordan and Evermann 1896–1900: 171
Catostomus platyrhynchus (Cope)	— Smith 1966: 58

Etymology *Catostomus* — inferior mouth; *platyrhynchus* — flat snout.

Common names Mountain sucker, northern mountain sucker, plains mountain sucker, Jordan's sucker. French common name: *meunier des montagnes.*

LAKE CHUBSUCKER

Erimyzon sucetta (Lacépède)



Description A small sucker, seldom, if ever, exceeding 10 inches (254 mm) in length in Canada and often mistaken for a large minnow. Body robust and deep, back arched, greatest depth at origin of dorsal fin 24.1–27.6% of total length, strongly compressed laterally, cross section at origin of dorsal a broad oval flattened at the bottom; caudal peduncle thick and its depth 8.6–9.9% of total length. Head about 20% of total length, deep, forming a rather steep angle, wide, interorbital width 41.4–45.6% of head length, interorbital area rounded, not flat; eye high, in centre of head length, diameter 33.3–45.0% of snout length; snout moderately long, 40.0–45.6% of head length, bluntly rounded; mouth protrusible, suctorial but very small and only slightly inferior, almost terminal, somewhat oblique, gape only half way to nostril; posterior edge of lower lip forming 90°–100° angle, very little cleft, papillae coarse, long ridges, upper lip much reduced, fine ridgelike papillae on inner surface only, often inconspicuous in deep groove which separates it from snout; no teeth in mouth, pharyngeal teeth short, close, club-shaped. Gill rakers short, 31–35 in material examined. Branchiostegal rays 3. Fins: dorsal 1, soft rayed, origin well ahead of centre of body, appears large for animal's size, base length 15.5–17.9% of total length, height about equal to base length, edge rounded in adults but straight in young, 10–12 heavy rays; caudal not markedly long but broad, only shallowly forked, and tips rounded; anal prominent, height twice base length, origin well behind dorsal insertion, base enclosed in scales, tip pointed, edge square to slightly emarginate, markedly falcate in breeding males, 7 rays, anterior 2 fleshy, heavy; pelvics abdominal, not long, with narrow base, no noticeable axillary process, tip rounded, 8 or 9 rays; pectorals low, moderately broad, tips a rounded point, 15 or 16 rays. Scales large, exposed portion deeper than long at deepest part of body, little crowded near head, 39–42 in lateral series; no lateral line. Peritoneum silvery; intestine long, several coils, undifferentiated; no pyloric caeca. Vertebrae 31 or 32.

There are small nuptial tubercles in rows on the rays of the anal fin and 3 or 4 larger, isolated, tubercles which form a triangle on the snout.

Colour Dorsal surface of back, upper sides and head to level of mouth, bronze to deep olive-green and scales with dark edges creating vague crosshatched pattern; lower sides golden to silvery, lateral band light and vague, or vague vertical bars in largest individuals; lower head, mouth, and ventral surface of body green-yellow to yellow; unpaired

fins olive, paired fins dusky or whitish. No marked difference in pattern of breeding individuals, colours intensified and darker. Young silvery to golden with very dark, very wide band from base of tail to eye and downward to snout, caudal fin sometimes reddish and anterior edge of dorsal fin black.

Systematic notes Usually considered to consist of two subspecies, *E. s. sucetta*, coastwise east of the Allegheny Mountains, and *E. s. kennerli*, Great Lakes and west of the mountains. Hubbs and Lagler (1964) mentioned the possibility of an undescribed form on the south-central tributaries of Lake Ontario (New York). Differences given were average ray counts, scale counts, and body depth (Hubbs 1930a). There is insufficient Canadian material available to us to judge how well it fits in the characterization of *E. s. kennerli*.

Distribution Restricted to eastern North America. It occurs from the southern half of New York to southern Florida, west to southern Texas, north through Arkansas, eastern Missouri, Illinois, to southeastern Minnesota, southern Wisconsin and Michigan, and extreme southern Ontario. Apparently rare in the midwest United States.

In Canada, this species is known only from Ontario, in western Lake Erie, ponds tributary to Rondeau Bay, ponds on Long Point and Point Pelee, and from Lake St. Clair. It was listed for Ontario as early as 1929. Specimens were first taken in Canada in 1949 (Scott 1952) and are still rare.

Cox (1896b), claimed *Erimyzon sucetta* Jordan occurred in the lower Saint John River, N.B. If this report, based on the fact that Adams (1873) listed *Moxostomus oblongus*, had any validity the fish might have been the closely related creek chubsucker *Erimyzon oblongus* which occurs in Maine. Neither species is known from New Brunswick today (Scott and Crossman 1959).

A record of the chubsucker in the Hudson Bay watershed by Lower (1915) must have been a misidentification of a shorthead redhorse.

Biology Nothing is known of the biology of this fish in Canada. The following is taken from Cooper (1935) and a summary of United States information by Carlander (1969). These fish spawn in March to April, usually in streams, but in rearing ponds with no streams, eggs were laid over beds of aquatic moss, among masses of filamentous algae or on grass stubble. Spawning lasts about 2 weeks and can take place as late as early July. The male cleans a gravelly area for a nest or eggs are scattered. Depending on size of female, egg number is 3000–20,000 and eggs are 2 mm in diameter, and nonadhesive. The eggs hatch in 6–7 days at temperatures of 72°–85° F. Fry, on hatching, are 6–7 mm. Growth rate during the first month in Michigan was 0.5 mm per day. Ages can be readily determined from scales.

Average calculated total length at each annulus for chubsuckers in Jones Lake, N.C., was as follows:

Age	Avg calc TL	
	(inches)	*(mm)*
1	2.1	53
2	5.3	135
3	7.6	193
4	9.6	244
5	11.2	284
6	12.0	305

Ages as high as 8 have been estimated in New York and the largest chubsucker may be an individual from Silver Springs, Fla., which was 15.2 inches (386 mm) long and weighed 2 pounds. It is unlikely that any exceed 8–10 inches (203–254 mm) in Canada.

In Canada, at present, the habitat of this animal would appear to be small, shallow, warm, weedy ponds irregularly connected to Lake Erie and Lake St. Clair.

Food of small chubsuckers is copepods, cladocerans, and chironomid larvae taken from or near the bottom. The food of the adults is probably not markedly different, consisting of a variety of bottom organisms.

The young of this species are probably eaten by a wide variety of other fishes and the adults in Canada would be ideal prey for basses and pikes living in the same habitats.

Hoffman (1967) listed the parasites of this species as follows: Protozoa (2), Trematoda (5), Cestoda (6), Nematoda (6), Acanthocephala (3), Crustacea (7).

Relation to man This species is too rare in Canada to bear any direct or indirect relation to man.

Nomenclature

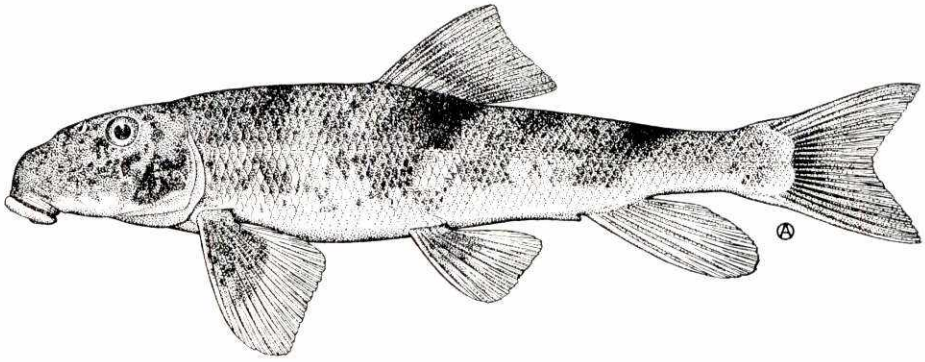
Cyprinus sucetta	— La Cepède 1803: 606 (type locality near Charleston, S.C.)
Moxostoma oblongum	— Gill 1865: 261
Labeo elegans	— Small 1865: 30
Catostomus tuberculatus Lesueur	— Fortin 1866: 73
Erimyzon sucetta Jordan	— Cox 1869b: 64
Moxostomus oblongus (Gunther)	— Cox 1869b: 64
Erimyzon sucetta (Lacépède)	— Jordan 1878b: 144
Erimyzon sucetta oblongus (Mitchill)	— Jordan and Evermann 1896–1900: 186
Erimyzon sucetta kennerlii (Girard)	— Hubbs 1930a: 35

Etymology *Erimyzon* — to suck; *sucetta* — from *sucet*, French for a sucker or sucking fish.

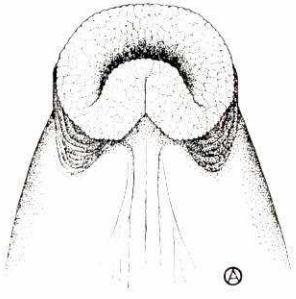
Common names Lake chubsucker, western lake chubsucker, chubsucker, chub sucker, pin sucker. French common name: *sucet du lac.*

NORTHERN HOG SUCKER

Hypentelium nigricans (Lesueur)



Description A smaller eastern sucker, in Canada usually only 5–10 inches (127–254 mm) in total length. The body is cylindrical, not laterally compressed, heavy forward, strongly tapered at the rear, shallow, greatest body depth near origin or dorsal fin, 15.5–18.4% of total length; back flat anterior to dorsal origin; caudal peduncle moderately long and shallow, depth 6.4–7.5% of total length. Head moderately long, about 20% of total length, prominent, bony, square in cross section, wide, interorbital distance 40.0–44.8% of head length, often exceeds body width, deeply concave between the eyes; eye high on head, large, diameter 26.3–37.5% of snout length, and far back on head; snout very long, 59.2–63.3% of head length, strongly curved downward with a distinct dorsal depression over the mouth, bluntly rounded to flat at tip; mouth ventral, narrow, although lips exceed width of snout, protrusible, suctorial but much less retractile than that of most suckers; gape not extending to nostril; lips very large, upper almost as thick as lower, fleshy, almost circular, cleft in lower lip incomplete and inconspicuous; papillae moderate in size, irregular, and round to oval. The distinct similarity of the head, snout, and mouth to the snout of a hog has led to the obvious common name; no teeth in mouth, pharyngeal teeth are slender and prominently hooked. Gill rakers short, about 21 in number. Branchiostegal rays 3. Fins: dorsal 1, soft rayed, a little ahead of midpoint of body, height equal to or less than length of base, base length 11.1–13.5% of total length, little emarginate, 10–13 principal rays; caudal moderately long, well forked, tips pointed to rounded; anal long (longer in males), height about 3 times base length, 7 (rarely 8) rays, anterior ray heavy; pelvics abdominal, low, base narrow, axillary process inconspicuous to absent, tip square, 9 rays; pectorals low, very broad and long, edge square with rounded tip, 15–17 rays, anterior ray heavy. Scales large, not crowded anteriorly, 49–51 in lateral series in material examined; lateral line complete, almost straight and at midpoint of body; peritoneum dusky with some black pigment; intestine long, little differentiated, 5 coils anteriorly; no pyloric caeca; swim bladder of 2 chambers but greatly reduced. Vertebrae 42–45 in material examined.



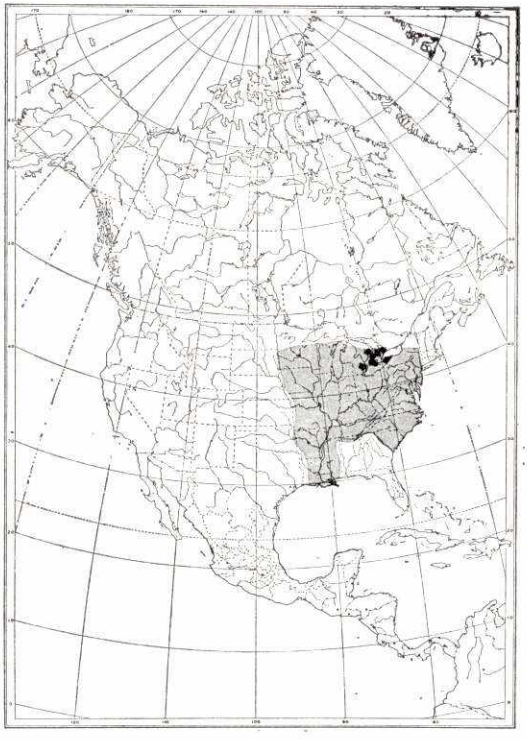
Nuptial tubercles on breeding individuals of both sexes. Those on males large on anal fins, smaller on rays of both surfaces of dorsal, pectoral, pelvic, and lower lobe of anal fins, and on some body scales, the top and sides of the head densely covered with fine tubercles. Females have smaller tubercles, and none on head, body, dorsal fin, or upper surfaces of the paired fins.

Colour Dorsal surface and the head to below the eyes are olive to brown, the sides to below the lateral line are lighter brown to yellow with a brassy sheen, the ventral surface is velvety white. The back and upper sides of young are marked with three dark, oblique saddles (anterior to dorsal fin, at mid-dorsal fin and over anal fin). The sides are marked with dark blotches and irregular spots; all fins are dusky to yellow with varying, irregular amounts of dark pigment more concentrated near the fin base, the leading edge of the paired fins, anal fin, and the ventral lobe of the caudal fin are often white. No precise difference in the colour of males and females even at spawning time.

Distribution This sucker is restricted to fresh waters of eastern North America from southern New York, south along the coast to the northern part of the Gulf states (replaced to the south by the Alabama sucker, *H. etowanum*), west to eastern Oklahoma, north through extreme southeastern Kansas, through Missouri, eastern Iowa, southeastern Wisconsin, east across Wisconsin and Michigan into southern Ontario.

In Canada, it occurs only in southwestern Ontario, in streams south of the Maitland River tributary to lower Lake Huron, lakes St. Clair and Erie and western Lake Ontario to about the Humber River. Many older accounts list Lake of the Woods but the specimens on which the report originated were misidentified white suckers.

Biology Virtually nothing is known of the biology of this sucker in Canada. The following is taken largely from Raney and Lachner (1946).



Spawning occurs in the spring, usually in May or when water temperature reaches 60° F (15.6° C). It usually occurs in 3–5 inches (76–127 mm) of water in riffles, but sometimes near the shallow sides of pools. Smaller males take up stations on the riffles, larger females swim out of nearby pools, and come to rest over an area of fine gravel. Two or three males crowd her closely and eggs and milt are emitted during vibrations of the group. As the eggs are extruded, the males become very active, often standing on their heads, their tails at the surface thrashing the water to foam. Spawning acts last about 2 seconds and are repeated every 4–7 minutes. No actual nest is built, but prespawning activity does clean an area of gravel. The demersal, nonadhesive eggs are broadcast and abandoned. *See* Fish (1932) for details and a drawing of the early development of young.

Young-of-the-year in Ohio are 2.0–3.5 inches (51–89 mm) long by October. Annuli are formed by mid-May when water temperature reaches 56°–60° F (13.3°–15.5° C) and age can be readily determined by means

of scales. Males grow more rapidly than females in years 1–4. After 4 years of age, females grow faster and achieve a greater size. The relation between age and total length for females in New York is as follows:

Age	TL	
	(*inches*)	(*mm*)
1	1.6–1.8	42–46
2	3.3–4.1	85–105
3	4.0–6.4	103–163
4	5.9–8.6	151–220
5	7.6–10.8	195–275
6	8.4–11.6	213–296
7	9.1–12.4	232–315
8	12.5–12.6	318–320
9	11.9–13.6	302–346
11	13.7	350

Maximum size according to Trautman (1957) is 24 inches (610 mm) and 5 pounds, but those seen in Canada are rarely, if ever, longer than 12 inches (305 mm). Some larger males mature at 2 years of age and 5.3 inches (135 mm) total length and most are mature at 3 or 7.1 inches (180 mm) in length. Most females mature at 3 years of age (average 6.7 inches or 170 mm total length) but some slower-growing ones not until 4. Sex ratio is approximately 1:1. Maximum age would appear to be 10 or 11 years.

The northern hog sucker inhabits the riffles and adjacent pools of warm, clear, shallow streams with gravel to rubble bottoms. It is infrequently found in shallow lakes near the mouths of streams. The bulky head, tapering body, low expanded pectoral fins, reduced swim bladder, all adapt this species for its life on the bottom of turbulent swift streams. They are quite inactive below 50° F (10° C). Siltation and increased turbidity may be limiting its range in the United States.

The diet consists mainly of insect larvae, crustaceans, and diatoms and other minute vegetation. The fish feeds in the riffles by scraping ooze off the tops of stones and by moving and overturning stones with its head and lips in order to suck up the invertebrates hidden below them.

The young are probably preyed on by other residents of these swift streams and the larger young are known to be eaten by smallmouth bass that live in the same streams. Adults are relatively free of predation. Many species of stream fishes, especially blacknose dace and creek chub, feed heavily on the eggs as they are laid. Its feeding habit on riffles may preclude it being a serious competitor with more valued stream fishes, in fact, other fishes feed at the downstream edge of riffles on material dislodged by the hog suckers ahead.

Parasites listed by Hoffman (1967) for this species were as follows: Protozoa (1), Trematoda (12), Cestoda (3), Nematoda (4), Acanthocephala (2), Mollusca (1), Crustacea (3). Fischthal (1942) described a new trematode, *Triganodistomum hypentelii*, from this species.

Relation to man The flesh is edible but not favoured, as the fish is small and bony. It apparently constituted a minor amount of food in the central United States in the past, but does so no longer. It is not usually considered a sport fish nor is it sought after even though it can be readily caught with a hook and small worm or a wet fly. Where abundant, it could probably provide enjoyment for an angler with light tackle when other fishes were not open to angling. Small adults are used for bait for muskellunge and largemouth bass in the United States. The northern hog sucker, in Canada, has no real direct or indirect relation to man.

Nomenclature

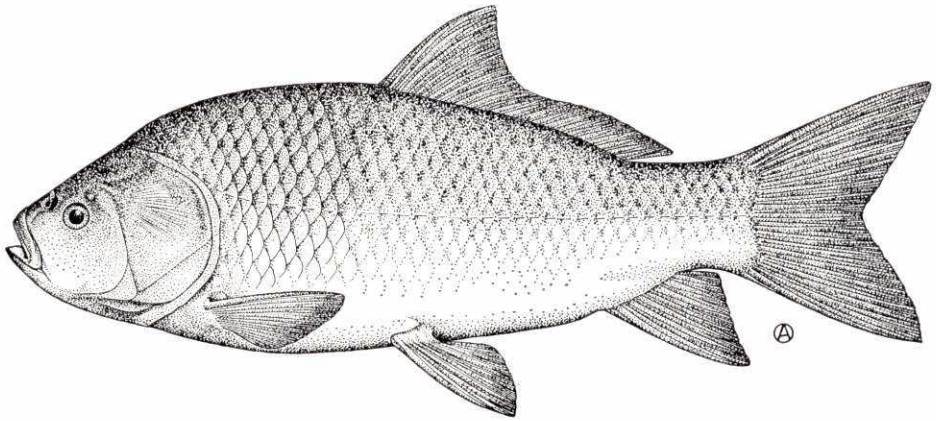
Catostomus nigricans — LeSueur 1817d: 102 (type locality Lake Erie)
Hypentelium nigricans Le Sueur — Hubbs 1926: 22

Etymology *Hypentelium* — below 5 lobes, supposedly in reference to 5-lobed lower lip; *nigricans* — blackish.

Common names Northern hog sucker, northern hogsucker, hognose sucker, hognosed sucker, black sucker, riffle sucker, bighead sucker, stoneroller, hogmolly. French common name: *meunier à tête carrée.*

BIGMOUTH BUFFALO

Ictiobus cyprinellus (Valenciennes)

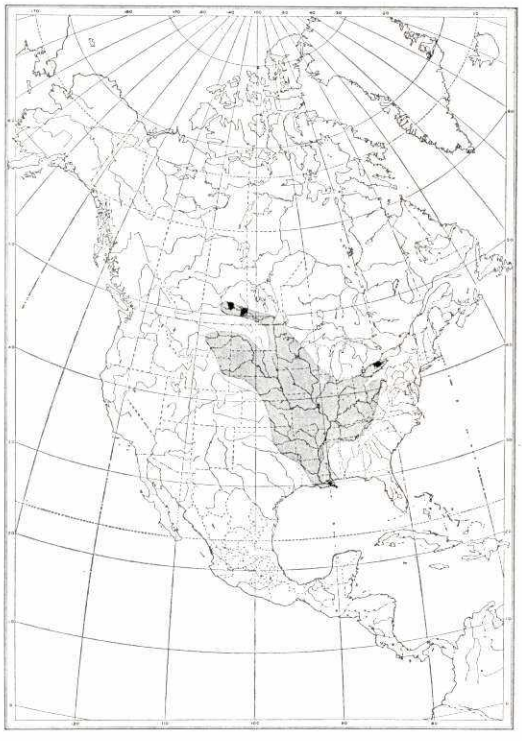


Description A large, deep bodied, laterally compressed sucker of the plains, usually 10–18 inches (254–457 mm) in length. Because of its terminal mouth, body shape and colour, and long dorsal fin, this species might easily be confused with a carp. Body very deep, greatest depth over pectoral fins 29.7–33.7% of total length; cross section at dorsal fin origin a deep oval, somewhat pointed at top and broader at bottom; caudal peduncle very short and deep, depth 10.2–11.6% of total length. Head naked, moderately long, 20–25% of total length, wide, interorbital width 33.8–46.1% of head length, deep, rising sharply to the high back, opercle wide, deep, and strongly marked with radiating lines near top; eye large, diameter 48.0–60.5% of snout length, not so high on head as other suckers, in the anterior third of the head; snout moderate, 26.9–34.1% of head length, bluntly rounded; mouth large, terminal and oblique, not suctorial, gape reaching to nostril; premaxillary protractile; lips moderately large and heavy but not papillose and unlike those of other Canadian suckers; no teeth in mouth, pharyngeal teeth present. Gill rakers, each with many lateral projections, on both sides of arch, those on anterior edge of first arch long, fine, closely spaced, at least 60 in number (*see* Johnson 1963). Branchiostegal rays 3. Fins: dorsal 1, soft rayed, origin ahead of midpoint of body, moderately high, height about half base length, base very long, 28.0–34.2% of total length, 27 or 28 rays in material examined, 23–30 elsewhere; caudal moderately long, very broad, moderately forked, tips pointed; anal origin under dorsal insertion,

fin height less than twice length of base, edge slightly emarginate, tip rounded to pointed, 7 or 8 rays, 8–10 to the south; pelvic abdominal, low, narrow, base, stays and axillary process absent or inconspicuous, edge rounded to pointed, 10 or 11 rays; pectorals not long, tip a rounded point, 14 or 15 rays. Scales large, exposed area deeper than long, not crowded forward, 39–41 in lateral series of material examined; lateral line prominent, complete, almost straight, and at midpoint of body. Peritoneum black; intestine very long, at least 4 loops, little differentiated; no pyloric caeca. Vertebrae 36 or 37.

Apparently no noticeable nuptial tubercles on either sex.

Colour Back, upper sides, and head to below eyes a dull brown to olive, sides lighter, ventral surface white, fins dusky to grey. At spawning time, top of head, back, and caudal peduncle slate to greenish, upper sides of head olive-green, upper sides more coppery, pale green to bluish, dorsal and caudal fins drab grey, anal fin olive, pelvic fins lighter, pectoral fins dull white under olive (Forbes and Richardson 1920).



Distribution Restricted to central North America. It occurs from Lake Erie (possibly native and introduced) south through the Ohio and Mississippi River basins to the Tennessee River in northern Alabama, west to Arkansas, south to near the Gulf of Mexico in Louisiana, northwest through eastern Texas and Oklahoma (rare), north through Iowa and South Dakota to the Milk River in central Montana. From Illinois in the Mississippi River drainage northwest through western Minnesota and north in the Red River into Manitoba and west into Saskatchewan. Introduced in Arizona and California.

In Canada, it occurs only in western Lake Erie (rare), the Red and Assiniboine rivers in Manitoba (rare to absent now), and west in the Qu'Appelle River system to central Saskatchewan where it is, in places, abundant. The first published record for this species in Canada may have been that of Gilchrist (1888) under the name *I. Bubalus.* Long known in the Ohio waters of Lake Erie it was first taken from the Canadian waters in 1957 (Scott 1957b) when an individual weighing 18 pounds 2 ounces was caught by a commercial fisherman in Long Point Bay. Records by Hubbs and Lagler (1947) and Dymond (1947) of the closely related *I. bubalus*, smallmouth buffalo, were based on Halkett's 1913 record. There are no authentic Canadian records of *I. bubalus.*

Biology Contrary to most cases, a study of the biology of this species in Canada, by Johnson (1963), is often quoted for biological information by recent texts on fishes in the United States.

Spawning takes place in the spring, for a very short period from mid-May possibly to early June and is at its height when water temperatures are 60°–65° F (15.5°–18.3° C). Adults move out of lakes and large rivers into small tributary streams and into

marshes or flooded lake margins in order to spawn. Onset of spring freshets and flooding is apparently necessary to initiate spawning activity. Spawning takes place in shallow water with considerable activity and splashing. A female 26.2 inches (665 mm) long was estimated to have about 750,000 eggs. The eggs, which are 1.2–1.8 mm in diameter when preserved, are adhesive and adhere to vegetation. No nest is built, the eggs are scattered and abandoned. Eggs apparently hatch in approximately 2 weeks. By late June, the young are approximately 18 mm long and by August have grown as large as 2.5 inches (64 mm). Johnson presented an age–fork length relation for fish 3–20 years from several lakes, where age is the number of winters completed, as follows:

Age	FL	
	(*inches*)	(*mm*)
3	5.6–8.3	142–211
4	10.1–14.0	257–356
5	9.4–15.7	239–399
6	11.4	290
7	11.8–16.9	300–429
8	13.0–19.0	330–483
9	14.8–18.7	376–475
10	15.5–18.2	394–462
11	16.9	429
12	20.5–24.6	521–625
15	21.7–24.0	551–610
18	24.5–25.5	622–648
20	27.4	696

He stated, however, that whereas age determination by scales was reliable to age 10, over age 10 the estimates were progressively less reliable. Growth is much slower in Saskatchewan than in the south. Fish in Pasqua Lake, Sask., 9 years of age, are only as large as fish 3 years of age in Tennessee. The largest bigmouth buffalo taken in Johnson's study was a female 31.1 inches (791 mm) fork length, which weighed 25.5 pounds. Females grow larger than males as the largest male was 26.1 inches (663 mm) fork length.

Males reach sexual maturity at sizes smaller than females. Some males mature at 12 inches (305 mm) and most are mature by 15 inches (381 mm) fork length. Females as large as 18.7 inches (475 mm) were immature but females over 20 inches (508 mm) usually were mature. Females in Saskatchewan do not spawn every year. Spawning occurs much younger in populations to the south and they probably spawn yearly.

Maximum weight for this species has been reported as 80 pounds from Spirit Lake, Iowa. Maximum age may exceed 20 years.

Bigmouth buffalo inhabit shallow depths in slow, sluggish, or still water of larger rivers, oxbow and flood plain lakes, sloughs, bayous, and shallow lakes. They are well adapted to reservoirs and apparently tolerant of turbid water. They tend to occur in schools of about 25 individuals. On warm still days they spread out over the surface of a lake where they rest quietly, often with the dorsal fin projecting, and often in the midst of clumps of dense algal bloom. Individuals are often hit by fast-moving boats at this time.

This species, unlike other suckers, eats planktonic as well as bottom organisms. Cladocera and copepods are the most important food of the young with chironomid larvae next and small amounts of aquatic beetles, amphipods, nauplii, ostracods, and diatoms often present. In larger young entomostraca are most important, providing about 75% of the food. Smaller quantities of aquatic beetles, aquatic bugs, molluscs, and amphipods were also eaten. Diatoms are not an important food of older fish. Johnson (1963) gave a detailed analysis of stomach contents by size and time. This species swims about, at an angle of 55° to the bottom, bouncing with short up-and-down motions, searching through the mud and debris. The food items are drawn into the mouth and the numerous fine, long gill rakers retain small food particles. Johnson estimated that this species occupies a food niche overlapping bottom feeders and limnetic plankton feeders.

Bigmouth buffalo share an environment with large predaceous fishes such as northern pike, black bullhead, burbot, yellow perch, and walleye, but suffer very little predation from them. The gibbous body may make them hard to engulf. Certainly large adults are probably free of predators of any type.

In Saskatchewan, production seems to be limited by proper water flow to initiate the

spawning and survival of young. Strong and weak year classes are very apparent.

Johnson reported only *Argulus appendiculosus* and Myxosporidia as parasites of this species in Saskatchewan. Hoffman (1967) listed the following for this species over the whole of its range: Trematoda (2), Cestoda (5), Nematoda (2), Acanthocephala (3), leeches (1), Crustacea (2).

Hybrids between this species and the smallmouth buffalo are known in Ohio. Hybrids between the bigmouth and black buffalo have been cultured.

Relation to man This species is of considerable commercial importance in the Mississippi River and large quantities are caught annually. In Saskatchewan, it supports a small commercial fishery but is regarded as a rough fish and thought by anglers to be detrimental to game fish. It could constitute a ready but presently little-used supply of high protein food there. They have a high potential for pond culture. A pond of 0.1 acres in Kansas yielded 256 pounds per acre, without fertilizing the pond or feeding the fish. Populations exceeding 1000 pounds per acre have been known in tributaries of the Mississippi River. In 1966–67, complete winter-kill of the fish in Buffalo Pound Lake, Sask., revealed that the bigmouth buffalo had been the dominant species there. The flesh is edible, firm, but coarse. It is not highly prized as table food, however.

Not usually considered a sport fish, but sometimes caught when angling for other species.

The blood of this species and the smallmouth buffalo, in common with only a few other fishes, contains unique cells of unknown function referred to by Chlebeck and Phillips (1969) as secretory granulocytes.

Nomenclature

Sclerognathus cyprinella Valenciennes	— Cuvier and Valenciennes 1844 vol. 17: 477 (type locality Lake Ponchartrain, La.)
Ictiobus Bubalus	— Gilchrist 1888: 306
Ictiobus cyprinella (Cuvier and Valenciennes)	— Eigenmann 1895: 107
Ictiobus bubalus Rafinesque	— Halkett 1913: 58
Macrostomatobus cyprinella (Cuvier and Valenciennes)	— Hubbs 1926: 19
Megastomatobus cyprinella (Cuvier and Valenciennes)	— Hubbs and Greene 1928: 387
Ictiobus cyprinellus (Valenciennes)	— Bailey 1951: 191
Megastomatobus cyprinella (Valenciennes)	— Scott 1957b: 22

Etymology *Ictiobus* — bull or buffalo fish; *cyprinellus* — diminutive of *Cyprinus*, little carp.

Common names Bigmouth buffalo, redmouth buffalo, common buffalofish, buffalo, buffalofish, gourdhead buffalo. French common name: *buffalo à grande bouche.*

SPOTTED SUCKER

Minytrema melanops (Rafinesque)

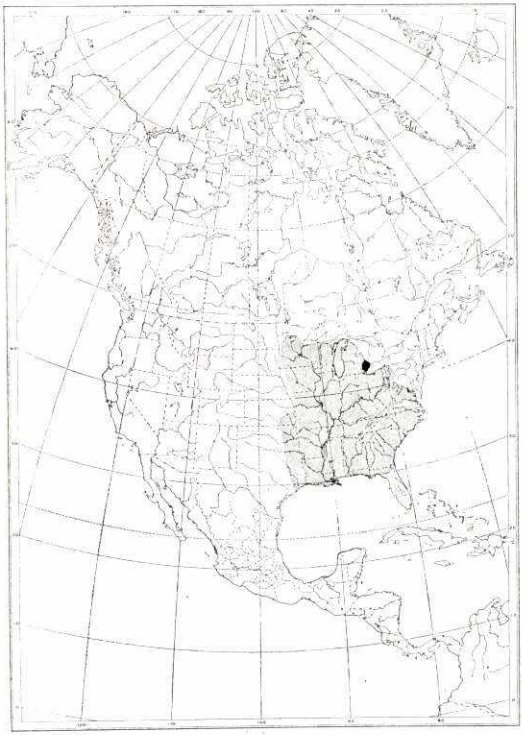
Description Body rather elongate, subcylindrical like white sucker as young, but more laterally compressed like redhorses with age. Usually 9–15 inches (229–281 mm) in length, body only moderately deep, greatest depth at origin of dorsal fin, 20.5–22.5% of total length, cross section a shallow broad oval; caudal peduncle moderately long and shallow, depth 7.9–8.7% of total length. Head only moderately long, length 19.6–20.8% of total length, shallow, upper surface a shallow angle, rather broad above, interorbital width 45.4–48.2% of head length, somewhat flat to rounded above, naked; eye moderate, diameter 29.2–41.6% of snout length, high on head, about midpoint of head length; snout long, 41.6–47.1% of head length, bluntly rounded; mouth small, horizontal, inferior, protrusible, suctorial, but little overhung by snout, and less than width of head; gape not quite reaching nostril, lips plicate, plicae rather fine and oblong, angle of lower lips near 90°, cleft short, incomplete; no teeth in mouth, pharyngeal teeth short, widely spaced, tips flat. Gill rakers long, about $\frac{1}{2}$ diameter of eye, slender. Branchiostegal rays 3. Fins: dorsal 1, soft rayed, origin ahead of midpoint of body, height greater than base length which is 12.9–14.1% of total length, edge somewhat emarginate, 11 or 12 principal rays; caudal moderately long, well forked, tips rather pointed; anal rather square in young, rounded in adults, height twice base length, 7 rays; pelvics abdominal, under anterior portion of dorsal fin, moderately long, square to rounded, base narrow, axillary process large but inconspicuous, 9 or 10 rays; pectorals only moderately long, tip pointed to rounded, 16 rays. Scales cycloid, rather large, not crowded forward, 44–47 in lateral series, lateral line absent in young, largest adults show intermittent completely developed tubes but lateral line rarely complete or conspicuous. Peritoneum colourless to white; intestine long, little differentiated, 4 or 5 coils; no pyloric caeca; swim bladder of two chambers. Vertebrae usually 43 or 44 to the south.

Nuptial tubercles, on males at least, on anal fin, both lobes of caudal fin, upper surface of snout (large), above and behind eye, lower cheek (few), and lateral areas of gular region on ventral surface of head.

Colour Dorsal surface of head, back, caudal peduncle, and upper sides dark green, olive to brown, most of sides of body and head bronze-green, copper, or silvery, ventral surface milk-white and silvery, a copper lustre everywhere. The conspicuous pattern, on which the common name is based, consists of a rather square, brown to black spot on the base of the exposed portion of each scale, the spots on the sides more conspicuous than those on darker back, and forming 8–10 obvious, horizontal rows over the whole body length beyond the head. The dorsal, caudal, and, sometimes, anal fins grey to olive, paired fins dusky to white. Breeding males have a narrow, chocolate-grey lateral band from tip of snout to base of tail, one above this of grey-pink, one above that dark lavender and the back is usually pale lavender. (Trautman 1957). Young, coppery to silvery, spots absent or apparent only over anal fin base.

Distribution Restricted to eastern North America. It occurs in the lower Great Lakes (excluding Lake Ontario), south through western Pennsylvania, east toward the coast through Virginia, south to northern Florida, west to eastern Texas, north in the eastern part of the states from Oklahoma to southeastern South Dakota, east through southern Minnesota, Wisconsin and Michigan to Lake Erie.

It has long been known in the United States waters of lakes Erie, St. Clair, and Huron and often listed as present or probably present in Ontario (Nash 1908). However, the



first actual specimen known to have been taken in Canadian waters was captured by a commercial fisherman, in late April 1962, in Lake St. Clair. Crossman and Ferguson (1963) reported the authentication of this species in the Canadian fauna and suggested the single individual was a stray. Since that time, other adult specimens have been taken in the Thames River but the species is still rare in Canada. It may have moved north into Lake St. Clair from Lake Erie or south from Lake Huron. Trautman (1957) commented that the species occurred in Lake Erie only as strays and that habitat destruction in the period 1920–1950 appears to be restricting it to the southern part of Ohio.

Biology Apparently very little is known of the biology of this species anywhere and nothing is known over its small Canadian range.

It apparently spawns in late spring or early summer at 59°–64° F (15.0°–17.8° C) in Oklahoma. Young-of-the-year, in Ohio, were 2–4 inches (51–102 mm) in length in October. Adults are usually 9–15 inches (229–381 mm) in length and weigh 6 ounces to 1 pound 12 ounces. Dwarf forms apparently mature as small as 6 inches (152 mm). The largest individual known was 17.7 inches (450 mm) long and weighed about 3 pounds (Trautman 1957). Maximum age would appear to be 6 years. It is assumed that their food consists of molluscs and other invertebrates, mainly immature insects. This species lives in lakes, overflow ponds, sloughs, oxbows and clean sluggish streams with sandy, gravelly, or hard clay bottoms without silt. It seems intolerant to turbidity, pollutants, and clay silt bottoms.

Parasites listed for the spotted sucker by Hoffman (1967) included only the protozoan *Myxosoma microthecum*.

See Carlander (1969) for a summary of the meagre information on United States populations.

Relation to man The young are probably preyed on by other fishes and birds. This species, which is not abundant anywhere, probably does not constitute a serious competitor with more valued fishes. In one report at least (Jordan 1878b), it was said to have been used by humans as food and that it was "pretty good for a sucker, which is not saying much." There is no evidence that it is so used today.

Nomenclature

Catostomus melanops — Rafinesque 1820b: 304 (type locality Falls of the Ohio River)
Minytrema melanops — Nash 1908: 108

Etymology *Minytrema* — reduced aperture in allusion to imperfections of the lateral line; *melanops* — black spots.

Common names Spotted sucker, striped sucker, black sucker. French common name: *meunier tacheté*.

This group of larger, superficially similar, usually laterally compressed suckers, in which the swim bladder consists of three chambers instead of two, is one of the most troublesome groups of freshwater fishes. In a study of some of them, published in 1956, Robins and Raney stated these fishes "have remained one of the most perplexing groups of fishes encountered by American Ichthyologists. Despite the numerous species and the large size . . . very little information is available on the spawning habits, age, growth, and other features of their life history. The gathering of such data has been hindered by the uncertain systematic position and inadequate diagnoses of the species. . . . Except for a brief spawning period, many species occur only in large bodies of water and are not easy to obtain. Meristic features . . . exhibit few interspecific differences. Pigmentation, shape of the fins, relative size and shape of body parts, and detailed structure of the lips have had to be relied upon."

The nomenclature of the group also presents problems, as some species have been published under a variety of names and different authors have combined and separated the various species in different ways. The actual species involved is often difficult to interpret from the names used in lists published before 1930. Robins and Raney recognized three subgenera: *Moxostoma (M. anisurum, carinatum, duquesnei, erythrurum,* and *macrolepidotum), Megapharynx (M. hubbsi and valenciennesi), and Scartomyzon* which does not have a Canadian representative.

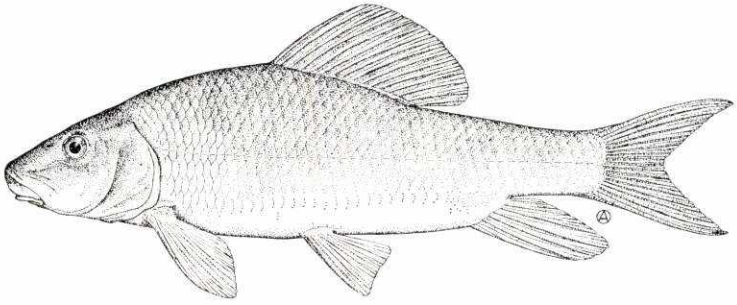
World Distribution of the Redhorses

Because of all these difficulties, the lack of biological information, the lack of reference material, and the limited distribution of many of the species in Canada, the species accounts which follow are, in general, brief. The species descriptions are more detailed in order to provide as many as possible of the characters quoted from Robins and Raney as those on which we must rely for identification. It is hoped that these detailed descriptions will make up for any inadequacies in the key.

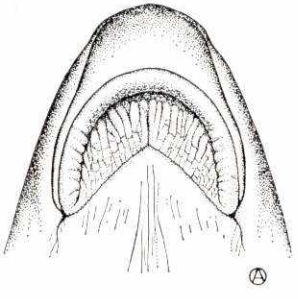
Because of the problems of identification and the confusion in nomenclature, any serious consideration of this group should be undertaken only after examination of a recent thorough study by Jenkins (1970).

SILVER REDHORSE

Moxostoma anisurum (Rafinesque)

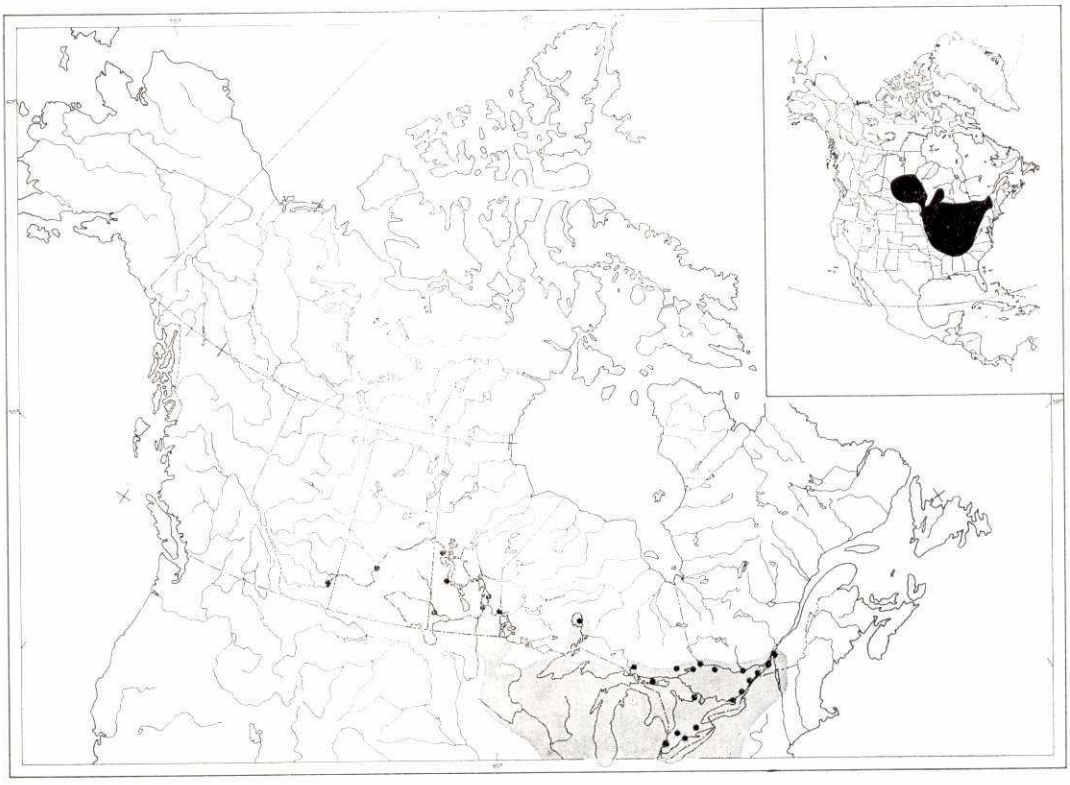


Description A large, laterally compressed sucker usually about 12–16 inches (305–406 mm) in length. Back with moderately high arch to dorsal fin, tapering behind; greatest depth, at dorsal origin, 20.9–25.9% of total length; cross section there a long, broad oval; caudal peduncle rather narrow, depth 7.8–10.2% of total length. Head naked, moderately long, about 20% of total length; upper and lower surface forming angle of about 40°, moderately broad, interorbital width 41.1–49.3% of head length, and deep; eye moderately large, its diameter 36.8–44.5% of snout length, high on head, at midpoint of head length; snout long 34.2–49.0% of head length, rounded and somewhat bulbous, with a marked groove above mouth;



mouth inferior, overhung by snout, protrusible, suctorial, its width less than width of head at mouth, gape barely reaching nostril; lips thick but not overly prominent, upper lip narrow, only inner edge plicate, lower lip wide, edges meeting at 90° or more, deeply cleft, plicae long, narrow, with cross striations; no teeth in mouth, pharyngeal teeth large, and heavy. Gill rakers long, 25–28 in number. Branchiostegal rays 3. Fins: dorsal 1, soft rayed, rather high and long, height about $\frac{3}{4}$ of base length which is 16.3–19.3% of total length, edge rounded, 15–17 principal rays; caudal moderately long, deeply forked, tips pointed or upper slightly produced and lower rounded; anal long, height 3 times length of base, origin well behind insertion of dorsal fin, pointed, usually 7 rays; pelvic abdominal, origin below fourth dorsal ray, edge square to slightly emarginate, 9 or 10 rays; pectorals low, long, rather narrow, tip round to pointed, 18 rays. Scales cycloid, moderately large, not crowded anteriorly, caudal peduncle scales usually 12(5-2-5), 42–48 scales in lateral line; lateral line complete, at midpoint of body and almost straight. Peritoneum colourless to silvery; intestine long, little differentiated, 5 rounded coils obvious ventrally; no pyloric caeca; swim bladder of 3 chambers. Vertebrae usually 36 plus the Weberian ossicles.

Nuptial tubercles on anal, caudal, and a few on body scales of males, and on anal fin only of females, and barely visible.



Colour Body bronze to olive-green dorsally, sides silvery, often with faint golden reflections, ventral surface silver to milk-white, snout often white. Fins light slate, white, or pale red tint, but they haemorrhage easily and can appear bright red in net-caught specimens. Scales edged with dark pigment but without spots at their bases (Trautman 1957).

Distribution Restricted to the fresh waters of North America. The silver redhorse occurs in the east from the St. Lawrence River, south through central New York, southwest through the western half of the coastal states to northern Alabama, then northwest through eastern Arkansas, Missouri, north to the Red and Souris rivers in northern North Dakota, northwest into Saskatchewan and west to Medicine Hat, Alta. In the north, its range extends east through central Saskatchewan and Manitoba, through the lower Great Lakes to southern Ontario.

In Canada, it occurs in the St. Lawrence River from Lac St. Pierre upstream, the Lake Champlain system, the Ottawa River, across Ontario at the level of the Goulais River just north of Sault Ste. Marie but including Lake Nipigon. Absent from the area between Lake Superior and Lake of the Woods, generally in Manitoba as far north as the source of the Nelson River, west in the Souris, Assiniboine, and Saskatchewan rivers into Saskatchewan, west in the South Saskatchewan River as far as Medicine Hat, Alta.

Biology There is no available published information on the biology of this species in Canada. The following information is largely from Meyer (1962) and based on Iowa specimens.

The silver redhorse spawns in swiftly flowing streams in the spring, generally when the temperature reaches 56° F (13.3° C).

Spawning was observed in the Chippewa River, Ont., on June 9. Even slight changes in temperature effect spawning activity. Males ripen sooner, and arrive on the spawning grounds sooner, presumably to acquire and defend spawning territory. The females are on the spawning grounds for a very short time. Spawning takes place in the main channel of turbid rivers in 1–3 feet of water on gravel to rubble bottoms. They apparently do not ascend tributary streams to spawn.

Egg number in females 13.3–19.3 inches (338–490 mm) in length varied, directly with size, from 14,910 to 36,340.

For details and a drawing of the early development of young *see* Fish (1932).

Growth is moderately fast in this species as compared to other redhorses. The greatest length increment is in the first year and length increments decrease beyond age 2, whereas weight increments continue to increase. Young silver redhorse form annuli in June in Iowa but older, larger individuals complete the formation of an annulus as late as August. The relation between age and observed length and the calculated weight in pounds (Meyer 1962) is as follows:

Age	Observed TL (*inches*)	Observed TL (*mm*)	Calculated wt (*lb*)
1	4.26	108	0.03
2	6.60	168	0.18
3	11.91	302	0.46
4	13.74	349	0.91
5	15.43	391	1.42
6	17.80	452	2.13
7	19.56	496	2.78
8	20.23	514	3.48
9	20.40	518	3.65

There is no pronounced difference in the growth rate of the sexes, and maturity is reached by both at age 5, in Iowa.

Maximum size may be the specimen listed by Trautman (1957) as 25 inches (635 mm) in length, which weighed 8 pounds 4 ounces. Maximum weight reaches 10 pounds in the Ohio River.

Although they occur in both, silver redhorse are usually more abundant in streams than in lakes. The young of this species inhabit slow-moving waters over hard or soft bottoms where overhanging banks may provide protection from predators. Adults are more common in areas where current is slower and there are long, deep, pools but avoid heavy silt, sedimentation, and pollution. They tend to be sedentary in summer.

This species, never abundant in Canada, has greatly decreased in numbers in Ohio, particularly in tributaries of Lake Erie (Trautman 1957) but is on the increase in Iowa and areas to the south (Meyer 1962).

Silver redhorse apparently feed exclusively on invertebrates which they suck up from the bottom. Individuals over 4 inches (102 mm) in length in Iowa had eaten immature insects such as chironomids, ephemeropterids, trichopterids in that order of frequency, and small molluscs.

The young silver redhorse may be subject to predation by a wide range of warmwater predators in rivers, but the large adults are probably relatively free from it. This species would compete with all river-residing, bottom-feeding fishes but especially with other redhorses and suckers.

Parasites listed for this species by Hoffman (1967) were Protozoa (2), Trematoda (2), Cestoda (1).

Relation to man Apparently in the past (Forbes and Richardson 1920) this species was a highly acceptable food fish and made up a high percentage of the fishes sold as suckers from Lake Michigan. It probably still constitutes a part of commercial catches in the Ohio and Mississippi rivers. It has never been of major importance as commercial or sport fish in Canada but is of small commercial value in the St. Lawrence River and marketed when caught with other species simply as suckers. In Iowa, Meyer estimated that the silver redhorse and two other species of redhorse made up 25% of the weight of fishes in the Des Moines River.

In 1960, a redhorse 24 inches (610 mm) in length, purported to be this species, was captured by an angler in Sparrow Lake, Muskoka District, Ont. It was reported to have provided a two-hour battle. Obviously, where this species is locally abundant they may constitute a potential sport fish of some significance.

Nomenclature

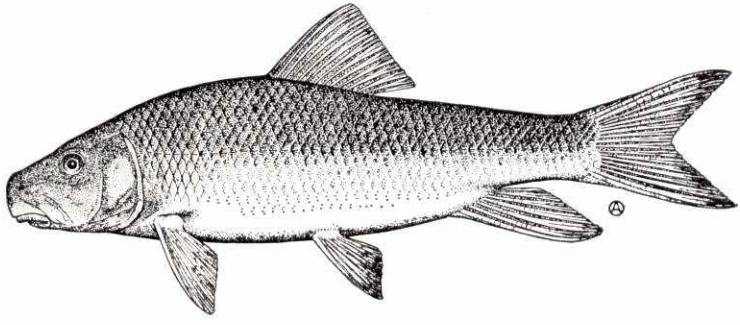
Catostomus anisurus	— Rafinesque 1820b: 300 (type locality Ohio River)
Catostomus carpio	— Cuvier and Valenciennes 1844: 457
Myxostoma carpio (Valenciennes) Jordan	— Jordan 1878b: 118
Myxostoma anisura (Rafinesque) Jordan	— Jordan 1878b: 126
Moxostoma valenciennesi	— Jordan 1886: 73
Moxostoma anisurum (Rafinesque)	— Jordan and Evermann 1896–1900: 190

Etymology *Moxostoma* — sucker mouth; *anisurum* — unequal tail in relation to the differences in the upper and lower lobes of the caudal fin.

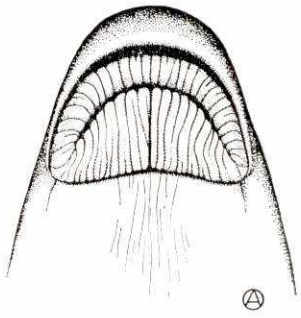
Common names Silver redhorse, silver mullet, white nose redhorse, white nosed mullet, white nosed sucker. French common name: *suceur blanc.*

RIVER REDHORSE

Moxostoma carinatum (Cope)



Description (2 specimens only). This moderately large sucker, usually 12–18 inches (305–457 mm) in length, does not seem so deep bodied as some of the redhorses. Body laterally compressed, but with low arch to back, tapering behind; greatest depth, at dorsal origin, 19.3–22.8% of total length; cross section a broad oval; caudal peduncle rather long and narrow, its depth 6.8–7.8% of total length. Head naked, moderately long, 8.9–20.0% of total length, not particularly deep, its upper surface not at steep angle, flat, very broad, interorbital width 47.9–50.0% of head length; eye moderate, diameter 37.6–39.5% of snout length, high on head about middle of head length; snout rather long, 45.0–46.6% of head length, square rather than bulbous; mouth inferior



but little overhung by snout, protrusible, suctorial, its width only slightly less than width of head at mouth, gape reaching nostril; lips thick but not overly prominent, upper lip narrow with prominent plicae, lower lip wide, at least 3 times width of upper lip, edges meeting in almost a straight line, deeply cleft, plicae long, narrow, without cross striations; no teeth in mouth, pharyngeal teeth large, heavy, club-shaped. Gill rakers long, 22–24 in number in material examined. Branchiostegal rays 3. Fins: dorsal 1, soft rayed, height about equal to base length, which is 12.1–16.0% of total length, edge square, 14 principal rays; caudal long, deeply forked, tips usually pointed, often in large adults upper lobe produced and lower lobe rounded; anal long, height 3 times length of base, origin well behind insertion of dorsal fin, pointed, usually 7 rays; pelvics abdominal, low, origin below seventh dorsal ray, edge square, tip pointed, usually 9 rays; pectorals low, moderately long, rather narrow, edge square with bluntly pointed tip, 15 or 16 rays. Scales cycloid, moderately large, not crowded forward, caudal peduncle scales 12(5-2-5), 42–47 scales in lateral line; lateral line complete, near midpoint of body and almost straight. Peritoneum colourless to silvery; intestine long, little differentiated, 5 or 6 rounded coils obvious ventrally; no pyloric caeca; swim bladder of 3 chambers. Vertebrae 38 plus the Weberian ossicles.

Nuptial tubercles on snout, anal, and caudal fins of males; on anal fin only in females.

Colour Dorsal surface and upper sides brown or olive-green with bright bronze overtone, sides paler, more golden, ventral surface golden to milk white. Dorsal, caudal, and anal fins pale red, anterior rays of pelvic and pectoral fins white, remainder of pelvic fins pale red to olive, and of pectoral fins olive. Each dorso-lateral scale with dark crescent at base.

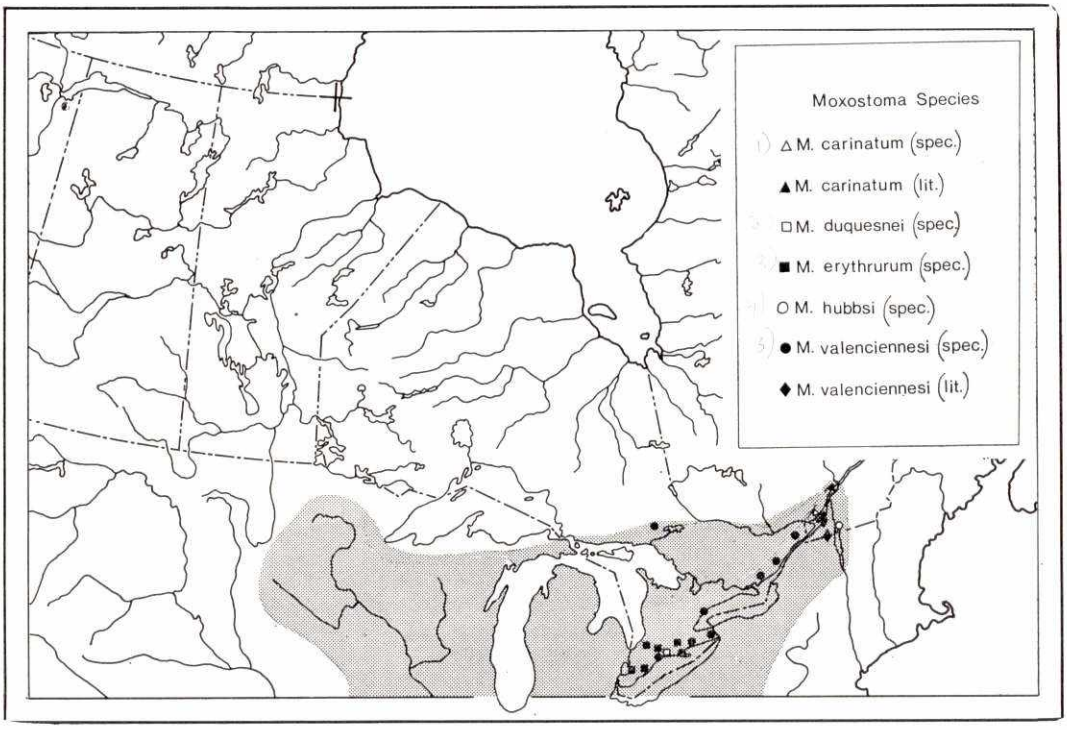
Distribution The river redhorse is restricted to the fresh waters of eastern North America. It occurs in the upper St. Lawrence River, is absent southwest to northwestern Pennsylvania, then occurs west of the mountains south to the Escambia River in Florida, west to the Pearl River, north through Arkansas, eastern Oklahoma to eastern Nebraska, east south of the Great Lakes through southern Michigan and Ohio. Many published range statements do not indicate the disjunct nature of the distribution. Bones found in Indian middens of Lake Erie's southern shores suggest it did occur, prior to the coming of the white man, in the area between the now disjunct areas of distribution.

In Canada, it occurs only in the St. Lawrence River in the area of Lac St. Pierre and Lac St. Louis, in Rivière Châteauguay, and Baie Laprairie below Lachine Rapids. It may occur in Lac des Deux-Montagnes. It probably occurs in the Ottawa River since a single specimen has been taken in Ontario in the Mississippi River, Lanark County, a tributary of the Ottawa. Not known today in even the United States tributaries of the Great Lakes. It was first recorded in Canada by Vladykov in 1942 as *Placopharynx carinatus* Cope.

Biology There is no published information on the biology or life history of this species in Canada. *See* Carlander (1969) for a short summary of information on data in generally unavailable reports.

It presumably spawns in large rivers in the spring but may resort to the upper reaches of some of the larger tributaries of their river habitats for this purpose.

Growth is moderately fast in the United States and the following relation between cal-



culated total length and age for specimens from the Meramec River in Missouri was quoted by Carlander.

Age	Calc TL	
	(*inches*)	(*mm*)
1	2.4	61
2	5.3	135
3	8.1	206
4	10.4	264
5	11.7	297
6	13.8	351
7	16.3	414
8	17.8	452
9	19.8	503
10	20.9	531
11	22.0	559
12	23.5	597

Trautman (1957) stated that the largest Ohio specimen was 29 inches (737 mm) in length and weighed 10 pounds 8 ounces. He also stated that Ohio River fishermen reported weights up to 14 pounds but they were usually 13–24 inches (330–610 mm) in length and 1–7 pounds in weight.

The habitat is apparently the deeper waters of larger rivers and the lower portions of their larger tributaries. River redhorse are abundant in upper reaches of the tributaries of these rivers only at spawning time. They are apparently intolerant of pollution or heavy siltation. This probably accounts for their diminution in numbers in the United States since 1925. It may also account for their disjunct distribution. They may have been continuous and disappeared from the area between the upper St. Lawrence River and the Ohio River. They may have been in Lake Erie in the past but most published records of their presence there would appear to be misidentification. Their intolerence of pollution does not augur well for their survival in the St. Lawrence in the area of Montreal and the outfall of the Ottawa River.

The food of this redhorse, as with the other species, consists of invertebrates swept up from the bottom and probably includes small molluscs and the young of various aquatic insects.

They are probably preyed on by other

fishes only as young, and their size as adults and their elusive nature may preclude serious predation on the adults.

Hoffman (1967) did not include this species in his list of parasites of suckers. This, doubtless, indicates lack of information rather than freedom from parasites.

Relation to man Little is known of the true relation of this sucker to man as a result of its elusiveness, its confusion in the literature and the general practice of marketing all species of suckers simply as suckers or all species of redhorses as mullets. The presence of bones of this species in Indian middens suggests it was eaten by Indians. It doubtless represents a small part of the catch in the Ohio and Mississippi rivers. Vladykov, in his report of this species as new to Canada, stated that it was not rare near Montreal, that the commercial fisherman knew it by a distinct name, that it was a commercial species of minor importance, and that during fall and winter fishing this species constituted about 2% of the catch of catostomid fishes. He said one fisherman caught, in 28 days, 90 river redhorse weighing a total of 360 pounds.

Nomenclature

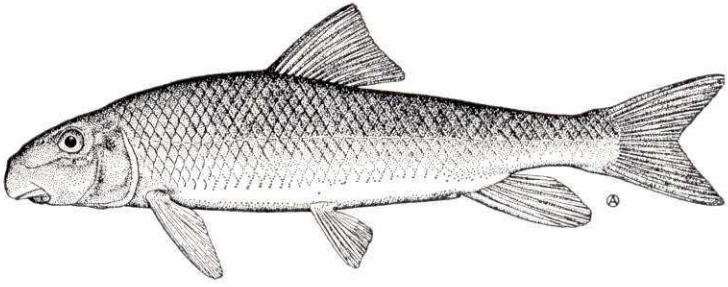
Placopharynx carinatus	— Cope 1870: 467 (type locality Wabash River, Lafayette, Ind.)
Placopharynx duquesnii Le Sueur	— Halkett 1913: 60
Moxostoma carinatum	— Legendre 1952: XI
Moxostoma carinatus	— Scott 1954: 43
Moxostoma carinatum (Cope)	— Scott 1958: 13

Etymology *Moxostoma* — sucking mouth; *carinatum* — keeled.

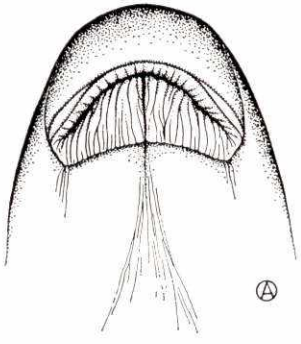
Common names River redhorse, river mullet. French common name: *suceur ballot.*

BLACK REDHORSE

Moxostoma duquesnei (Lesueur)



Description This redhorse, one of the smaller species, is rarely seen larger than 15 inches (381 mm) and is usually 10–13 inches (254–330 mm) in total length. Body laterally compressed but very low arch to back, body shallow; greatest depth 17.6–18.7% of total length; cross section at dorsal origin a wide oval or subcylindrical; caudal peduncle narrow, least depth 6.4–7.0% of total length. Head naked, moderately long, 16.3–17.5% of total length, broad, interorbital width 42.2–45.7% of head length, slightly rounded dorsally, not deep, upper and lower surfaces forming angle of about 30°; eye only moderately large, its diameter 37.2–52.4% of snout length, high on head but at midpoint of head length; snout long, 39.6–49.8% of head length; rounded and bulbous; mouth inferior, considerably overhung by snout, protrusible, suctorial, its width less than head width at this point, gape reaching to point midway between nostril and orbit; lips thick but not prominent, upper lip very narrow, coarse plicae on posterior edge only, lower lip about 5 times as wide as upper, edges slightly concave, meeting almost in straight line, deeply cleft, plicae long, irregular, narrow, no cross striations; no teeth in mouth, pharyngeal teeth large, club-shaped. Gill rakers medium length, 30–32 in number. Branchiostegal rays 3. Fins: dorsal 1, soft rayed, not markedly high, height slightly exceeds base length which is 12.3–14.3% of total length, edge slightly emarginate, 12 or 13 principal rays; caudal long, well forked, tips pointed or dorsal lobe produced and ventral somewhat rounded; anal fin long, height $2\frac{1}{2}$ times base length, origin well behind dorsal insertion, tip with rounded point, 6 or 7 rays; pelvics abdominal, below midpoint of dorsal fin, short, not broad, edge square, 9 or 10 rays; pectorals low, long, narrow, tip a narrow, rounded point, usually 16 rays. Scales cycloid, rather large, not crowded forward; caudal peduncle scales usually 12(5-2-5) but sometimes 13(6-2-5), 47–50 in lateral line; lateral line complete, at midpoint of body, straight. Peritoneum silvery; intestine long, little differentiated, 4 or 5 rounded coils obvious ventrally; no pyloric caeca; swim bladder of 3 chambers. Vertebrae usually 39, plus Weberian ossicles.



Nuptial tubercles on anal and lower lobe of caudal fin in males. Bowman (1970) said

he never saw tubercles on females and that in males the tubercles were restricted to the anal and caudal fins. However, there are minute tubercles on the head and body of females and on the head, lateral and dorsal body scales, and all fins of males.

Colour Dorsal surface and upper sides grey or olive-brown with silver-blue overtone, sides lighter and usually silver-blue, sometimes with bronze reflections, ventral surface silvery to milk-white. Fins usually slate grey to orange but the ventral fins are at times tinged with red. Scales usually dark edged but not dark at base (Trautman 1957).

At spawning time males in Missouri developed a light pinkish midlateral band. Above and below this, the body was metallic greenish black, ventral surface white, dorsal and caudal fins slate, anal, pelvic, and pectoral fins deep pink. Mature females showed no colour difference from other times of the year (Bowman 1970).

Distribution (*See* map p. 569) The black redhorse is restricted to the fresh waters of eastern North America as are many of the redhorses. It occurs in the Great Lakes tributaries in the United States, from western New York (drainages of lakes Erie and Ontario) and south, west of the mountains, to central Alabama and northeastern Mississippi, west through northern Arkansas, north through eastern Oklahoma, southern Missouri, southeastern Kansas and northeastern Iowa (rare), southeastern Minnesota, the southern third of Wisconsin and Michigan, and into southwestern Ontario.

In Canada, it is known only from specimens collected from the Grand River (Hubbs and Brown 1929), and from Catfish Creek, tributaries of Lake Erie. Many published statements of the distribution of this species include the upper St. Lawrence River and Lake Champlain drainages. Hubbs (1930a) quoted Greeley for a record from Lake Champlain in New York. It has not, however, been recorded from Quebec and records for the St. Lawrence drainage and Lake Champlain are probably erroneous. Several attempts to collect specimens of the black redhorse in Catfish Creek since 1938 have been unsuccessful and it is possible that the species no longer occurs in Canada. Specimens of this rare species should be carefully watched for in tributaries of Lake Erie.

Biology There is nothing known of the biology of this species in Canada. The following summary is based on Missouri populations described by Bowman (1970). They spawn in the spring, in 0.5–2.0 feet of water on gravel shoals in streams, during the day and night for a period of about 4 days in late April. Stream temperature at spawning time varied, from year to year, from 56°–72° F (13.3°–22.2° C). There is considerable activity, such as jumping out of the water, before males take up territories which they defend. A single female is attended by two males, the three vibrating during actual egg laying. No nest is built, eggs are scattered over the gravel and abandoned. Average number of eggs per female varied, in relation to weight of the female, from 1357 to 6055.

Growth is moderately fast in the south and the relation between age and average calculated total length at the end of each year of life for the Niangua River, Mo., is as follows:

Age	Avg calc TL	
	(*inches*)	(*mm*)
1	3.3	84
2	5.0	127
3	6.8	173
4	8.4	213
5	9.6	244
6	10.6	269
7	11.3	287
8	11.7	297
9	11.9	302
10	12.8	325

In Ohio, young-of-the-year in October are 2.0–3.5 inches (51–89 mm) in length, adults are usually 10–15 inches (254–381 mm) in length and 6 ounces to 1.5 pounds in weight, Trautman (1957). The largest Ohio specimen was 17.3 inches (439 mm) in length and weighed 2 pounds 4 ounces.

This species is usually looked upon as in-

tolerant of siltation, and an inhabitant of pools in the swifter flowing portions of medium to large streams with clear water and gravel, rock, or sand bottoms. The only stream from which it is known in Canada is usually heavily silted. The turbidity of the Canadian streams tributary to Lake Erie may explain why this species is so rare, and *M. macrolepidotum* and *M. erythrurum* survive. The northern range of this species seems to be decreasing as a result of silting of streams.

Black redhorse are bottom feeders, they suck in bottom material near riffles and expel the silt and waste. Food is entirely invertebrate, composition varies with size and season but in Missouri was composed of Hydracarina, Diptera, Ephemeroptera, Cladocera, Copepoda, Ostracoda, Amphipoda, and Nemathelminthes. No evidence was found of egg predation by this species.

Hoffman (1967) listed the trematodes *Anonchohaptor anomalus* and *Neodactylogyrus duquesni* as parasitic on this species.

Relation to man This species, along with other redhorses, makes up a small percentage of fish marketed in the south as suckers or mullets. Bowman spoke of them taken by angling and by spearing in Missouri. They apparently are not guilty, as often thought, of egg predation on more valuable species and are not serious food competitors of game species such as smallmouth bass.

Nomenclature

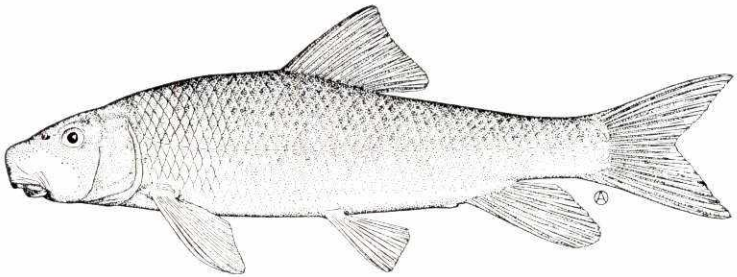
Catostomus Duquesnii	— LeSueur 1817d: 105 (type locality Ohio River at Pittsburgh, Pa.)
Placopharynx duquesnii (LeSueur)	— Dymond 1922: 64
Moxostoma duquesnii	— Radforth 1944: 48

Etymology *Moxostoma* — sucking mouth; *duquesnei* — after Fort Duquesne, an older name for Pittsburgh, Pa., the type locality.

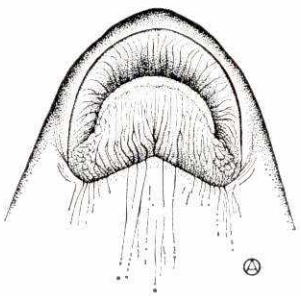
Common names Black redhorse, black mullet, finescale redhorse, finescale mullet. French common name: *suceur noir*.

GOLDEN REDHORSE

Moxostoma erythrurum (Rafinesque)



Description This shallow-bodied redhorse is usually 11–18 inches (279–457 mm) in length. Body laterally compressed, with little or no arch to back, tapering behind; greatest depth at origin of dorsal fin, 18.3–21.3% of total length; cross section a long oval; caudal peduncle rather long and narrow, its least depth 6.6–8.4% of total length. Head naked, of medium length, slightly less than 20% of total length, rounded on top, broad, interorbital width 41.2–47.6% of head length, not deep, upper and lower surfaces forming angle of about 30°; eye moderate, its diameter 37.2–54.1% of snout length, high on head, at midpoint of head length; snout rather long, 40.3–45.8% of head length, round to square, not overly bulbous; mouth



inferior, little overhung by snout, protrusible, suctorial, its width at corners less than head width, gape reaching nostril; lips thick but not overly prominent, upper lip moderate in width, with shallow plicae on lower and inner surfaces, lower lip not 2 times as wide as upper, posterior edges meeting at about 100°, moderately cleft, plicae narrow, irregular, with some cross striations; no teeth in mouth, pharyngeal teeth flat, comb-like, and chisel-like. Gill rakers long, 25–27 in number. Branchiostegal rays 3. Fins: dorsal 1, soft rayed, height slightly greater than base length which is 12.7–15.7% of total length, edge slightly emarginate, 11–14 principal rays; caudal long, broad, well forked, tips pointed; anal long, height $2\frac{1}{2}$ times base length, origin behind insertion of dorsal, tip rounded, 7 rays; pelvics abdominal, low, origin below midpoint of dorsal fin, edge square, 9 rays; pectorals low, long, moderately wide, tip bluntly pointed, usually 16 rays. Scales cycloid, large, not crowded forward, caudal peduncle scales 12(5-2-5), 42–44 scales in lateral line; lateral line complete, near midpoint of body, almost straight. Peritoneum colourless to silvery; intestine long, little differentiated, 2 or 3 long coils obvious ventrally; no pyloric caeca; swim bladder of 3 chambers. Vertebrae usually 36 plus Weberian ossicles.

Nuptial tubercles large on snout, anal fin, lower lobe of caudal fin in males. Tubercles on females but difficult to see.

Colour Dorsal surface and upper sides grey to bronze or olive, usually with bronze

to golden cast in adults and large young, silver cast in smaller individuals, sides paler with bronze-silver overtone, ventral surface silver to milk-white. Dorsal and caudal fins light slate grey, anal and paired fins white to pale orange, or all fins orange to red-orange. Scales golden green at bases but without dark spots (Trautman 1957).

Distribution (*See* map p. 569) The golden redhorse is restricted to the fresh waters of eastern North America. It occurs south from Lake Ontario tributaries of western New York, west of the mountains, through the western parts of Pennsylvania and West Virginia to Tennessee and the north of Georgia, Alabama and Mississippi, west through much of northwestern Arkansas, eastern Oklahoma, and extreme northern Texas, north through southeastern Kansas, through the eastern parts of the states from Nebraska to North Dakota, east across central Minnesota, Wisconsin, Michigan, and into Ontario.

In Canada, it occurs only in Ontario in the drainages of Lake Erie, Lake St. Clair and southern Lake Huron. It is present in the Lake Erie system at least as far east as the Grand River where it occurs with *M. macrolepidotum*, *M. valenciennesi*, and *M. anisurum* but not apparently in the Niagara River where *M. macrolepidotum* and *M. valenciennesi* are common.

Biology Nothing is known of the biology of this species in its limited distribution in Canada. The following life history details are taken from Meyer (1962) for the Des Moines River, Iowa, and from the summary of data in Carlander (1969).

They spawn in spring, later than other redhorses in the same area, usually in mid-May in Iowa, when water temperature reaches 59°–60° F (15.0°–15.5° C). Spawning takes place in riffles in the main stream, spawning adults apparently do not ascend smaller tributaries. Spawning lasts for only a short period. Males arrive on spawning grounds first where they establish and defend territories but no nest is built and at spawning the eggs are scattered and abandoned. Average egg number for females 11.5–15.7 inches (292–399 mm), 4–6 years of age, ranged from 6100–25,350 in Iowa but estimates ran as high as 35,000 in Ohio.

Growth of this species in Iowa was slower than that of other redhorses. Trautman (1957) cited length of young-of-the-year in October as 2.5–4.5 inches (64–114 mm). The relation between age and mean length at capture for golden redhorse in the Des Moines River was given as follows:

Age	Mean length	
	(*inches*)	(*mm*)
1	4.9	124
2	7.4	188
3	10.4	264
4	11.4	290
5	12.8	325
6	18.6	472
7	19.2	488

Data from Oklahoma indicated that the size range for age 7 there was 23.1–24.6 inches (587–625 mm). Trautman gave maximum size from Lake Erie as 26 inches (660 mm) in length and a weight of 4.5 pounds. He stated that the usual length was 11–18 inches (279–457 mm). The heaviest individuals are apparently females. Scott (1967) listed the average length of Ontario specimens as 13 inches (330 mm).

Golden redhorse females mature first at age 4 in Iowa and possibly later in Ontario, but dwarfed individuals in Ohio can be mature at 9.5 inches (241 mm).

The golden redhorse is apparently better adapted to river habitats than to lakes. The young often inhabit slow-moving streams with soft bottoms and this is the type of stream in which this species is found in Ontario. Trautman spoke of them as characteristic of relatively clear streams where riffles were composed of sand, gravel, boulders, and bedrock and the pools were free from heavy silt and aquatic vegetation. It is one of the few redhorses whose range does not seem to have been limited in the last decade by habitat change. They tend to be sedentary, remaining in or near the same pool, but may at

times show marked downstream movements.

The food consists entirely of invertebrates sucked up out of the bottom sediments and is made up of immature insects, worms, and molluscs, such as chironomids, mayflies, caddisflies, oligochaetes, and fingernail clams.

Only as young is this species likely to be subject to significant predation. Size of adults, turbidity, and faunal composition of the habitats probably limits predation on adults to northern pike. Young and adults of this species probably do not compete for food or space with species more valued by man as significantly as was previously thought.

Hoffman (1967) listed the following parasites for this species Protozoa (3), Trematoda (4), Nematoda (3), Acanthocephala (2), leeches (1).

Relation to man In Canada this species is too limited to be of much consequence. Its size and stream habitat preclude any significant entry into the commercial catch. Although bony, Cross (1967) spoke of it as excellent food, superior to many sport fishes of Kansas in flavour and texture. Cross also stated that the golden redhorse had long supported a "gig-fishery" in which they are speared at night from a boat, thus contributing food and diversity to the recreational fishery. They are also taken on hook and line with natural bait.

Nomenclature

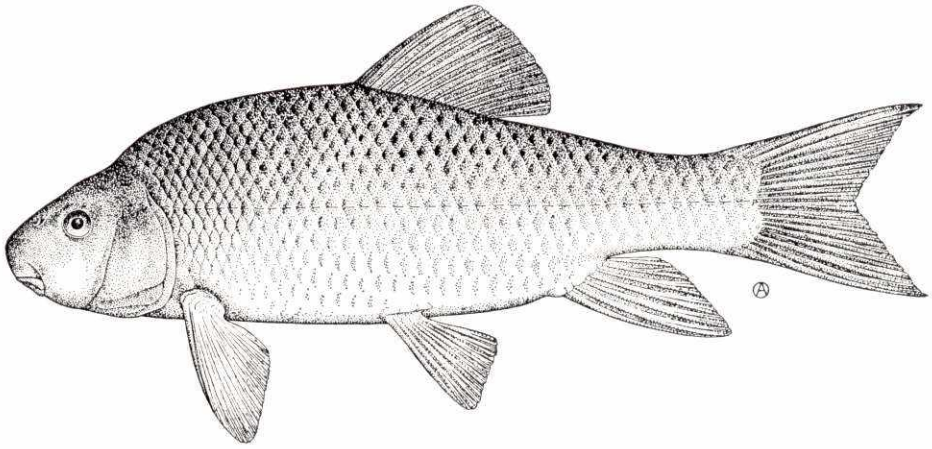
Catostomus erythrurus — Rafinesque 1818c: 354 (type locality Ohio River)
Moxostoma erythrurum (Rafinesque) — Hubbs 1930a: 6

Etymology *Moxostoma* — sucking mouth; *erythrurum* — red tailed.

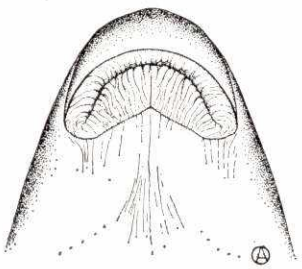
Common names Golden redhorse, golden mullet. French common name: *suceur doré*.

COPPER REDHORSE

Moxostoma hubbsi (Legendre)



Description A deeper bodied redhorse usually 15–18 inches (381–457 mm) in length. Body moderately to strongly compressed laterally, back with moderately high arch rising sharply behind head, creating a humpback appearance, tapering behind dorsal; greatest depth at dorsal origin 19.2–26.0% of total length, cross section here a deep, broad oval; caudal peduncle long and appears rather deep, but least depth only 8.0–10.3% of total length. Head naked, appears short and small on deep body, length is 14.1–17.6% of total length, deep, upper and lower surfaces meet at about 45° angle, rounded on top, very wide, interorbital width 51.6–54.2% of head length; eye moderate, diameter 40.0–45.4% of snout length, not so high on head, a little ahead of midpoint of head length; snout moderately long, 37.2–40.7% of head length, with a high, blunt point, not bulbous; mouth small, inferior, little overhung by snout, protrusible, suctorial, its width slightly less than that of head, gape reaching nostril; lips thick but not prominent, upper lip narrow with indistinct narrow plicae on inside edge, lower lip about 3 times as wide as upper, edges meet at about 105°, deeply cleft, plicae weak, long, narrow, without cross striations; no teeth in mouth, pharyngeal teeth in single row, massive, 18–21. Gill rakers medium length, widely spaced, 18 or 19 in number. Branchiostegal rays 3. Fins: dorsal 1, soft rayed, height about equal to base length which is 12.2–15.5% of total length, edge convex, 13 or 14 rays; caudal wide, moderately long, well forked, tips pointed; anal long, height 3 times base length, origin well behind insertion of dorsal, tip pointed, usually 7 rays; pelvics abdominal, origin below fifth or sixth dorsal ray, edge square, tip rounded, 9 or 10 rays; pectorals long, broad, edge square, tip a rounded point, usually 16 or 17 rays. Scales cycloid, moderately large, a little crowded forward, caudal peduncle scales 16(7-2-7), 45–47 in lateral line; lateral line complete, at midpoint of body and straight. Peritoneum black; intestine long, little differentiated, 4 long coils visible ventrally; no pyloric caeca; swim bladder of 3



chambers. Vertebrae 39 plus Weberian ossicles.

Nuptial tubercles on head, body, and all fins of at least the males.

Colour Dorsal surface of the body, the head, and upper sides varying from a bright coppery sheen through golden to olive, sides golden to pale olive, the ventral surface a much paler shade of the colour of sides or off-white. The fins are usually coppery to dusky.

Systematic notes This species was first referred to by Legendre in 1942 on the basis of three males and one female, 23.8–27.5 inches (605–698 mm) in total length, taken from the St. Lawrence River in the area of Lac des Deux-Montagnes near Montreal. On the advice of C. L. Hubbs, Legendre considered the specimens as examples of a species, *Catostomus carpio*, described by Cuvier and Valenciennes in 1844 on the basis of a specimen from Lake Ontario. This species had been reclassified by Jordan in 1878 as *Myxostoma carpio* (Valenciennes) Jordan, and again in 1886 as *Moxostoma valenciennesi*. Jordan and Evermann in 1896 placed it in the synonymy of *Moxostoma anisurum* (Rafinesque). Legendre however recognized the distinctness of his animals from other redhorses placed at that time in the genera *Moxostoma* and *Placopharynx* and named it *Megapharynx valenciennesi*. In 1952, he realized that the specimens represented an entirely new species and renamed it *Moxostoma hubbsi*.

Megapharynx was retained by Robins and Raney (1956) as a subgenus embracing *Moxostoma hubbsi* and *M. valenciennesi*.

Distribution (See map p. 569.) This species is restricted to the fresh waters of northeastern North America. It is presently known only from Quebec where it occurs in Lac St. Louis, Lac des Deux-Montagnes, Lac St. Pierre, the Ottawa River near Montreal, the Richelieu River, and the Yamaska River system, including Rivière Noire. It is abundant nowhere but a few specimens are seen each year.

Biology There is no published information available concerning the biology or life history of this rather rare species.

It spawns in the spring, probably in the moderate depths of the rivers. It grows to at least 27.5 inches (698 mm) in length, at which time it is likely to be 12–15 years of age.

Food of the copper redhorse will no doubt consist of a variety of invertebrates (molluscs and immature insects) which it sucks up off the bottom.

Relation to man This species is too rare to bear any relation to man. In contrast, man's activities seriously threaten the future of this species in that its total known range is subject to heavy industrial and domestic pollution.

This species is in the list of rare or endangered Canadian fishes (McAllister 1970).

Nomenclature

Megapharynx valenciennesi — Legendre 1942: 229 (type locality St. Lawrence River, at Dorion, Que.)

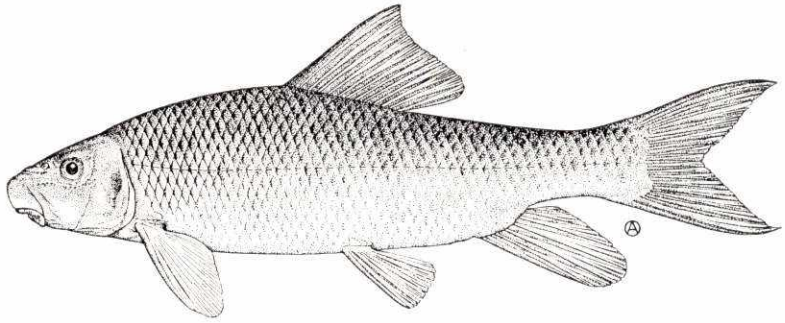
Moxostoma hubbsi — Legendre 1952: VI

Etymology *Moxostoma* — sucking mouth; *hubbsi* — after Dr Carl L. Hubbs, North America's foremost ichthyologist.

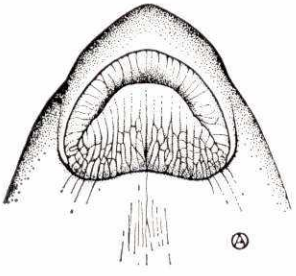
Common names Copper redhorse. French common name: *suceur cuivré* or *moxostome cuivré*.

SHORTHEAD REDHORSE

Moxostoma macrolepidotum (Lesueur)



Description A redhorse of intermediate body depth and robustness, usually 14–18 inches (356–457 mm) in length. Body laterally compressed, back with only moderate arch, tapering behind; greatest depth at origin of dorsal fin 18.0–22.9% of total length, cross section there a broad oval; caudal peduncle rather long and narrow, depth 7.2–9.3% of total length. Head naked, short, length 17.0–19.0% of total length, head angle not steep, upper and lower surface forming angle of about 35°, moderately broad, interorbital width 36.3–48.0% of head length, not deep, back little humped behind head; eye large, its diameter usually 50.0–83.3% of snout length in smaller individuals, but as low as 36.9% in large individuals, high on head, a little beyond centre



of head length; snout long, 37.5–47.9% of head length, rounded, somewhat bulbous; mouth rather small, inferior, overhung by snout, protrusible, suctorial, its width much less than head width, gape barely reaching nostril; lips thick but not prominent, upper lip narrow, plicae weak, lower lip wide, $2\frac{1}{2}$ times width of upper lip, edges meeting in almost straight line, cleft, plicae narrow, most obvious toward posterior, cross striations obvious; no teeth in mouth, pharyngeal teeth large. Gill rakers 22–30. Branchiostegals 3. Fins: dorsal 1, soft rayed, rather high, height exceeds base length which is 13.1–17.3% of total length, edge noticeably emarginate, rays 12–14, usually 14; caudal long, broad, deeply forked, tips pointed or upper lobe produced and pointed, lower rounded; anal long, height $2\frac{1}{2}$ times base length, origin well behind insertion of dorsal fin, edge rounded, 6–8, usually 7, rays; pelvics abdominal, origin below middle of dorsal base, edge square to rounded, 8 or 9, usually 9, rays; pectorals low, long, wide, tip a rounded point, usually 17 rays. Scales cycloid, large, little crowded forward, caudal peduncle scales 11–14 but usually 12(5-2-5), 40–46 scales in lateral line; lateral line complete, at midpoint of body, straight. Peritoneum colourless to silvery; intestine long, little differentiated, 6 rounded coils, slightly to right side, obvious ventrally; no pyloric caeca; swim bladder of 3 chambers. Vertebrae usually 38 plus the Weberian ossicles.

Obvious nuptial tubercles confined on males to anal and caudal fins, minute ones on all other fins, head, and lateral and dorsal surfaces of body.

Colour Dorsal surface and upper sides brown to olive with golden, green or coppery reflections, lower sides lighter in colour with deeper bronze overtones, ventral surface milk-white to dusky yellow. Dorsal fins sometimes red, otherwise red leading tip, dark edge and dusky to orange in main area; caudal fin all bright red or wide posterior margin of red only, anal fin usually bright red to orange, others orange to yellow-pink, with red suffusion. Each upper body scale with a black crescent at base.

Systematic notes The published scientific and vernacular nomenclature of all of the redhorses is confused, but this species has been reported more often for Canada, over a longer period of time, and the names in print are consequently more confusing than some of the rarer southern Canadian forms. It has been, at various times, referred to as *M. aureolum*, *M. breviceps*, and *M. lesueurii* or *lesueuri*. Hubbs (1930a, b) stated that three species, *M. duquesnii*, *M. rubreques* (=*valenciennesi*), *and M. erythrurum*, had been previously confounded by various authors under the name *M. aureolum* and that *M. aureolum* (=*macrolepidotum*) had to be "returned to the short-headed redhorse" then known as *M. lesueurii*. Also, specimens of the species now called *M. valenciennesi* were regularly confused with and called *M. aureolum* or common redhorse. To compound the problem, the common name has shifted also. This species has for some time been known as the northern redhorse but Jenkins (1970) found that *M. breviceps*, *M. coregonus,* and *M. lachrymale* are conspecific with *M. macrolepidotum* and suggested that shorthead redhorse, the common name previously applied to *M. breviceps*, apply to the expanded species.

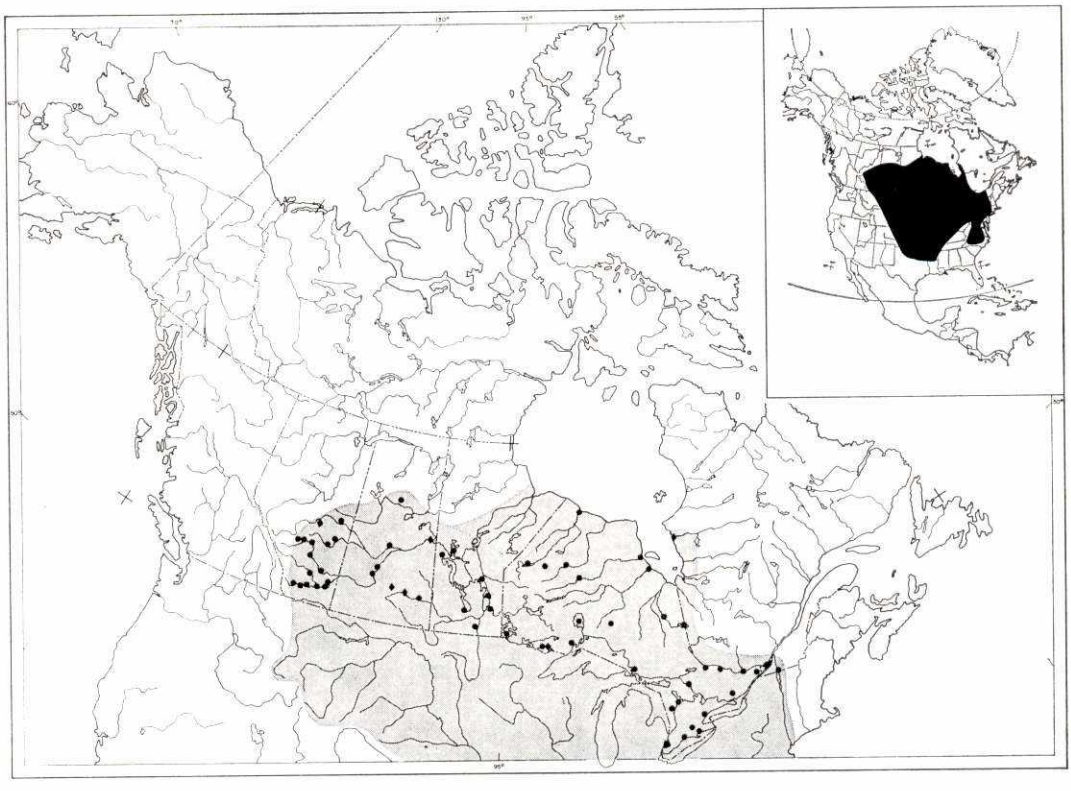
Distribution The shorthead redhorse is restricted to the fresh waters and in rare cases, brackish water, of North America and has a wider and more northern distribution than any of the other redhorses. As now expanded, it occurs from the Upper St. Lawrence River, south in the Lake Champlain drainage to the coast in New York, east of the mountains as far south as South Carolina, west across Pennsylvania and Ohio, southwest through the states from Indiana to Arkansas, the Tennessee River drainage of Alabama, west into Texas, northwest through the eastern portions of the states from Colorado to Montana, north to central Alberta, east along approximately the 55° parallel to southern Hudson Bay and the east coast of James Bay.

In Canada, it occurs in Quebec in the St. Lawrence, Richelieu–Lake Champlain, and Ottawa systems and as far north as James Bay, through the whole of Ontario, in Manitoba from the Churchill River south, from the Belanger River south in Saskatchewan and from the South Saskatchewan River south in Alberta. This redhorse occurs farther north and west in Canada than any other species of redhorse and will be the one most often encountered everywhere, especially north or west of Lake Nipigon. Vladykov (1933) said that it descends to brackish water in Hudson Bay. If this is true it is the only Canadian species of redhorse to do so.

Statements of its occurrence in the Arctic Red River (Preble 1908) and north of Great Slave Lake (Evermann and Goldsborough 1907a) are probably nomenclatorial or identification errors.

This species was first recorded in Canada by Richardson (1823) as *Catastomus Lesueurii* from Pine Island (=Cumberland) Lake, Sask.

Biology In spite of the extent of distribution of this species, it has never been looked on as valuable and consequently published accounts are usually only a statement of its presence or of its confused nomenclature. Growth data given by Reed (1962) for shorthead redhorse in the Saskatchewan River would appear to be the only Canadian biological information available other than general statements on food and spawning, which apply to all redhorses. Most of the



following is taken from Meyer (1962), who described an Iowa population, and from the summary of information in Carlander (1969).

Characteristics of sexual maturity have been reported from June 2 (Lake Nipigon) to July 17 (Lake Abitibi) in Canada but Dymond (1926) assumed they spawned in late May in Lake Nipigon. In Iowa they spawn in late April when water temperature is 52° F (11.1° C). This species migrates, in the spring, out of larger bodies of water into smaller rivers or streams to spawn on gravelly riffles. Spawning takes place at night or in the early morning. The males arrive first, establish and defend territories, spawning lasts only a few days, no nest is built, the eggs are scattered and abandoned. Egg number in Iowa for females 12.8–18.1 inches (325–460 mm) in length and 3–6 years of age, varied from 13,500 to 27,150. Egg number has been reported as high as 29,732 in Oklahoma. For details and an illustration of the early development of young-of-the-year of this species, *see M. aureolum* in Fish (1932), and also Mansueti and Hardy (1967).

This species grows faster than other redhorses in Iowa. Trautman (1957) said young-of-the-year in October, in Ohio, were 2–4 inches (51–102 mm) in length. The relation between age, fork length, and weight in the Saskatchewan River is as follows:

Age	Length		Wt
	(*inches*)	(*mm*)	(*oz*)
1	–	–	–
2	3.3	84	–
3	4.4	112	2
4	10.6	269	10
5	12.0	305	12
6	–	–	–
7	13.2	335	17
8	14.0	356	22
9	14.7	373	24
10	15.4	391	30
11	15.5	394	31
12	16.5	419	40

Growth in Saskatchewan is much slower than that in Minnesota and individuals are much lighter in weight at a given age. Some may be only 1.7 inches (44 mm) in length at the beginning of the second summer and only 3 inches (77 mm) at the third. In Iowa, males of this species mature as young as 3 years of age and in South Dakota females at 2. Maturity in Saskatchewan is probably at 4 or 5 and in the Great Lakes possibly 3 or 4. Individuals in the slower-growing Canadian populations live longer as no ages greater than 9 are given for more southern populations, but maximum age in Canada is probably 12–14 years. Scott (1967) gave maximum length in Ontario as possibly over 20 inches (508 mm) and the average as 12–15 inches (305–381 mm). Trautman (1957) stated that maximum size in Ohio was 24.4 inches (620 mm) in length and a weight of 4 pounds 2 ounces, but said that Lake Erie fishermen considered 6 pounds to be maximum weight. This species, before the combination by Jenkins of the previously separate forms under the name *M. macrolepidotum*, was considered more of a lake than river form. It must now be said to inhabit the shallow, clear water of lakes or clear rivers, over bottoms of sand or gravel without heavy silt. They seem less tolerant of chemical pollution than do some sport fish but can withstand water temperatures as high as 99° F (37.2° C) (Cross 1967). It is considered now much less abundant in Ohio than it was before 1915, as a result of silting and pollution.

Like other suckers, the shorthead redhorse obtains its food by sucking up bottom material and straining from it a random variety of invertebrates. The food of this species in Lake Nipigon in the past was given by Clemens et al. (1924) as consisting of the immature forms of Ephemeroptera, Trichoptera, Chironomidae, Tipulidae, Stratiomyidae, Ostracoda, molluscs, Oligochaeta, various crustaceans, Hydracarina, and diatoms.

This species when young is probably preyed on by an assortment of piscivorous fishes. As adults, it is probably relatively free of predation except by very large northern pike and muskellunge. It is a food competitor with any other sucker with which it cohabits and probably with the lake sturgeon and other bottom feeders as well. Their small numbers in Canada reduce the threat this imposes to other species more valued by man.

Combining the lists for those forms now combined in this species given by Hoffman (1967), *(M. macrolepidotum* and *M. breviceps)*, the known parasites consist of Protozoa (1), Trematoda (1), Nematoda (1), and Crustacea (2).

Relation to man This species and all other redhorses in Canada are too poorly known to even estimate their relation to man in their ecological role. This species has always constituted a minor part of the commercial landings of the Great Lakes and other Canadian fresh waters. Nash (1908) suggested that persistent commercial netting in Ontario during the spawning season had made it comparatively scarce by 1908. Since the shorthead redhorse is probably the most abundant, it obviously constitutes the bulk of the proportion of redhorses which are marketed as suckers or mullets. The flesh is sweet and flaky but the numerous bones bothersome. This species was probably utilized as human food to a far greater extent in the past as their spawning migrations made them readily accessible. Jordan and Evermann (1908) said shorthead redhorse were held in high esteem by farmers who snared, seined, and trapped great numbers of them in the spring and salted them away for winter. Attempts in Ontario to market and serve this species as mullet were never very successful. The Department of Home Economics of the University of Manitoba in 1939 investigated the potential of the commercial and home canning of this species. However, no apparent increase in home canning or any commercial venture resulted from this study (Lantz 1948).

Migdalski (1962) said this species was marketed in larger cities and brought better prices than the white sucker. He also said that there is enough angling pressure on the redhorse to rate it as a sport fish and that many are taken during spring spawning migrations using worms, grubs, grasshoppers, or small pieces of meat as bait.

Nomenclature

A true picture of the Canadian synonymy of this species is difficult as a result of the confusion of the many forms of redhorses until very recent times. What seems like unnecessary repetition of synonyms is necessary where authors have used names for separate species that are now combined under *macrolepidotum* and for authors who used one name one year and another name later.

Catostomus macrolepidotum	— LeSueur 1817d: 94 (type locality Delaware River)
Catastomus Lesueurii	— Richardson 1823: 721
Cyprinus (Catastomus) Sueurii	— Richardson 1836: 118
Cyprinus (Catastomus) aureolus (LeSueur)	— Richardson 1836: 119
Catastomus aureolus	— Forelle 1857: 281
Catastomus Sueuri	— Small 1865: 30
Moxostoma aureolum (LeSueur)	— Eigenmann 1895: 108
Moxostoma lesueuri Richardson	— Jordan and Evermann 1896–1900: 194
Moxostoma breviceps (Cope)	— Jordan and Evermann 1896–1900: 196
Moxostoma aureolum LeSueur	— Halkett 1913: 60
Moxostoma macrolepidotum LeSueur	— Halkett 1913: 60
Moxostoma lesueuri Richardson	— Halkett 1913: 60
Moxostoma breviceps Cope	— Halkett 1913: 60
Moxostoma Aureoleum	— Lower 1915: 43
Moxostoma aureolum (LeSueur)	— Dymond 1922: 63
Moxostoma lesueurii (Richardson)	— Dymond 1939: 21
Moxostoma aureolum (LeSueur)	— Dymond 1947: 15

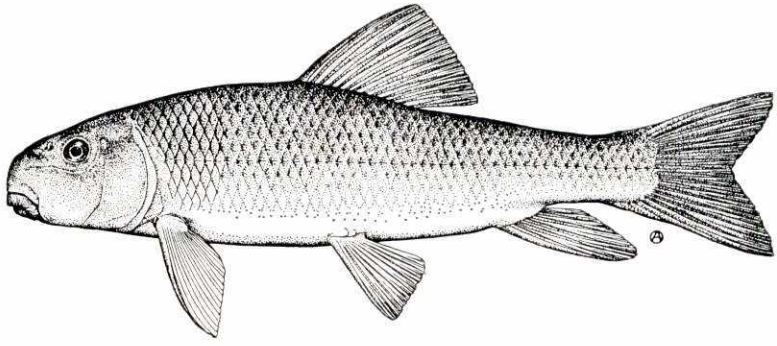
Etymology *Moxostoma* — sucking mouth; *macrolepidotum* — large scales.

Common names Shorthead redhorse, northern redhorse, northern shorthead redhorse, short-headed red-horse, common redhorse, short-headed mullet, common mullet, red sucker. French common name: *suceur rouge*.

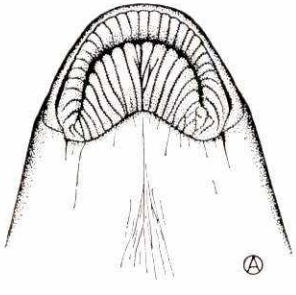
Until recently, this species has been generally known as northern redhorse. Jenkins' 1970 decision that several previously separate forms should be combined under *M. macrolepidotum* required a new common name for the expanded species and he selected shorthead redhorse.

GREATER REDHORSE

Moxostoma valenciennesi Jordan



Description (Based on the single available study specimen and the literature). A large, somewhat laterally compressed sucker, usually 15–18 inches (381–457 mm) in length. Back with shallow arch to dorsal fin, tapering behind; greatest depth at dorsal origin, about 24% of total length; cross section there a deep, broad oval; caudal peduncle rather long and narrow, its depth about 8–9% of total length. Head massive and long, its length about 19–20% of total length, upper surface not steep, broad, interorbital width about 47% of head length, and deep, upper surface rounded; eye small, diameter about 27–28% of snout length, rather high on head and at midpoint of head length



or slightly beyond; snout long, 53% of head length, almost square and vertical at tip; mouth inferior but not overhung by snout; protrusible, suctorial, its width very little less than snout width, gape barely reaching to nostril; lips very thick, more conspicuous than in many other redhorses, upper lip wide, plicae coarse and conspicuous even on anterior edge; lower lip wide, 2½ times upper lip, edges meeting at an angle of 90°–110°, deeply cleft, plicae coarse, deep, no cross striations; no teeth in mouth, pharyngeal teeth heavy but compressed and comb-like. Gill rakers about 27–31 in number. Branchiostegal rays 3. Fins: dorsal 1, soft rayed, height exceeds base length, which is about 14–15% of total length, leading edge straight to definitely rounded, usually 13 rays; caudal long, moderately forked, tips blunt points, or upper produced and lower rounded; anal long, height almost 3 times base length, origin well behind insertion of dorsal fin, tip a rounded point, usually 7 rays; pelvics abdominal, low, wide, origin below fourth dorsal ray, edge square, usually 9 rays; pectorals low, long, moderately wide, tip pointed, usually 16–18 rays. Scales cycloid, large, not crowded anteriorly, caudal peduncle scales 16(7-2-7), about 42–45 scales in lateral line; lateral line complete, at midpoint of body and straight. Peritoneum colourless to black; intestine long, little differentiated, 5–7 rounded coils obvious ventrally; no pyloric caeca; swim bladder of 3 chambers. Vertebrae usually 38–40, plus the Weberian ossicles.

Nuptial tubercles on males confined to anal and caudal fins.

Colour Dorsal surface and upper sides olive-green with bronze reflections, sides paler and more golden, ventral surface golden or milk-white. Dorsal, caudal and anal fins deep red, lighter in young individuals, anterior tip of dorsal fin white to pink, anterior rays of pelvic and pectoral fins whitish, remainder of pelvic fins pale red, and of pectoral fins olive (Trautman 1957). Each scale base with a definite dark crescent.

Systematic notes As is the case with the other redhorses, an analysis of early records of this species in Canada and the United States is confounded by the confusion of the various forms. Records prior to 1930 are doubtful, and often the common name used then is more trustworthy than the scientific name applied then to this species. The most recent synonym applied to this form was *M. rubreques* but certain past records of *M. aureolum* are considered to apply to this form. Hubbs (1930a) said that three species, *M. duquesnii*, *M. rubreques* (=*valenciennesi*) and *M. erythrurum* had been previously confounded by various authors under the name *M. aureolum*, and that *M. aureolum (=macrolepidotum)* had to be "returned to the short-headed redhorse" then known as *M. lesueurii*. Notes of the late Dr J. R. Dymond show that confusion was still great in the 1930's as he had then been prepared to rather indiscriminately reduce most previous Canadian records of *aureolum* (such as Nash 1908; Evermann and Latimer 1910; and Dymond 1922) to the synonymy of *M. rubreques* on Hubbs' suggestion that it was this species which was the commonest in the Great Lakes and known by the fishermen as *the* redhorse. Also, there was confusion between the form now bearing this name and the copper redhorse, prior to the clarification by Legendre (1942, 1943, 1952).

Distribution (*See* map p. 569.) The greater redhorse is restricted to the fresh waters of central and eastern North America and primarily the Upper Mississippi and Great Lakes–St. Lawrence systems. It occurs from the St. Lawrence (downstream from Montreal) south into New York in the Lake Champlain system, southwest, just south of the Great Lakes, through northwestern Ohio, northern Indiana and Illinois, northwest through Wisconsin and Minnesota to eastern North Dakota and east through southern Ontario.

Recent identifications, of previously unidentified material, by R. Jenkins has extended our knowledge of the distribution of this species in Canada. In Canada it occurs in Quebec in the St. Lawrence River and tributaries downstream to Lac St. Pierre, the Richelieu–Champlain system, the Ottawa River, and tributaries of lakes Ontario (the type locality), Erie, St. Clair, and Huron, north at least to the Spanish River near Sudbury. Many published suggestions of its possible occurrence in Lake of the Woods would seem to be in error. In Ontario this species is often found with *M. macrolepidotum* in the south and with that species and *M. anisurum* farther north.

Biology Apparently less is known of the biology of this species than any of the redhorses other than the copper redhorse. There are only general comments published on it from Canadian waters and Carlander's usually very useful handbook (1969) does not even have a section on this species.

It is doubtless a spring-to-summer spawner, probably May to early July in Canada, and is said to spawn in moderately rapid streams. Trautman (1957) listed young-of-the-year in Ohio as 1.5–3.0 inches (38–76 mm) in length. He said the largest Ohio specimen was 24.5 inches (622 mm) long and weighed an estimated 3–5 pounds. This is the largest of the redhorses in Canadian waters. Hubbs (1930a) gave maximum weight as 12–16 pounds. Dymond et al. (1929) quoted fishermen as saying Lake Ontario specimens reached 13 and 16 pounds, but the identities may have been in error. Scott (1967) said that individuals weighing over 10 pounds

were caught in the past in Lake Ontario but that average weight was approximately 2 pounds. Specimens from near Montreal reported by Vladykov (1942) were 15.8–19.6 inches (401–499 mm) in length. A specimen taken in the Richelieu River in July 1970, which was 23.1 inches (587 mm) in length but only 6 pounds 1 ounce in weight, approximates the maximum given by Trautman.

The habitat of this form was said by Trautman to be large streams having clear water and bottoms of clean sand, gravel, or boulders. This species probably occurs, in limited numbers, in the Great Lakes themselves near the mouths of tributary streams. These characteristics pertain in the eastern and northern streams of Ontario where this species is taken but not in the Grand River (Lake Erie) or tributaries of the Niagara River which are softer bottomed and muddy. Trautman attributed their reduction in number and in area occupied, to increased siltation and pollution. Consequently, this species is similarly in danger over most of its range in Canada.

The food of this species is, in all likelihood, the same range of invertebrates, immature insects, worms and molluscs, as that utilized by the other redhorses.

Parasites, probably of this species, listed by Hoffman (1967) under *M. rubreques,* were: Trematoda (1), Cestoda (2), Acanthocephala (3), Crustacea (1).

Relation to man With virtually no knowledge of its biology, its ecological role can only be guessed as of minimal importance to man. In the streams it inhabits it probably competes with few important forms. In the St. Lawrence, Niagara, and other large Canadian rivers it may compete with important invertebrate-eating bottom-feeders such as the lake sturgeon. In Canada its stream habitat, relatively low abundance, and low market acceptance make its contribution to commercial catches extremely low or nil.

Nomenclature

As a result of the past confusion in the forms of redhorses and the consequent clouded nomenclature, a true picture of the Canadian synonymy is virtually impossible.

Catostomus carpio	— Cuvier and Valenciennes 1844: 457 (type locality Lake Ontario)
Moxostoma valenciennesi	— Jordan 1886: 73
Moxostoma anisurum	— Günther 1868: 20
Moxostoma aureolum	— Nash 1908: 32
Moxostoma aureolum LeSueur	— Halkett 1913: 60
Moxostoma aureolum (LeSueur)	— Dymond 1922: 63
Moxostoma rubreques (Hubbs)	— Hubbs and Brown 1929: 21

Etymology *Moxostoma* — sucking mouth; *valenciennesi* — after Achille Valenciennes, the famous French naturalist who first described this species on the basis of a specimen from Lake Ontario.

Common names Greater redhorse, common redhorse, redhorse. French common name: *suceur jaune.*

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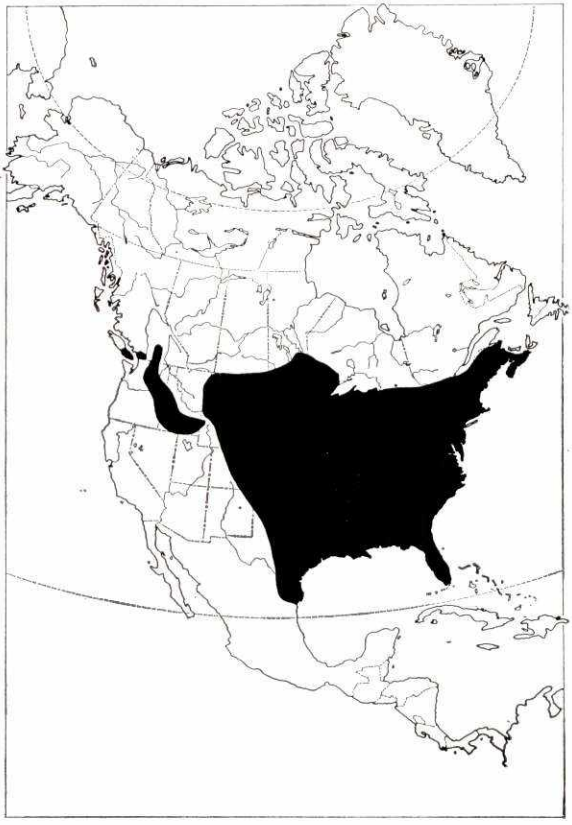
Catfish Family — Ictaluridae

Small to large fishes with the body naked and rotund forward, but laterally compressed beyond the dorsal fin. The head is large, flattened, and possessing several pairs of whisker-like barbels. Teeth of jaws and palatines are small and cardiform. Dorsal fin, with a serrate spine, forward and rounded; pectoral fins low and armed with a serrate spine; pelvic fins abdominal; anal fin long; caudal fin forked, square, or round; a free or an adnate, adipose fin present. The fin spines of some of the smaller madtoms equipped with a groove and venom sac.

Characteristic of temperate to subtropical larger rivers, lakes, and slow-moving waters of North America and Central America.

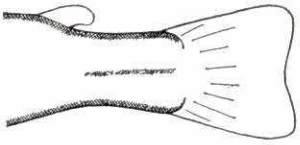
A family of about 5 genera and 25 species restricted to the New World. Known from the Miocene to Recent.

There are a number of fascinating characteristics associated with this family, such as: the intimate connection of the swim bladder with the Weberian ossicles and their role in the reception and production of sound; the role in orientation, schooling, breeding, and feeding of a highly developed sense of "taste" centred in sensory cells on the body and concentrated on the barbels (*see* Brown 1957a, b; Bardach et al. 1967; Kleerekoper 1969); the nocturnal habit; the problems of age analysis in scaleless fishes (*see* Lewis 1949; Sneed 1951; Appelget and Smith 1951; and Marzolf 1955); venom associated with the fin spines (*see* Reed 1907); and their major commercial, angling, and pond cultural value (*see* Kendall 1910; Maloy and Willoughby 1967; and Kennamer undated).



KEY TO SPECIES

1 Adipose fin short, fleshy, free at posterior end, obviously well separated from the caudal fin; tail round, squared, or forked; can be up to 24 inches (610 mm) in length 2



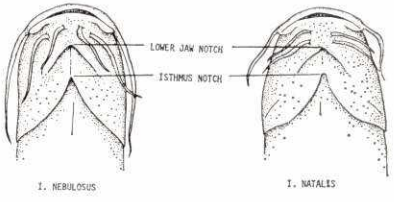
Adipose fin long, low, a simple, ridge-like extension of the caudal fin, with or without a notch marking point of connection; tail round or squared; never over 12 inches (305 mm) in length 5

2 Caudal fin deeply forked; obvious bony ridge connecting skull and origin of dorsal; barbels at corners of mouth more than 3 times as long as those near nostrils ..... CHANNEL CATFISH, *Ictalurus punctatus* (p. 604)

Caudal fin round, square, or slightly indented, never deeply forked; area between head and origin of dorsal compressible, no bony ridge; barbels at corners of mouth about twice as long as those near nostrils 3

3 Upper barbels grey to yellow, lower barbels yellow to white; depressed anal fin overlaps anterior rays of caudal fin; distance from isthmus notch to lower jaw notch much less than distance from lower jaw notch to tip of lower jaw ..... YELLOW BULLHEAD, *Ictalurus natalis* (p. 595)

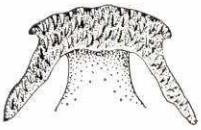
Upper and lower barbels dark brown to black; anal fin does not reach anterior rays of caudal fin; distance between isthmus and lower jaw notches almost equal to distance from lower jaw notch to tip of lower jaw 4



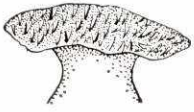
4 Barbs on trailing edge of pectoral spines strong, even near tip, and catch fingernail when moved toward tip; anal rays usually 21–24; dorsal interray membranes not noticeably darkened ..... BROWN BULLHEAD, *Ictalurus nebulosus* (p. 598)

Barbs on trailing edge of pectoral spines weak or absent, especially near tip; if present near base, barbs usually catch fingernail only when moved toward base; anal rays usually 17–21; dorsal interray membranes usually noticeably darkened ..... BLACK BULLHEAD, *Ictalurus melas* (p. 591)

5 Dorsal surface more or less flat to origin of adipose fin; greatest depth (at origin of dorsal fin), into body length (to base of caudal rays) over 6 times; strongly countershaded, dark above, yellow to white below, small, white to yellow spot at dorsal insertion; premaxillary tooth patch with lateral extensions; can be to 12 inches (305 mm) in length ..... STONECAT, *Noturus flavus* (p. 611)



Dorsal surface rises to obvious apex at dorsal origin, greatest depth into body length (to base of caudal rays) about 4 times; generally dark, or pale with dark saddles and bars; premaxillary tooth patch without lateral extensions; never over 6 inches (152 mm) in length 6

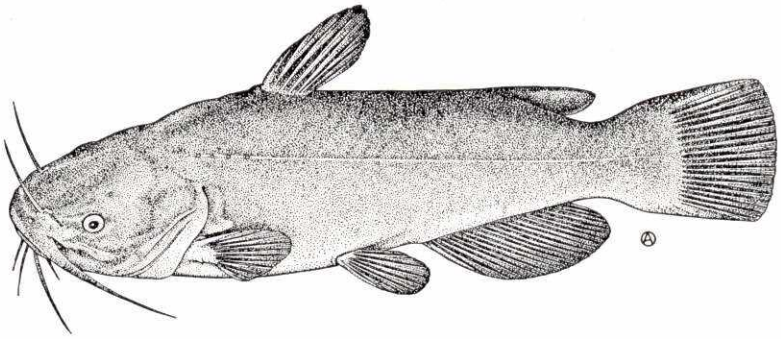


6 Body pale, conspicuously marked with dark saddles and bars; ventral surface white to yellowish; caudal fin outlined in black and white; very strong barbs on pectoral spines; dorsal spine about 66% of maximum height of dorsal fin ..... BRINDLED MADTOM, *Noturus miurus* (p. 619)

Body generally dark, ventral surface dusky, often 3 noticeable dark horizontal lines behind dorsal fin; myotomes often obvious; caudal fin dusky; no barbs on pectoral spines; dorsal spine not more than 50% maximum height of dorsal fin ..... TADPOLE MADTOM, *Noturus gyrinus* (p. 615)

BLACK BULLHEAD

Ictalurus melas (Rafinesque)



Description This smaller bullhead is usually only 5–7 inches (127–178 mm) in length. The following description is based on specimens from Manitoba and Saskatchewan. A rather massive body, heavy, rounded forward, somewhat potbellied, greatest depth at dorsal fin origin 19.2–23.6% of total length, angle from tip of snout to dorsal fin origin steep; body behind dorsal fin laterally compressed; caudal peduncle short, rather deep, depth 8.6–10.5% of total length. Head massive, long, its length 24.5–28.5% of total length, very wide, interorbital width 48.1–57.1% of head length, naked, rounded on top; eye small, its diameter 10.4–14.7% of head length, very round, slightly protruding; snout moderately long, 36.6–44.6% of head length, broad and shallowly rounded on top; paired nostrils on each side widely separated, the posterior one of each pair opening through expanded base of a moderately long, flattened snout barbel; mouth terminal, horizontal, short but wide, maxillary short, gape reaching only half way to eye, lips fleshy but not prominent, 1 pair of long, flattened maxillary barbels, the longest of 4 pairs of barbels, arise from upper lip at angle of mouth, reach opercular opening; fine, cardiform teeth in several irregular rows on dentary, premaxillary and on a rounded patch on the last pharyngobranchial; under surface of head very broad, flat, 2 pairs of barbels just behind lower jaw, inner pair shorter. Gill rakers moderately long, pointed, 14–20 in number, ranging from 10–14 on lower limb and 4–6 on the upper limb, widely spaced. Branchiostegal rays usually 8 or 9 on each side. Fins: dorsal 1, ahead of midpoint of body, snout to dorsal origin 32.4–35.1% of total length, soft rayed but first is a stout spine (modified soft ray), spine equal to or less than ½ height of fin, spine curved slightly, barbs on posterior edge very weak or absent, height of fin at least twice length of base, which is 6.8–9.2% of total length, edge of fin rounded, one spine and 5 or 6 soft rays; adipose long, fleshy, little turned up, free at posterior end but attached for much of its length, fin length 12.2–20.4% of total length; caudal with expanded base, but only moderately broad, posterior margin truncate to emarginate; anal base long, 12.2–20.4% of total length, greatest height almost equal to base length, posterior edge rounded, 15–19 rays (not including 2 anterior rudiments); pelvics abdominal, low, origin behind insertion of dorsal fin, broad, rounded, tips overlapping origin of anal fin in males, usually 8 rays; pectorals rather high, broad, rounded, anterior heavy spine about ½ length

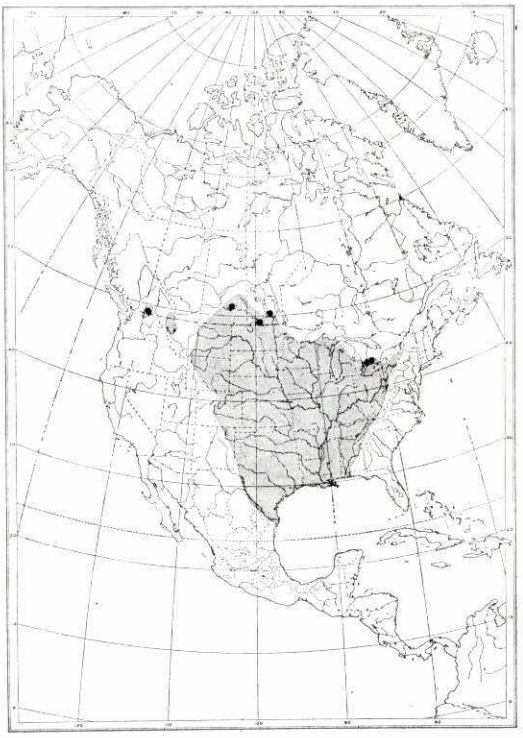
of fin, barbs on posterior surface of spine absent or extremely weak, one spine and 8 soft rays; skin truly naked but well supplied with "taste" receptors, no scales on any part of body; lateral line complete, almost straight and at midpoint of body. Peritoneum heavily speckled with black, intestine well differentiated, coiled, no pyloric caeca. Swim bladder silvery, with thick walls. Vertebrae usually 34 or 35, plus Weberian ossicles.

No nuptial tubercles.

Colour Dorsal surface of head, body and upper sides dark brown, olive to black, sides a lustrous green to gold, ventral surface yellow, muddy white to milk-white, extending up at base of caudal fin as a pale bar; barbels grey, black, or black spotted; dorsal, caudal, and paired fins dusky with black edges and dark black interray membranes contrasting with lighter rays. Anal fin with basal third lighter, membranes of distal third black, giving a bicoloured appearance. Sides beyond dorsal fin show dark vertically angled lines which are separations between muscle blocks. Spawning males jet black with bright yellow or white belly; young black with white belly.

Systematic notes This species is often considered as consisting of two subspecies, the northern black bullhead *I. m. melas*, which would be the form in Canada, and *I. m. catulus* in the Gulf states and northern Mexico.

Distribution This species is restricted to the fresh waters of North America. The northeastern limit of the black bullhead would appear to be St. Lawrence River tributaries in New York in the vicinity of the Oswegatchie River. Its range extends south along the southern shore of Lake Ontario, west of the mountains to the Tennessee River and Mobile Bay drainages in Alabama, west through the Gulf states, through Texas and extreme northern Mexico, north through the eastern parts of the states from New Mexico to Montana, and to Saskatchewan, east



through Manitoba, through the Great Lakes states below Lake Superior at the level of Green Bay, Lake Michigan, to extreme southwestern Ontario. Introduced widely elsewhere including Connecticut, California, Arizona, and Washington State. The introductions in the Columbia River in Washington, resulted in natural spread to Oregon, Idaho (?), and British Columbia.

In Canada, the native range of the black bullhead is limited to Lake Erie and its western tributaries and the Qu'Appelle–Souris–Assiniboine systems in southern Saskatchewan and Manitoba. It is present in Osoyoos Lake (Okanagan–Columbia system), British Columbia, probably as a natural immigrant resulting from introductions in the Columbia River in Washington State.

This species is rare in Canada and the ROM research collection contains no representatives from Ontario. This is strange considering an apparent increase in numbers in Ohio and areas to the south. When small, it is difficult to separate this species from *I. nebulosus*. This, and the fact that young

brown bullheads (1–4 inches or 25–102 mm) are pitch black have resulted in many misidentifications and erroneous distribution records, such as that of Meek and Clarke (1902) for Gull and Muskoka lakes, Ont., and that of Evermann and Latimer (1910) for Lake of the Woods, Ont.

Biology Nothing is known of the biology of this species in Canada. The black bullhead is usually considered a spring spawner, and the time most often quoted is May and June, or when the water temperature reaches 69.8° F (21° C). However, spawning time must be longer since in one year in Iowa (Forney 1955) the first spent female was taken June 26, the first young were taken July 7 and the last ripe female was captured August 6. Forney estimated peak of spawning activity as early July. Spawning takes place in areas of moderate to heavy submerged vegetation. In shallow water, the female excavates a nest, the diameter of which is approximately equal to her length, by pushing away gravel and fanning away silt and debris. Prior to spawning, the pair butt one another, and each slides its barbels over the body of the other. Egg deposition follows a head to tail clasping in which the caudal fin of the male is wrapped around the head of the female (Wallace 1967). Intermittent spawning acts, as many as five in an hour, alternate with periods when the female fans, with her fins, those eggs already laid. After the first day both sexes fan and guard the mass of eggs. Usually about 200 eggs are laid but the ovaries contain 3000–4000 prior to spawning. Other estimates from Iowa ran as high as 6820 eggs. The eggs are covered with a gelatinous coat, are somewhat adhesive, pale cream in colour, and about 3 mm in diameter. When temperatures are high, eggs hatch in as little as 5 days. Newly hatched young school in a loose sphere and associate closely with a guarding parent for several weeks. Soon after the size of the young exceeds 1 inch (25 mm) the parents abandon them. The reactions involved in this schooling and association were described in detail by Bowen (1931, 1932).

Growth of the young is highly variable but in a year of fast growth in Iowa mean total length increased during the period from July 1 to August 20, from 1.07 to 3.0 inches (26–76 mm).

The following relation between age (as calculated by soft fin ray sections) and total length for a North Dakota population is from Carlander 1969:

Age	Total length	
	(inches)	*(mm)*
0 (Aug.)	3.0	76
1	4.3–4.6	109–117
2	4.5–6.7	114–170
3	7.4–10.2	188–259
4	10.1–12.4	257–315

Growth is extremely variable year to year, and place to place. Stunting occurs. A maximum size of 12.4 inches (315 mm) at age 4 is indicated. However, ages 8 and 9 are also quoted for this species in Iowa at total lengths between 10.4–13.8 inches (264–351 mm). The largest black bullhead listed by Carlander was 14.9 inches (378 mm) in length and possibly weighed 2 pounds. Trautman (1957) listed maximum size as 16.8 inches (427 mm) in length and a weight of 12 pounds 2 ounces, but said adults were usually 4.5–12.0 inches (144–305 mm) in length and weighed 1–15 ounces. Walden (1964) mentioned a sporting-tackle record fish of 24 inches (610 mm), 8 pounds weight, from Lake Waccabuc, N.Y., in 1951. Scott (1967) reported that Ontario specimens averaged less than 8 inches (203 mm) in length.

The habitat of this species is usually considered to be lower sections of small- to medium-sized streams of low gradient, ponds, and backwaters of larger rivers and silty, soft-bottomed areas of lakes or impoundments. It does not inhabit the areas in which brown and yellow bullheads usually occur but seems to replace those species there if the habitat deteriorates. The black bullhead is apparently also more tolerant of pollutants than the other two species. This species can withstand extremely high water temperatures. Upper lethal temperature of individuals acclimated at 73.4° F (23° C) was 95° F (35° C),

(Black 1953). Contrary to many species, this fish is apparently increasing in number and in area occupied in the northern United States but would still appear to be rare in Canada.

The adults of this species, like those of other bullheads, are almost entirely nocturnal. The young apparently feed most actively just before dawn and again just after dark, the adults during the night. Activity was described in detail by Darnell and Meierotto (1965). Food is sought along the bottom by means of the tastebuds on the barbels and possibly those on the body. The usual items of food are immature insects, clams, snails, crustaceans, plant material, leeches, and fishes. Immature insects and molluscs alternate dominance from place to place and from time to time. Fishes are of minor importance but common shiners and perch have been reported. The young eat immature insects, crustaceans, and leeches.

Predation on the black bullhead, even as young, is apparently very low. This may result in part from their habitat, the type of fishes associated with them there, and protection afforded by the spines and nocturnal habit.

The black bullhead is a competitor of sunfishes and some other bottom feeders but utilizes molluscs which many of the other species do not.

Parasites listed by Hoffman (1967) were: Protozoa (5), Trematoda (28), Cestoda (5), Nematoda (8), Acanthocephala (3), leeches (4), Crustacea (7).

This species hybridizes with the brown bullhead in Ohio waters of Lake Erie.

Relation to man This species is presently of little or no importance to man in Canada. It probably makes up a small proportion of the commercial fishes marketed as catfish or bullheads in the United States. Greeley (1929) quoted Fowler as saying they were abundant in Lake Erie, and were frequently marketed in and around Erie, Pa. This species is an important sport fish in all of the midwest states of the United States. It also is a good farm pond species there and if fed daily grows to 6 inches and 1 pound weight in a year and will easily yield 200 pounds of fish per acre. The flesh is said to be tastier than that of the brown bullhead.

Nomenclature

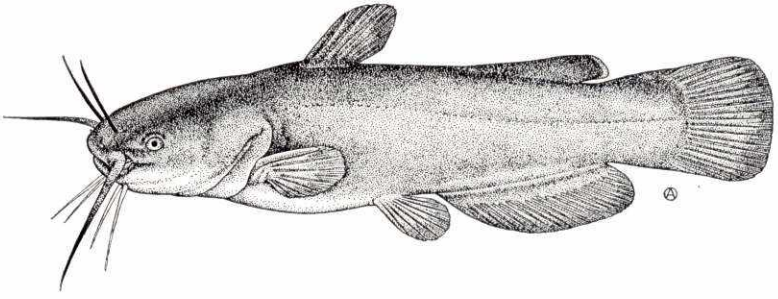
Silurus Melas	— Rafinesque 1820d: 51 (type locality Ohio River)
Ameiurus melas (Rafinesque)	— Jordan and Evermann 1896–1900: 141
? *Ameiurus vulgaris*	— Thompson 1898: 214
Ameiurus melas melas (Rafinesque)	— Hubbs and Brown 1929: 42
Ictalurus melas melas (Rafinesque)	— Taylor 1954: 44

Etymology *Ictalurus* — fish-cat; *melas* — black.

Common names Black bullhead, black catfish, yellow belly bullhead, hornedpout. French common name: *barbotte noir*.

YELLOW BULLHEAD

Ictalurus natalis (Lesueur)



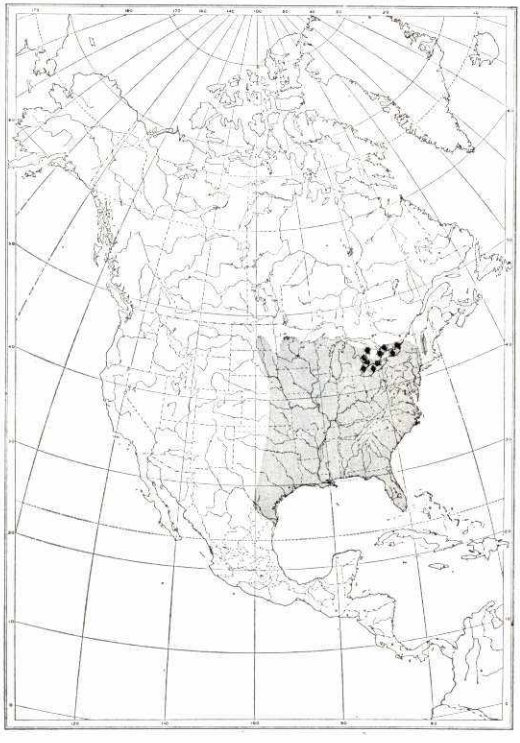
Description This is a medium-sized fish, usually 8–12 inches (203–305 mm) in length. It has a more rotund, robust body than the brown bullhead, greatest body depth, at dorsal fin origin, 19.2–25.1% of total length, laterally compressed behind the anal fin; caudal peduncle short and deep, depth 10.0–11.9% of total length. Head heavy, long, its length 22.1–27.1% of total length, very wide, interorbital width 38.2–54.9% of head length, naked, rounded on top; eye small, its diameter 9.4–20.5% of head length, round, protruding; snout moderately long, 36.2–43.4% of head length, broad and rounded, paired nostrils widely separated, posterior pair opening through expanded base of long snout barbels; mouth terminal, moderately long, and wide, gape reaching almost to eye; upper jaw slightly longer than lower; lips thick but not prominent; 1 pair of flattened maxillary barbels, the longest of the 4 pairs of barbels, reach to or just past end of operculum; fine, cardiform teeth in an oval pad on premaxillary, in several rows on lower jaw and on 2 pairs of rounded patches on the last pharyngobranchial bones; undersurface of head broad, flat, with 2 pairs of white to pale yellow barbels, inner pair shorter. Gill rakers moderately long, well spaced, 14–16 in number (usually 10+4). Branchiostegal rays usually 8 or 9. Fins: dorsal 1, ahead of midpoint of body (snout to dorsal origin is 29.1–34.4% of total length), soft rayed with first modified ray a stout spine, spine about $\frac{3}{4}$ height of fin, spine straight, barbs on posterior edge very weak, height of fin longer than base which is 6.8–8.7% of total length, edge of fin a rounded point, 1 spine and 6 soft rays; adipose long, fleshy, little turned up, free length equal to or greater than base, fin length 10.3–15.9% of total length; caudal rounded, with broad base; anal base long, 20.2–27.4% of total length, depressed fin touches or overlaps base of caudal fin, greatest height just over $\frac{1}{2}$ base length, rounded, but anterior and posterior rays almost equal in length, rays (not counting 2 anterior rudiments) for 22 specimens from 10 localities, 22(8), 23(5), 24(7), 25(2); pelvics abdominal, low, overlapping base of anal fin in some, 8 rays; pectorals broad,

rounded, spine more than $\frac{1}{2}$ length of fin, barbs on posterior edge of spine strong in young, weaker in large individuals, 1 spine and 7 or 8 soft rays, almost always 8; skin naked and supposedly thinner than that of the black and brown bullheads, no scales on any part of body; lateral line complete, nearly straight, at midpoint of body. Peritoneum grey, not heavily speckled. Intestine well differentiated, coiled, no pyloric caeca. Swim

bladder heartshaped, silvery, with thick walls. Vertebrae usually 38 plus Weberian ossicles.

Colour Back, top of head, and upper sides olive through brown to almost black depending on habitat, sides lighter, yellow-brown to yellow, never mottled, ventral surface from chin to pelvic fins yellow to white; upper barbels light to dark brown, chin barbels yellow through buff to pale pink, no black pigment or spots on barbels; fins dusky to pale brown, some pigment on membranes, bases darker, anal fin sometimes with vague dark bar through centre, tip of adipose sometimes pale. Young usually dark brown to black, with white under head and belly, lower barbels white.

Systematic notes Radforth (1944) suggested Canadian populations represent postglacial entry from the Mississippi River and from the eastern seaboard. There is little in the present morphological data to strengthen this idea other than a slight tendency toward one more anal ray in the Lake Erie area, 22(5), 23(2), 24(3), 25(2), as compared with the St. Lawrence River area, 22(3), 23(3), 24(4). However, available material is insufficient for a definite decision. Anal ray numbers were rechecked by dissection and x-ray since 26 or more (counting rudiments ?) is often used as a distinguishing characteristic for this species in the United States. Also some of the material reported in Hubbs and Brown (1929) from Dedrick's Creek, near Port Rowan, Ont., was re-examined in 1952 and said to have "long anal fins which, without dissection, have at least 26 rays." None of the Canadian material presently examined, including another collection from near Port Rowan, had more than 25 rays (not counting 2 anterior rudiments, visible only by dissection or x-ray). This species is often considered to consist of two subspecies, *I. n. natalis* in the Great Lakes and Mississippi River watersheds, *I. n. erebennus* coastwise from New Jersey to Florida and west to Alabama. The yellow bullhead is frequently mistaken in Canada for the commoner and more generally distributed brown bullhead.



Distribution The yellow bullhead is restricted to the fresh waters of eastern and central North America. It occurs from the Connecticut River in New Hampshire (introduced) south along the coast to Florida, west through the Gulf states to southern Texas and northern Mexico, north through the eastern half of the states from Oklahoma to North Dakota, east across central Minnesota to southern Lake Huron, through extreme southern Ontario and into New York. Introduced in California and probably elsewhere.

In Canada it occurs only in Ontario. Its range there extends from the extreme Upper St. Lawrence River and its tributaries, including the Gananoque and the Rideau River systems (more common), lakes Ontario (rare), Erie, St. Clair, and Huron (south), and their tributaries. It may be more abundant and more generally distributed in eastern Ontario than in southwest Ontario. The species is poorly represented in research collections and should be watched for during fishing activities.

The first record of this species in Canada

is probably that of Reighard (1894) for Lake St. Clair.

Biology There is virtually no published information on this species in Canada other than notes by Toner (1937, 1943) and Curran et al. (1947). Other than age and growth data, very little is available from anywhere and much of the following was taken from Carlander (1969). Spawning takes place in the spring for a period of about 2 weeks, usually in late May to early June, possibly earlier than other bullheads in the same area. One or both sexes build a nest varying from the usual shallow depression to a burrow 2 feet deep, often under a stream bank or near the protection of stones or stumps. Batches of creamy white, glutinous eggs, usually 300–700, are laid and fertilized during a spawning clasp. Total egg number has been calculated at 1652–4270 in females 6 ounces to 1 pound 4 ounces in weight (approximately 9–13 inches or 230–330 mm in length). Eggs hatch in 5–10 days. The male guards the nest and the brood of young until they are about 2 inches (51 mm) in length. Fish (1932) and Mansuetti and Hardy (1967) gave details of the early development of young. Young-of-the-year in October in Ohio are usually 2.0–3.5 inches (51–89 mm) in length, and growth in Michigan during the first month was 0.6 mm per day. The following age–total length, and length–weight relations (a composite of several northern United States populations), give a crude approximation for Canadian populations.

Age	Total length		Wt
	(*inches*)	(*mm*)	(*oz*)
1	1.2–2.6	30–66	0.06
2	7.1–9.6	180–244	3.58–5.75
3	7.6–10.8	193–274	3.58–10.05
4	8.9–11.6	226–295	5.75–12.20

The above data are taken from the following sources: Length and weight, age 1, from Carlander (1969); length, ages 2, 3, 4, for Wisconsin, from Carlander (1969); weight, ages 2, 3, 4, for Ohio, from Langlois (1936).

Trautman (1957) said that average size of adults was 5.5–15.0 inches (140–381 mm) length, and 2 ounces to 2 pounds weight. Scott (1967) said they attain an average size of $\frac{1}{2}$–1 pound in Ontario. Trautman cited the largest specimen as 18.3 inches (465 mm) and 3 pounds 10 ounces. Maximum age would appear to be 6 or 7 years. Sexual maturity is probably attained at 2–3 years of age.

The habitat of the yellow bullhead is usually in areas of very heavy aquatic vegetation in shallow, clear-water parts of bays of lakes, small shallow lakes, ponds, and slow-moving streams, with various bottom types from muck to gravel. This species is apparently more capable of withstanding adverse conditions than black or brown bullheads but removal of stumps, logs, or vegetation leads to a decrease in number.

This species consumes a wide variety of food which it searches out along the bottom at night, largely with its barbels. It is considered a scavenger. Food ranges from offal crustaceans (from entomostracans to crayfish), immature aquatic insects, molluscs and, to a minor degree, fishes.

Catfishes are in general afforded some protection against predation by their nocturnal habit, their spines, and their discriminant senses of taste and olfaction (Todd et al. 1967). Catfishes have, however, been recorded in the stomach contents of basses, walleyes, other catfishes, snapping turtles, water snakes, and as the host of lampreys. The yellow bullhead has been recorded from the stomach of a moccasin, *Agkistrodon piscivorus*, by Yerger (1953).

This species probably competes indirectly with a number of other bottom feeders. Catfishes are often accused of being heavy predators on the eggs of other, more valuable, species, but this would appear to be untrue.

The parasites of this species were listed by Hoffman (1967) as follows: trematodes (21), cestodes (6), nematodes (7), acanthocephalans (3), leeches (1), molluscs (1), crustaceans (5), and linguatulans (1).

Relation to man In certain areas of the United States the yellow bullhead may make up a small portion of those species marketed simply as bullheads. It is unlikely that they

do so in Canada. They are taken by anglers in the United States using live bait. Anglers in eastern Ontario probably take them at times thinking they are the much commoner brown bullhead. The flesh is whiter than that of the brown bullhead and is delicious.

Nomenclature

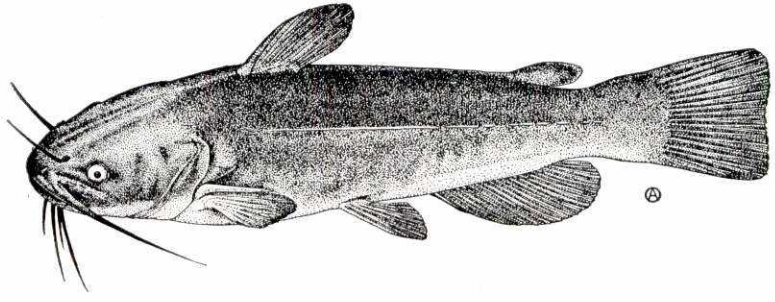
Pimelodus natalis	— LeSueur 1819: 154 (type locality North America)
? *Silurus (Pimelodus) coenosus* (Richardson)	— Richardson 1836: 132
? *Pimelodus coenosus* Richardson	— D'Urban 1859: 270
Amiurus natalis	— Günther 1864: 101
Ameiurus natalis (LeSueur)	— Reighard 1894: 21
Ictalurus natalis (LeSueur)	— Taylor 1954: 44

Etymology *Ictalurus* — fish cat; *natalis* — having large nates or buttocks.

Common names Yellow bullhead, northern yellow bullhead, yellow catfish, bullhead. French common name: *barbotte jaune*.

BROWN BULLHEAD

Ictalurus nebulosus (Lesueur)



Description This moderate-sized bullhead is usually 8–14 inches (203–356 mm) long. In the following description percentages are for populations from New Brunswick to Ontario only but meristics include, where possible, specimens as far west as British Columbia. Body massive, rounded, and heavy forward, usually less potbellied than yellow bullhead, greatest body depth at origin of dorsal fin, 17.7–26.3% of total length; angle from tip of snout to origin of dorsal fin less steep; body behind dorsal fin laterally compressed; caudal peduncle moderately deep, depth 8.1–9.9% of total length, and long.

Head massive, moderately long, its length 22.6–26.3% of total length, very wide, interorbital width 45.2–53.2% of head length, head naked, shallowly rounded to slightly concave on top; eye small but at times larger than eye of yellow bullhead, diameter 10.0–18.7% of head length, round, slightly protruding; snout moderately long, 35.6–44.2% of head length, broad, shallowly rounded; paired nostrils widely separated, posterior one of each pair opening through base of moderately long, flattened snout barbel; mouth terminal but upper jaw slightly longer than lower jaw, mouth horizontal, not long but wide, maxillary not long, gape extending to posterior nostril, lips fleshy but not prominent; 1 pair of long flattened maxillary barbels, the longest of 4 pairs of barbels, reaching to end of operculum or base of pectoral fin; fine, cardiform teeth in several irregular rows on lower jaw, premaxillary, and on 2 pairs of rounded patches on the last pharyngobranchials; undersurface of head very broad, flat, with 2 pairs of rather heavy, flattened barbels, inner pair shorter. Gill rakers moderately long, pointed, usually 9 on upper limb and 4 or 5 on lower limb, widely spaced. Branchiostegal rays usually 9, 9, but can be 8, 8 or several unequal combinations from 8 to 10 on each side. Fins: dorsal 1, ahead of midpoint of body, snout to dorsal origin 30.4–34.3% of total length, soft rayed but first is a stout spine (modified soft ray), spines in dorsal and pectorals can be "locked" in erect position by an interesting arrangement of bones and muscles, spine a little more than $\frac{1}{2}$ height of fin, slightly curved barbs on posterior surface very weak or absent, height of fin about twice base length which is 6.6–9.3% of total length, edge of fin rounded, almost always 1 spine and 6(57) soft rays, but rarely 1 spine and 7(1) soft rays; adipose long, fleshy, somewhat curved upward, free length usually exceeds base, fin length 10.7–14.7% of total length; caudal with squarish expanded base, moderately broad, edge truncate to emarginate, tips never pointed, principal (or segmented) rays usually 23(14) but sometimes 22(3); anal base long, 17.5–20.7% of total length, greatest height just over $\frac{1}{2}$ base length, rounded but middle rays longer than posterior rays, rays 18(21), 19(6), 20(29), or 21(3), (not including 2 anterior rudiments); pelvics abdominal, low, origin behind dorsal insertion, broad, rounded, tips not overlapping origin of anal, 8 rays; pectorals rather high, broad, rounded, anterior heavy spine almost

as long as fin, barbs (usually 4–8) large, recurved, rays usually 8 but sometimes 7(2) or 9(7). Skin truly naked of scales but well supplied with taste glands; lateral line complete, almost straight and at midpoint of body. Peritoneum silvery to grey, not noticeably speckled with black; intestine well differentiated, coiled, no pyloric caeca. Heart-shaped swim bladder silvery with thick walls. Vertebrae usually 34–39 plus Weberian ossicles.

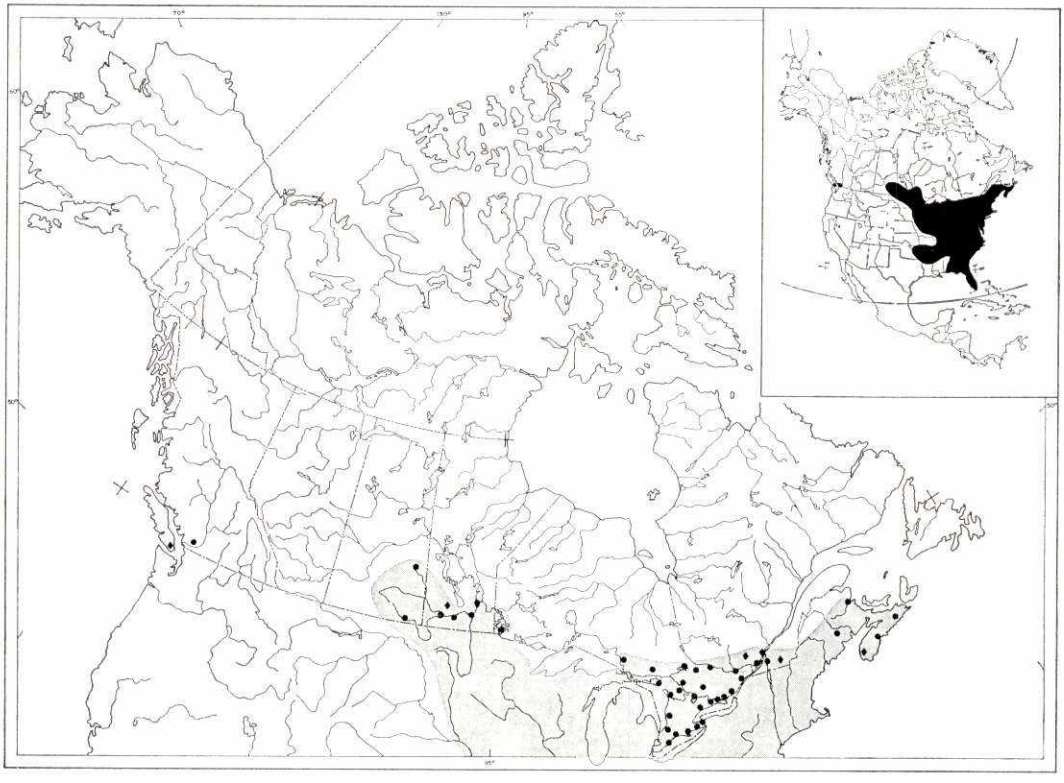
No nuptial tubercles.

Colour Dorsal surface of head and body and upper sides yellow-brown, olive, grey to almost blue-black, sides of lighter-coloured individuals often mottled with vague brown blotches, lower sides over pelvic fins dirty white, undersurface of body ahead of pelvic fins pale yellow to white; all barbels dark brown to nearly black, except sometimes base of chin barbels pale yellow to white; fins same colour as body but paler, some darker pigment on ray membranes.

The chromatophore system of this species and the effect of habitat on colour have been extensively studied (*see* Rasquin 1949).

Systematic notes The brown bullhead is often considered as two subspecies – *I. n. nebulosus*, in Canada and south in the United States to a line northwestward from Virginia, through the northern part of the Ohio valley, to North Dakota, and *I. n. marmoratus*, the form occurring to the south (Hubbs and Lagler 1958).

The only meristic trends suggested in the limited Canadian material examined are



fewer vertebrae in the west (34 or 35) as compared to Ontario and east (36–39); and for pectoral rays to be lower (7 or 8) northward to the east, and west of southern Ontario (8 or 9). Much more data would be required to verify these suggested trends.

Distribution The native distribution of this species is restricted to the fresh waters and, rarely, brackish waters of eastern and central North America. It occurs from the Maritime Provinces of Canada south along the coast to Florida, west to central Alabama, northern Mississippi and Louisiana, to eastern Texas and Oklahoma, northeast through the states from eastern Missouri to central North Dakota (rare) and to southern Saskatchewan, east through southern Manitoba, south of Lake Superior, and across Ontario and Quebec at about the level of Lake Nipissing. It has been extensively introduced westward including Idaho and California. It was released in Germany in the early 1900's and has been widely moved from there to England, many European countries, and the USSR.

In Canada it occurs from the mainland of Nova Scotia, through New Brunswick, the southern tip of Quebec, north to Mattawa but primarily in the eastern townships, across southern Ontario at the level of Lake Nipissing, to the south shore of Lake Superior, and again in the Lake of the Woods area, west through southern Manitoba and as far west as the Whitesand–Assiniboine system of southeast Saskatchewan. It occurs also, as a result of introductions, in British Columbia in the lower Fraser River and in several lakes on lower Vancouver Island, between Victoria and Nanaimo.

The brown bullhead is primarily a freshwater fish but McKenzie (1959) recorded it from 40 feet deep in water of a salinity between 8 and 15‰, in the estuary of the Miramichi River, N.B.

Biology The brown bullhead is another of the species well represented in Canada for which there is no detailed life history information. *See* Emig (1966) and Carlander (1969) for summaries of life history information.

A great deal has been written on the breeding and brood-guarding habits of this species, possibly beginning with Eycleshymer in 1901, and was largely summarized by Breder and Rosen (1966).

The brown bullhead spawns in the late spring and summer, probably May and June in Canada, when water temperature reaches 70° F (21.1° C). In the south, spawning may continue through September and individuals may spawn more than once in one year. One or both sexes clear a shallow nest, the diameter of which is just in excess of body length, in a bottom of mud or sand or among the roots of aquatic vegetation, usually near the protection of a stump, rock, or tree. At times nest burrows are built. Brown bullheads will also nest under boards, in hollow stumps, and even inside automobile tires nailed on docks as boat fenders. The water over these nesting sites can be as shallow as 6 inches (152 mm) or as deep as several feet and the nests are usually found around the shores of lakes, or in coves, bays, or creek mouths.

Spawning apparently takes place in the daytime. The male and female caress one another with their barbels, circle about the nest or remain quietly over it. Eventually they settle over the nest, bodies in contact, but facing in opposite directions, and spawning takes place. No mating clasp is mentioned for this species. A large number of spawning acts take place with an increasing number of eggs released at each. Sometimes one or both parents eat some or all of the eggs. The eggs are pale cream in colour, coated with a gelatinous mucus, adhesive and about 3 mm in diameter. Females from 8–13 inches (203–230 mm) length may have from 2000–13,000 eggs in the ovaries. The eggs in the nest are cared for by one or both parents. They are fanned with the paired fins, moved, stirred with the barbels and fin spines, and at times picked up in the mouth and ejected. This fanning and manipulation is necessary, possibly as a result of the gelatinous coat on the eggs, as bullhead eggs will not hatch without it, even in water with more than adequate oxygen. Eggs take 6–9 days to hatch at 69°–74° F (20.6°–23.3° C). Fish (1932) and Mansueti and Hardy (1967) gave details of egg, larval, and juvenile development. At hatching the young are about 6 mm in length, yellow, and somewhat transparent but begin to darken on the second day. The yolk sac is too large to enable them to swim and they lie on their sides in the nest until about the seventh day. They then begin to swim and feed actively. The young, whose shape and pitch-black colour make them resemble tadpoles, are shepherded about for several weeks in a loose sphere by one or both of the parents until they are about 2 inches (51 mm) in length. Then the guarding and the school break down and the individuals disperse. Two individual broods in Lake Danford, Que., were netted and counted. They contained 610 and 778 young.

Growth is moderately rapid and by October the young in Ohio are 2.0–4.8 inches (51–122 mm) in length. There are no published age–length relations for Canadian populations, but those given below for Little Lake Butte des Mortes in northern Wisconsin (Priegel 1966) may approximate those of Canadian populations.

Age	Mean TL	
	(*inches*)	(*mm*)
2	6.0	152
3	7.6	193
4	9.5	241
5	10.5	267

The weight–metric fork length regression for Lake Jesse, N.S., was given by Smith (1939) as log W= −5.166+3.125 log FL and specimens were 3.2–9.3 inches (81–237 mm) fork length and an average weight of about 3 ounces. Langlois (1936) gave weight in Ohio fish ponds as varying from 0.01–38.75 ounces for fish from 0.8–16.9 inches (22–431 mm) total length. The greatest number of individuals were between 9.9 and 11.8 inches (252–301 mm) long and weighed 8.3–12.9 ounces.

Sexual maturity is usually attained by age 3 by females 8–13 inches (203–330 mm) in length, and males slightly smaller. Maximum age would appear to be 6–8 years. In Canada adults are usually 8–14 inches (203–356 mm) in total length and weigh ¾–1 pound. Trautman (1957) listed maximum size in Ohio as 18.8 inches (478 mm) and 3 pounds 14 ounces weight. However, Carlander (1969) cited individuals as large as 20.9 inches (532 mm) in Florida. They have been reported by anglers as large as 6–8 pounds in the Napanee River, Ont. In unsuitable habitats, such as cold elevated lakes, they grow poorly and stunted populations result.

Brown bullheads usually occur near or on the bottom in shallow, warmwater situations, in ponds, small lakes, shallow bays of larger lakes, and larger, slow-moving streams with abundant aquatic vegetation, and sand to mud bottoms. They are sometimes found as deep as 40 feet. They are very tolerant of conditions of temperature, oxygen, and pollution which might be limiting for other species. They can survive temperatures as high as 97° F (36.1° C). Their upper lethal temperature, under experimental conditions, varied from 83.5°–99.5° F (28.6°–37.5° C), with acclimation temperatures from 42.8°–96.8° F (6°–36° C). They survive high carbon dioxide and low oxygen concentrations. In winter, they can live at 0.2 ppm oxygen. As a result of this tolerance and their bottom habit, they are most difficult to eradicate chemically. It has been reported that they burrow into the bottom mud to avoid adverse conditions. They seem particularly resistant to domestic and industrial pollution as in many heavily polluted streams near Montreal they were the only species present.

This species, like the other bullheads, feeds on or near the bottom, mainly at night, and food is searched out largely by means of the barbels, and by the senses of "taste" and "smell". The adults are truly omnivorous in that their food is composed of offal, waste, molluscs, immature insects, terrestrial insects, leeches, crustaceans (crayfish and plankton), worms, algae, plant material, fishes, and fish eggs. The young (30–60 mm) feed primarily on chironomid larvae, cladocerans, ostracods, amphipods, bugs, and mayflies. As they increase in size, cladocerans are replaced by an increase in hemipterans and ostracods and by newly hatched fishes (Keast and Webb 1966), but small fishes and eggs are taken at times. *See* Raney and Webster (1940) for a detailed analysis of food of young in New York.

Brown bullheads, especially the young, are apparently eaten by a variety of predatory fishes, at times out of proportion to their numbers relative to other available forage fishes. Species listed as predators are chain pickerel, northern pike, muskellunge, walleye, and sauger. This predation probably takes smaller fishes for which the spines do not provide maximum protection. Individuals of various species, including a muskellunge, have been reported with the spines of a consumed bullhead protruding through the body to the exterior, the wounds healing around the spines, and the predator still apparently healthy. The protective and survival value of the spines to individuals and to the species might be in doubt.

Brown bullheads probably compete quantitatively for bottom organisms with a wide variety of fishes. Their nocturnal feeding habits, and their tactile searching makes the competition indirect but no less effective. This species has definitely been reported to have eaten the eggs of at least cisco, herring, and lake trout. However, many authors feel they are not egg predators to the extent that it has been assumed. Martin (1957) said that brown bullheads were the chief predators on lake trout eggs in the lakes of Algonquin Park, Ont. He mentioned having seen hundreds feeding on lake trout eggs in one lake. This was, however, "when low lake levels had forced the trout to spawn on rubble," an apparently unsatisfactory situation "which offered little protection to the eggs."

The parasites of this species, from various localities in Canada, have been listed by Bangham and his coauthors (1936, 1939, 1940, 1941, 1946, 1954, 1955). The summary list given by Hoffman (1967) is as follows: Protozoa (4), Trematoda (36), Cestoda (8), Nematoda (16), Acanthocephala (8), leeches (5), Mollusca (1),

Crustacea (9). Ali and Hanyu (1964) reported the development of double and triple lenses in the eyes of brown bullheads in Quebec, possibly resulting from the presence of an eye fluke, *Diplostomum* sp.

Brown bullheads hybridize with black bullheads in Lake Erie and other localities where they occur together in habitats marginal to one or both species.

Relation to man This species is not one of the more popular freshwater fishes in Canada. Some people even claim their appearance to be distasteful. In spite of this it is a species of some considerable commercial and recreational importance. The flesh is firm, reddish to pink in colour, and delicious cooked in a variety of ways or hot-smoked. Brown bullheads readily take a variety of live or dead natural bait or doughballs, and are rather easily caught, sometimes in large numbers. This species is not covered by season, size, or bag limit regulations and it often provides the angler with enjoyment and food prior to the opening of the season for more favoured sport fish. Best angling success is usually obtained by still fishing with worms or minnows usually just as darkness falls.

They are a very suitable pond culture species and to the south yield very high production. Standing crops have been calculated as high as 486.6 fish per acre or 132 pounds per acre in California. The only available standing crop figures for natural waters in Canada are those of Smith (1938, 1939) for Nova Scotia lakes. These ranged from 6.7–38.0 fish per acre and up to 5.5 pounds per acre. Some shallow areas of Ontario lakes must produce much more than this.

The commercial catch in Canada is mostly in Ontario where they are marketed simply as bullheads. Some yellow bullheads may enter into the catch but they would be negligible compared to the contribution of brown bullheads. The commercial catch in Ontario in 1966 was 347,721 pounds with a value of $59,734.66. The catch came, in descending order of contribution, from southern inland lakes, Lake Ontario, northern inland lakes, Lake St. Clair, and Lake Erie. The Bay of Quinte (Lake Ontario), St. Lawrence River and Rideau Lakes areas are the major commercial grounds. The catch and value have been higher in some past years.

Nomenclature

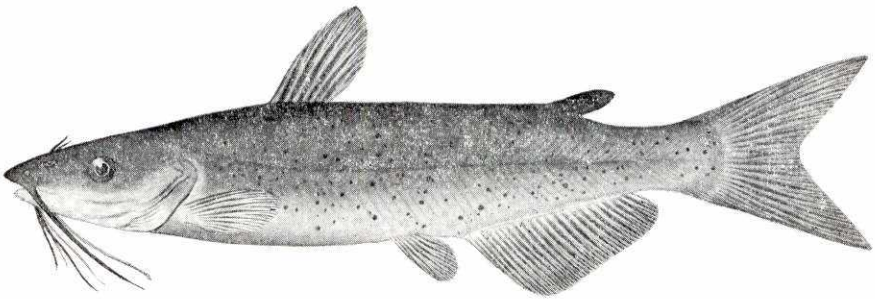
Pimelodus nebulosus	— LeSueur 1819: 149 (type locality Delaware River at Philadelphia, Pa., although often given as Lake Ontario)
? *Silurus Felis* ?	— Richardson 1823: 723
Silurus (Pimelodus) coenosus (Richardson)	— Richardson 1836: 132
? *Silurus (Pimelodus) nigrescens* (LeSueur)	— Richardson 1836: 134
Pimelodus vulgaris	— Thompson 1842: 138
Pimelodus felis	— Agassiz 1850: 281
Pimelodus catus	— Perley 1852: 195
Pimelodus atrarius	— Small 1865: 27
Amiurus nebulosus LeSueur	— Wright 1892: 429
Amiurus vulgaris	— Wright 1892: 442
Amiurus catus Gill	— Cox 1896b: 64
Ameiurus lacustris (Walbaum)	— Evermann and Goldsborough 1907a: 92
Ameiurus vulgaris (Thompson)	— Evermann and Goldsborough 1907a: 92
Ameiurus nebulosus (LeSueur)	— Evermann and Goldsborough 1907a: 92
Ictalurus nebulosus nebulosus (LeSueur)	— Taylor 1954: 43

Etymology *Ictalurus* — fish cat; *nebulosus* — clouded, in relation to mottled and grey colouring.

Common names Brown bullhead, northern brown bullhead, marbled bullhead, common bullhead, bullhead, brown catfish, common catfish, catfish, mudcat, hornpout, horned pout, minister. French common name: *barbotte brune*.

CHANNEL CATFISH

Ictalurus punctatus (Rafinesque)



Description This species is the largest of the catfishes in Canada and adults are usually 14–21 inches (356–533 mm) in length and 2–4 pounds in weight. In the following description percentages are for Ontario specimens only but meristic values include specimens from Manitoba. Body massive but less potbellied, less rounded forward, moderately deep, greatest depth, at origin of dorsal fin, is 14.2–22.7% of total length; angle of head from tip of snout to dorsal fin origin shallow; body behind pelvic fins laterally compressed, deeper here than other catfishes, caudal peduncle moderately long, deep, least depth 7.0–8.5% of total length. Head massive, long, its length 19.6–24.6% of total length, very wide, wider in males than females, interorbital width 39.1–52.3% of head length, head naked, flat to shallowly rounded on top; eye not so small as in other catfishes, diameter 10.8–19.3% of head length, round, slightly protruding, high on head, ahead of midpoint of head; snout long, 35.6–49.2% of head length, broad, flat to shallowly rounded on top; paired nostrils separated, posterior one of each pair opening through base of short snout barbel; mouth inferior, definitely overhung by somewhat papillate upper lip, mouth short but wide, maxillary short, gape reaching only to anterior nostril; 1 pair of long, flattened, wide, maxillary barbels, the longest and largest of 4 pairs of barbels, arises at angle of mouth and extends past head length; fine, cardiform teeth in several irregular rows on dentary, premaxillary, and on pairs of rounded patches on the pharyngobranchial bones; undersurface of head very broad, flat, chin with 2 pairs of wide, flattened barbels, outer pair twice length of inner pair. Gill rakers long, widely spaced, slender, pointed, 14–18, usually 9–12 on lower limbs, 5 or 6 on upper limb. Branchiostegal rays 8 or 9 according to McAllister (1968), but varied from 7,7 to 8,8 in material examined. Fins: dorsal 1, ahead of midpoint of body, snout to dorsal origin 28.0–31.1% of total length, soft rayed but first is stout spine (modified soft ray), spine a little less than $\frac{2}{3}$ height of fin, almost straight, no barbs on posterior surface, height

of fin a little less than twice base length which is 6.4—8.3% of total length, tip usually pointed, edge almost square, one spine and 6 rays; adipose fleshy, long, length 7.3–12.3% of total length, little turned up, free length about equal to base length; caudal with less noticeably expanded base, but very broad and deeply forked, the tips pointed (the only catfish in Canada with a forked tail); anal base long, 19.6–24.9% of total length, edge square to rounded but anterior rays longest, greatest height about $\frac{1}{2}$ base length, rays 23(2)–26(1), usually 24(15) or 25(9) (excluding 2 anterior rudiments); pelvics abdominal, low, origin behind insertion of dorsal fin, broad, edge square to rounded, tips overlap origin of anal fin, 8 rays; pectorals low, broad, tips rather pointed, edge square to slightly rounded, anterior heavy spine at

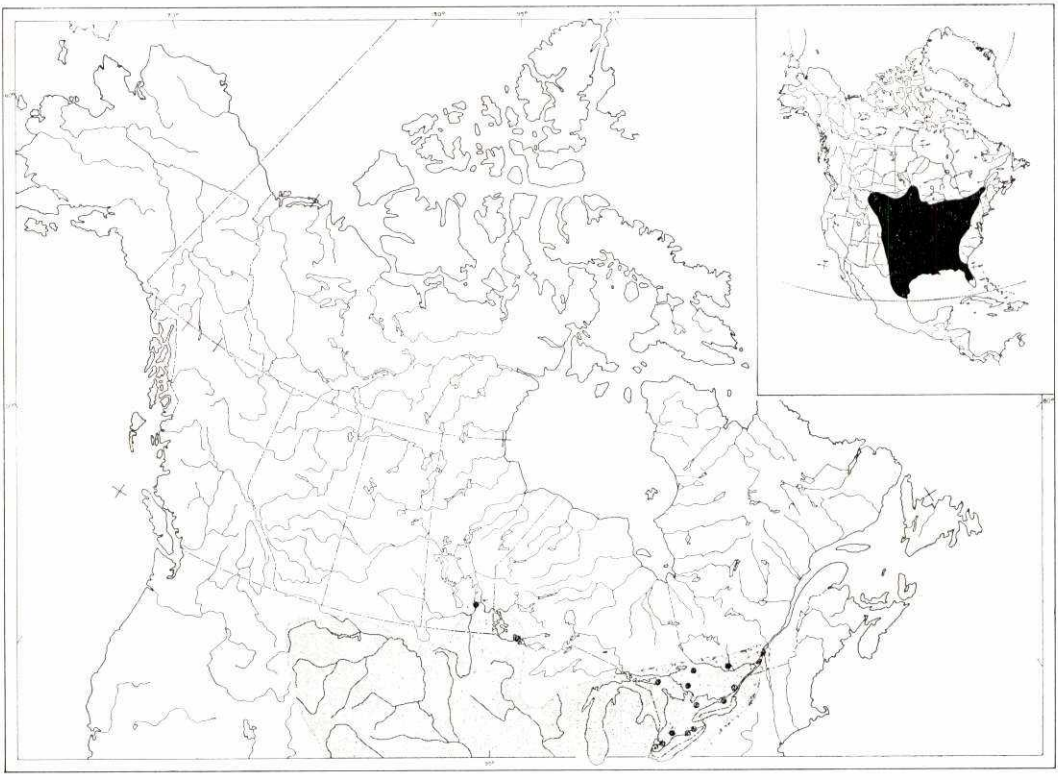
least $\frac{3}{4}$ length of fin, barbs on posterior edge of spine strong, one spine and 8 or 9 rays, usually 9(20 of 22); skin naked of scales but well supplied with chemoreceptors or "taste" receptors, especially on barbels; lateral line complete, straight and near midpoint of body. Peritoneum speckled with black, intestine well differentiated, coiled; no pyloric caeca. Swim bladder heart-shaped, thick walled, silvery. Vertebrae usually 42–44 plus Weberian ossicles.

No nuptial tubercles but head of male becomes swollen above and behind the eyes at spawning time.

Colour Individuals less than 12–14 inches (305–356 mm) pale blue to pale olive with silvery overcast, ventral surface silver-white to milk-white, sides with varying number of olive to almost black spots of varying size but smaller than pupil. Adults with dorsal surface of head and back, and upper sides steel-blue to grey, lower sides lighter, ventral surface of head, and body to pelvic fins, dirty white to silver-white. Fins not noticeably different from adjacent body, nor membranes contrasting. Barbels darkly coloured but without spots, base of inner chin barbels often colourless. Males at breeding time often brighter blue than otherwise. There are albino races in the southern part of the range.

Systematic notes There was, for many years, considerable taxonomic and nomenclatural confusion associated with what we now recognize as this species. Differences in shape and colour, now known to be associated with sex, size, season, and locality were once construed to be indicative of several different species or subspecies. Many names such as *lacustris*, *punctatus*, *robustus*, *meridionalis*, and *anguilla*, in the genera *Amiurus*, *Ameiurus*, *Ictalurus*, *Villarius* and *Haustor*, were applied over the range to forms now considered to be this species. At one time, Canadian populations in the Great Lakes were referred to as both *Ictalurus punctatus* (Rafinesque) — the spotted catfish, the name applied to it then where it occurred elsewhere in Canada, and *Ameiurus lacustris* (Walbaum) — the Great Lake catfish, which was thought to occur only in the lower Great Lakes. Later this species in Canada was referred to as *Ictalurus l. lacustris*, the northern counterpart of *I. l. punctatus* of the Mississippi River and south. Much of the name problem arose as a result of a confusion in the early literature between the channel catfish and the burbot. This was largely resolved by Speirs (1952). More recently, populations in Canada, the Great Lakes, and the Mississippi River system have been referred to as *I. punctatus punctatus* with the idea that there are possibly several distinct subspecies in the far south.

There remains the problem of Richardson's (1836) name, *Silurus borealis*. The fish described from Pine Island Lake (=Cumberland Lake, Sask.) certainly seems to be the channel catfish, but that species does not, at present, occur in the same watershed (Saskatchewan River) nor within 350 miles of that location. No species of catfish now occurs any closer than the black bullhead in the Whitesand River, Sask., about 200 miles to the south. Whether Richardson's animal was a burbot and the description is wrong, or his specimen was correct and his locality data



wrong, is impossible to say.

Material examined indicates little in the way of trends in meristic variability within Canada. The lowest anal ray count (23) was from Sparrow Lake, Muskoka District, Ont., and the highest (26) from Lake Erie with Quebec and Manitoba counts intermediate.

Distribution This species is restricted to the fresh waters, and to a limited extent brackish waters, of east and central North America. Vladykov (1949c) cited a specimen from the St. Lawrence River at St. Roch des Aulnaies, an area usually thought brackish to salt water. The native range would appear to be from the St. Lawrence and its tributaries in Quebec, south, west of the Appalachian Mountains, to southern Georgia and central Florida (Lake Okeechobee), west through the Gulf states to eastern Texas and northern Mexico (as far south as the Rio Panuco system), northwest through the eastern part of the states from New Mexico to Montana, east to the Red River system in Manitoba, southwestern Ontario, southern Minnesota, Wisconsin, and Michigan and through Ontario and Quebec at the level of Lake Nipissing.

It has been so widely introduced in the United States, both east and west (Connecticut, California, Utah, etc.) outside this native range as to be found nearly everywhere in the United States.

In Canada the channel catfish occurs in the St. Lawrence River and its tributaries, from a point about 45 miles below Quebec City (mouth of Rivière Ouelle) in southern Quebec, the Ottawa River and tributaries, all the Great Lakes except Superior, all of Ontario, north to a line from the Ottawa River through Lake Nipissing and the French River to Lake Superior, and in the Nelson River system of extreme western Ontario and Manitoba, north to the southern portion of lakes Winnipeg and Manitoba. Many United States publications give the southern parts of the Prairie Provinces of Canada as the northern limit of distribution but, in spite of extensive collecting, it is presently known to occur

in only Manitoba. *See* Willock's 1969 discussion of Richardson's 1836 record and Stegner's 1955 record of its occurrence in Saskatchewan.

Biology This fish is locally abundant in certain parts of Canada but poorly known. There is very little published information on its biology in Canada other than that of Magnin and Beaulieu (1966). In contrast, there is a voluminous literature from the United States. Most of the following was derived from Magnin and Beaulieu, and summaries of United States literature by Miller (1966) and Carlander (1969).

Channel catfish spawn in late spring or summer when water temperatures reach a point between 75° and 85° F (23.9°–29.5° C) with 80° F (26.7° C) the apparent optimum. Channel catfish kept in a power plant effluent pond at a constant 80° F (26.7° C) and fed on pellets, spawned April 14, 2 months ahead of those in the rivers nearby. Depending on habitat, the spawners may or may not migrate into rivers or moving water at spawning time. Spawning takes place in secluded, semidark nests built by the male, in holes, undercut banks, log jams, or rocks. They will not spawn in transparent ponds unless something is provided, like nail kegs, in which to spawn. Females spawn only once a year but males, at least in the southern United States, "may spawn several times," (Miller 1966).

Spawning behaviour is said to be much like that of the brown bullhead and was described in detail by Clemens and Sneed (1957). There is one claim that males secrete mucus which gives a smooth waxy surface to the bottom of the nest. Eggs are 450–500 per ounce and yellow when laid but become browner as hatching nears. Before they are laid, they are 3.5–4.0 mm in diameter. Females 1–4 pounds bear approximately 4000 eggs and a female 26 inches (660 mm) long, was estimated to have 34,500 eggs. Males protect the nest after egg laying, aerate and clean the eggs by fanning with the paired fins, and press and pack the eggs with body and fins. Eggs hatch in 5–10 days at temperatures from 60° to 82° F (15.6°–27.8° C). Newly hatched fish have large yolks and remain on the bottom for 2–5 days and then swim to the surface and begin to feed. The development of eggs, embryo, and young was described in detail by Fish (1932), Saksena et al. (1961), and Mansueti and Hardy (1967). Like other catfishes, the male probably broods the young.

Growth is rapid in early years and young in October in Ohio were 2–4 inches (51–102 mm) long, and at 1 year of age were 3.5–7.5 inches (89–190 mm) long. At capture, age–length relations (interpreted from pectoral spine sections and vertebrae) and weight for the St. Lawrence River, western Lake Erie, and the Mississippi River were as follows:

Age	St. Lawrence R., Que. Avg FL (*inches*)	St. Lawrence R., Que. Avg FL (*mm*)	St. Lawrence R., Que. Wt (*lb*)	Western L. Erie Avg FL (*inches*)	Western L. Erie Avg FL (*mm*)	Western L. Erie Wt (*lb*)	Upper Mississippi R., Iowa Avg TL (*inches*)	Upper Mississippi R., Iowa Avg TL (*mm*)
1+	3.9	100	–	2.5	63	0.005	–	–
2+	6.7	170	–	6.5	166	0.10	9.8	249
3+	8.0	205	.18	8.9	226	0.25	11.7	297
4+	9.4	240	–	10.6	268	0.41	13.7	348
5+	10.2	260	.47	11.7	298	0.55	15.7	399
6+	11.2	285	–	13.0	328	0.76	18.1	460
7+	12.0	305	.75	14.3	362	0.98	21.0	533
8+	12.6	320	–	–	–	–	22.3	566
9+	13.3	338	–	–	–	–	24.9	632
10+	13.8	350	1.15	–	–	–	28.0(1 only)	711
11+	14.5	370	–	–	–	–	26.2(2 only)	665
12+	15.0	382	–	–	–	–	28.3(2 only)	719
15+	16.3	415	1.96	–	–	–	–	–
20+	18.3	465	2.76	–	–	–	–	–
24+	19.5	495	–	–	–	–	–	–

There is tremendous variability in growth depending on habitat, and a very significant increase in growth rate southward. Length at age 10 in the St. Lawrence River is about 14 inches (356 mm), in the Ottawa River about 14.3 inches (363 mm), in Lake Erie about 17 inches (432 mm), and in the Mississippi River in Iowa about 28 inches (711 mm). The expression for the length–weight relation also emphasizes this difference. Those expressions for the St. Lawrence River, Lake Erie, and the Mississippi River at Lansing, Iowa, were as follows: $\log W = -4.012 + 3.039 \log FL$; $\log W = -4.910 + 2.956 \log TL$, and $\log W = -6.759 + 3.66 \log TL$, where W is weight in grams, and FL and TL are fork and total lengths in mm.

Size at sexual maturity in Canada is not known, but in the south they usually mature at 10.5–16.0 inches (267–406 mm), and 5–8 years of age. In some natural areas, they mature as early as 2 years and in ponds in Texas at 18 months.

Channel catfish often grow to weights of over 30 pounds in Canada. Bensley (1915) reported a specimen from Georgian Bay which weighed 37 pounds. However, in waters other than the Great Lakes, weights of 2–4 pounds are most common with occasional fish up to 10 pounds. Magnin and Beaulieu (1966) mentioned a specimen from the St. Lawrence River which was 29 inches (737 mm) in fork length, weighed over 16 pounds, and was said to be near 40 years of age. Trautman (1957) said that Ohio commercial fishermen gave maximum weight as 32–38 pounds but that average size was 11–30 inches (279–762 mm) and 12 ounces to 15 pounds in weight. He cited the largest specimens as 33–46 inches (839–1169 mm) in length and 25–30 pounds in weight. The *Field and Stream* anglers' record is a fish which weighed 58 pounds, was $47\frac{1}{2}$ inches (1202 mm) in length, $29\frac{1}{8}$ inches (716 mm) in girth, and was caught in the Santee–Cooper Reservoir, S.C., in July, 1964. Other than the estimated 40 years for the single St. Lawrence River specimen, maximum age in Canada would appear to be 24 years. Faster growing populations to the south have not been estimated to exceed 14 years of age, and some only 7 years.

The habitat of the channel catfish in Canada is lakes and moderate to large rivers. They usually inhabit cool, clear, deeper water with sand, gravel, or rubble bottoms and not the shallower, more turbid, vegetated areas frequented by the bullheads. During the day they are most often found in deeper holes in the protection of rocks or logs. Young and smaller adults often move short distances at night, out of lakes into the fast water of tributary rivers, in order to feed. Although largely sedentary animals, local movements in lakes have been recorded and in some areas there are marked downstream movements in fall. Marked fish liberated at lake centre returned quickly to site of marking. Greatest periods of movement appear to be just before sunrise and sunset. Fish tagged in the St. Lawrence River by Magnin and Beaulieu were later recaptured upstream, downstream, and some distance up tributary rivers. Distance travelled varied from 0 miles (30%) to 75–99 miles (0.34%) with approximately 50% of the individuals moving 10–39 miles. Those authors gave records of four catfish tagged in fresh water and later recaptured in an area downstream (Montmagny) where the deep water was 5‰ saline, and a single individual in an area (Rivière Ouelle) where the salinity at the surface was 19‰ and at the bottom 21‰. They quoted Vladykov as saying that in the St. Lawrence many channel catfish spend the winter in fresh water in the area of Lac St. Pierre, in the spring when the ice melts they descend the river toward salt water, and after mid-September they begin to move upstream again.

Lethal oxygen levels were calculated by Moss and Scott (1961) at 0.95, 1.03, and 1.08 ppm at temperatures of 77°, 86°, and 95° F (25°, 30°, and 35° C). Maximum survival temperatures of 86.5°, 91.0°, and 92.3° F (30.3°, 32.8°, 33.5° C), for acclimation temperatures of 59°, 68°, and 77° F (15°, 20°, 25° C) were determined (Strawn 1958, *in* Carlander 1969) but Moss and Scott had them survive at 95° F (35° C).

This species feeds on a wide variety of plant and animal material. They may feed both at night and during the day. Bottom

feeding is more characteristic but food is obviously taken at the surface, especially by younger fish. This species, like the other catfishes, doubtless depends on its barbels and sense of taste at night, but there is a suggestion it feeds more by sight than other catfishes in its clearer habitat. There are no Canadian food studies. The young feed primarily on aquatic insects. Older fish feed on mayflies, caddisflies, chironomids, molluscs, crayfish, crabs, green algae, larger water plants, tree seeds, such fishes as are present in the habitat and, rarely, birds. In Canada various minnows and yellow perch dominate. *See* Bailey and Harrison (1948) for the food of this species in Iowa.

The young may fall prey to a variety of fishes but the adults, by virtue of their size, are probably comparatively free from predation. Except in areas where algae and other plants form a large part of its diet, the channel catfish probably competes for food with all other bottom feeders and some predatory species of fishes in its habitat.

A hybrid between this species and the flathead catfish *Pylodictis olivaris* (Rafinesque) has been reported. Sneed (1964) gave results of an attempt to produce artificial hybrids with blue, white, and flathead catfishes.

The parasites listed for this species (as *I. punctatus* and *I. anguilla*), over the whole of its range, by Hoffman (1967) were as follows: Protozoa (14), Trematoda (22), Cestoda (6), Nematoda (8), Acanthocephala (2), leeches (3), Crustacea (6). Notes on parasites of this species in the Great Lakes were given by Bangham and Hunter (1939) and Bangham (1955).

Relation to man This species is an excellent food fish, a commercial fish of some importance in the Great Lakes and St. Lawrence River, and a formidable sport fish. The flesh is white, flaky but solid and very flavourful. Some people find it too rich or strong, and stripping the "red muscle" from the centre of the sides usually avoids this. The commercial statistics isolate this species as catfish, contrasted with bullheads for the composite catch of the smaller species. The catch in Ontario between the years 1964 and 1968 varied from a high of 990,000 pounds in 1967 to a low of 620,000 pounds in 1966, and for Canada as a whole from a high of 1,243,000 pounds in 1964 to a low of 693,000 pounds in 1966. Market value in Canada ranged from a high of $232,000 in 1967 to a low of $158,000 in 1966. In 1968, in Ontario, the catch was 651,000 pounds, the value to the fisherman $142,000 or 21¢/pound, and the marketed value was $160,000. Lakes St. Clair and Erie yield the highest commercial catches. It is a very important commercial species in the Mississippi River areas of the United States and on fish farms there. Commercial production apparently regularly falls behind demand.

The channel catfish, although a challenging sport fish because of its potential size, was, in the past, actively sought after by only a limited number of anglers in Canada. This was possibly because best catches were possible only after dark and usually in areas where angling is difficult and hard on tackle. Many were caught, however, while fishing for other species. A growing number of anglers now search them out in various rivers in order to try to catch even heavier individuals. Channel catfish are usually caught by still fishing, in rapid river water near falls and dams, at dusk to early night, with large minnows, pieces of fish or meat, or large balls of worms.

This species is an excellent pond-culture fish and is extensively so used in the United States. *See* Regier (1963b) for its use in farm ponds in New York State, where crops up to 300 pounds per acre have been obtained, and Miller (1966) for summaries of propagation management, standing crop, and angling success rates in various localities in the United States. Channel catfish have been successfully used for angling in artificial ponds in a public fishing area in Ontario.

The spines of this and other species of catfishes have always been part of Indian artifacts. The bases were rounded, the barbs removed, and the spines used as awls for leather work or, if the hole in the base was intact, as needles. One such specimen from the shores of Lake Huron in Ontario was carbon dated at 1000 years B.C.

Nomenclature

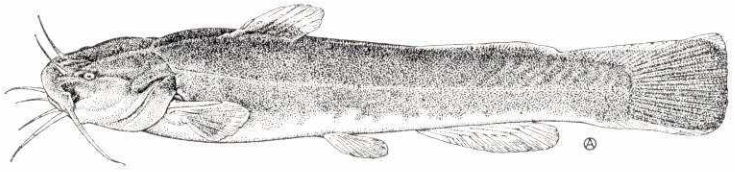
Silurus punctatus	— Rafinesque 1818c: 355 (type locality Ohio River)
? *Pimelodus nigricans*	— LeSueur 1819: 153
Silurus (*Pimelodus*) *borealis* (Richardson)	— Richardson 1836: 135
Pimelodus nigricans	— Forelle 1857: 281
Synechoglanis beadlei	— Gill 1859: 40 (type locality St. Catharines, Ont.)
Amiurus borealis	— Günther 1864: 100
Amiurus caudifurcatus	— Günther 1864: 102
Ictalurus lacustris (Walbaum)	— Jordan and Gilbert 1883a: 108
Ictalurus punctatus Rafinesque	— Eigenmann 1895: 107
Ictalurus punctatus (Rafinesque)	— Jordan and Evermann 1896–1900: 134
Ameiurus lacustris (Walbaum)	— Jordan and Evermann 1896–1900: 137
Ictalarus nigricans (Lacépède)	— Montpetit 1897: 251
Ictalurus punctatus (Rafinesque)	— Jordan, Evermann, and Clark 1930: 152
Haustor lacustris (Walbaum)	— Jordan, Evermann, and Clark 1930: 152
Ictalurus punctatus Rafinesque	— Hubbs 1926: 49
Villarius lacustris Walbaum	— Hubbs 1926: 50
Ictalurus lacustris	— Radforth 1944: 64
Ictalurus lacustris lacustris (Walbaum)	— Hubbs and Lagler 1941: 63
Ictalurus punctatus (Rafinesque)	— Speirs 1952: 101
Ictalurus punctatus punctatus (Rafinesque)	— Hubbs and Lagler 1958: 90

Etymology *Ictalurus* — fish cat; *punctatus* — spotted (characteristic only of individuals under 12 inches or 305 mm).

Common names Channel catfish, channel cat, spotted catfish, Great Lake catfish, Great Lakes catfish, lake catfish, northern catfish. French common name: *barbue de rivière*.

STONECAT

Noturus flavus Rafinesque



Description This small catfish, usually no more than 6–8 inches (152–203 mm) in total length, is the largest of the three catfishes in Canada with an adnate or attached adipose fin. For detailed description *see* Taylor (1969). Body round at dorsal and pelvic fins, somewhat laterally compressed behind this, little change in dorsal or ventral bodyline, not markedly potbellied, greatest depth, at dorsal origin, 12.8–21.9% of total length; caudal peduncle short but deep, depth 9.2–11.6% of total length. Head very wide at rear but not long, length 21.0–24.5% of total length, interorbital width 36.7–46.1% of head length, pronounced longitudinal groove between eyes in breeding individuals, head naked; eye small, round, protruding, almost on top of head, diameter 9.2–17.6% of head length, possibly smaller in areas of heavy silt; snout fleshy, somewhat pointed, length 35.2–41.5% of head length, broad and flat on top, overhangs mouth, posterior nostril of each pair opening through base of snout barbel, barbel reaches to posterior edge of eye; mouth horizontal, subterminal, overhung by fleshy upper lip, upper jaw short, gape just reaching level of posterior nostril, lips fleshy, 1 pair flattened maxillary barbels, longest of 4 pairs of barbels but do not reach to edge of operculum; fine cardiform teeth in several irregular rows on premaxillary, dentary, and in patches on last pharyngobranchial bones, patch on premaxillary broad, rectangular, with backward lateral extensions, and somewhat constricted at centre; undersurface of head broad and flat, 2 pairs of barbels on chin, inner pair shorter. Gill rakers moderately long, pointed, widely spaced, 5–10 in number, usually 4–6 on lower arch and 1 or 2 on upper arch, but as high as 8 on lower arch in Alberta. Branchiostegal rays usually 10 on each side (9–11 over whole range) but often 9 or 11 on one side. Fins: dorsal 1, origin ahead of midpoint of body, tip of snout to dorsal origin 28.3–32.3% of total length, 6, or rarely 7, soft rays and 1 obvious, weak spine (modified soft ray), spine almost straight, about $\frac{1}{3}$ height of fin, pointed, no barbs on posterior edge; height of fin about equal to base length which is 9.7–12.2% of total length, edge rounded; adipose low, long, length 13.7–19.1% of total length, adnate (attached to back) for whole length, connected to anterior edge of caudal fin, and connected by low ridge to dorsal insertion; caudal broad, margin fleshy, tip rounded to truncate; anal with long base, 15.6–18.4% of total length, low, greatest height about $\frac{3}{4}$ base length, fleshy edge rounded, rays 15(9), 16(12), 17(1), usually 16(not counting 2 anterior rudiments); pelvics abdominal, origin behind dorsal insertion, low, very round, not reaching anal base, rays 8–10, usually 8; pectorals rather high, broad, edges square to slightly rounded,

anterior spine stout, about $\frac{3}{4}$ length of fin, posterior edge smooth to roughened, anterior surface weakly barbed near tip, 1 spine and 8(3)–11(1) rays, usually 9(5) or 10(5), poison gland opening by pore above base of

fin (*see* Reed, 1907, 1924a, b). Skin naked; lateral line incomplete and short. Peritoneum colourless, intestine coiled and well differentiated, no pyloric caeca. Swim bladder of 2 chambers. Vertebrae usually 38 or 39 (37–41 over whole range) not counting anterior, fused vertebrae (Weberian ossicles).

No nuptial tubercles.

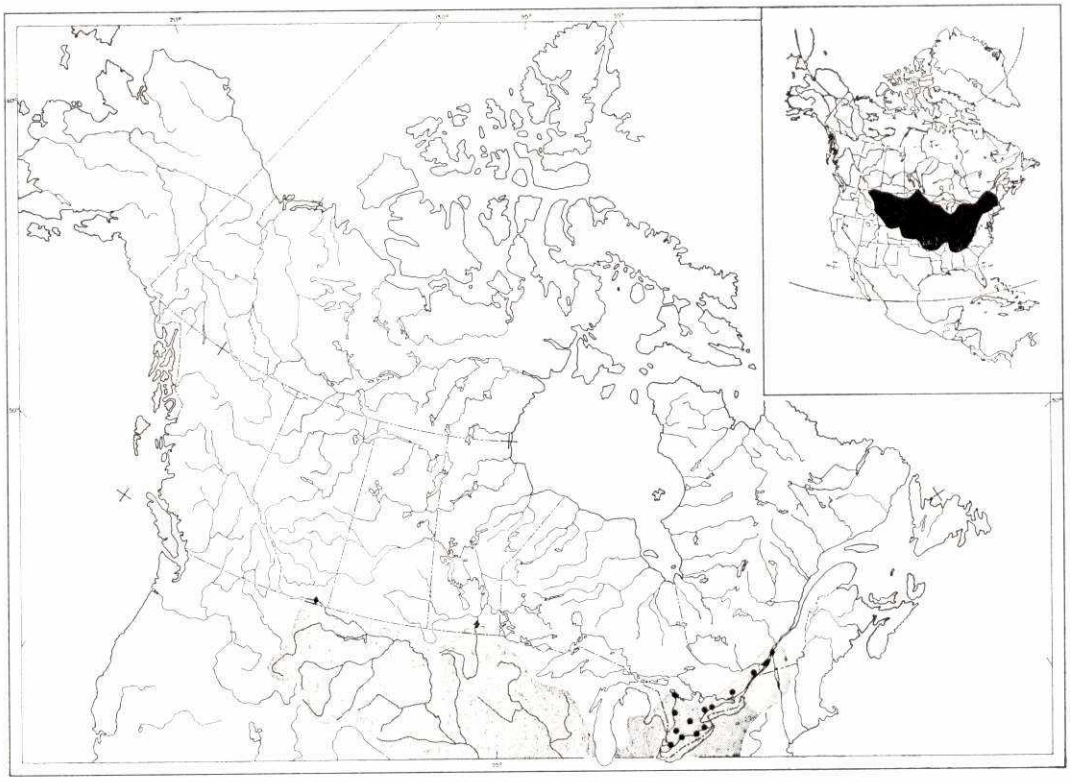
Colour Dorsal surface of body and head yellow, slate-grey, olive, to steely blue; areas around top of head, dorsal fin base, and between dorsal and adipose fins dark grey, sides lighter yellow-grey, lower surface of head and ventral surface of body white to grey. Pelvic fins, lower edge of caudal peduncle, edges and sometimes end of caudal fin, and edge of adipose fin white; a grey blotch extends into adipose fin; irregular dark grey blotch covers most of middle of caudal fin; anal fin lightly pigmented, dorsal fin with light margin, a distal dark grey band and intermediate light grey area; pectoral fins dark grey, white margins, upper edge of pectoral spine dark grey, front edge white; upper barbels grey, chin barbels white; a light yellow elliptical or oval spot at posterior end of dorsal fin (Taylor 1969). A colour illustration appeared in Greeley (1929).

Systematic notes Rafinesque's original description may be a composite of *N. flavus* and *N. gyrinus* (Taylor 1969). Characteristics of this species seem comparatively stable over the disjunct Canadian range, and in fact, over the whole range, according to Taylor, but his Canadian material was limited. Stewart and Lindsey (1970) reported two dorsal spines in Manitoba material. In small, cleared and stained ictalurid specimens, a primary unit shows, which later fuses to the main spine. Those authors also listed 44 or 45 vertebrae and contrasted this with the counts for Kansas of 41–44 given by Cross (1967). Taylor gave counts (less anterior fused vertebrae) for Nebraska to Montana as 37–40 and gave no counts over 41. It is probable that the high Manitoba count includes the five fused anterior vertebrae; if not, this most northerly population is unique. Gill rakers in Ontario were 4–6 + 1–2 but a single specimen from Alberta had 8+2. Eye diameter in Alberta was smaller but Taylor said that varying degrees of reduction in size or function of eyes occurred in populations in silted water. Head length seemed greater in the Alberta population compared with Ontario specimens.

Distribution This species is restricted to the fresh waters of North America. It occurs from the St. Lawrence River and tributaries in Quebec, south in the Hudson, Allegheny, and Mohawk systems in New York (a canal immigrant?), west of the mountains, to western North Carolina and northern Alabama (Tennessee River), north through central Tennessee, west through northern Missouri, Kansas, and northeastern Colorado, northwest from Wyoming to Alberta, east through North Dakota, north into Manitoba, southeast across the tip of Lake Superior to central Michigan and into southern Ontario and Quebec.

In Canada the stonecat occurs in the St. Lawrence River and its tributaries in Quebec, from Rivière Etchemin (at Lévis) upstream; in the lower Ottawa River, in tributaries of lakes Ontario, Erie, and Huron (excluding Georgian Bay) to the level of the tip of the Bruce Peninsula. Absent west to the Red River, north in that river only to Winnipeg, Man., absent from Saskatchewan, present in the Milk River (Missouri River drainage) of southern Alberta.

The distribution of this species, in Canada, west of Ontario has long been argued as the result of various interpretations of unverified published records for: Medicine Hat, Alta., (Eigenmann 1895); Manitoba (Bissett 1927); Hudson Bay drainage (Bajkov 1928); and for the Red and Assiniboine rivers in Manitoba, and the South Saskatchewan River in eastern Alberta, (Hubbs and Lagler 1947; Rostlund 1952). Because of this doubt, Taylor (1969) tentatively placed the Manitoba records of *N. flavus* of Bissett, Bajkov, Jackson (1934), Hinks (1943), and Dymond (1947) in the synonymy of *N. gyrinus* which was known to occur there. The presence of the stonecat in Alberta was veri-



fied by Nursall and Lewin (1964) and by Willock (1968). Stewart and Lindsey (1970) confirmed its presence in Manitoba when they reported on nine specimens taken in the Red River near Winnipeg in the summer of 1969. Underhill (1957) and Taylor (1969) considered it absent from the Red River in Minnesota. We must assume it is present there, or it was at one time, or that the Manitoba population resulted from an introduction.

Biology Almost nothing is known of the biology of this species in Canada or elsewhere. Most of the following was derived from Carlander (1969), Taylor (1969), and Greeley (1929). It spawns in the summer over a long period possibly ending as late as August. Peak period of spawning commences in June or July when water reaches 82° F (27.8° C). It may spawn in streams or shallow, rocky areas of lakes. The mass of sticky eggs is deposited beneath stones. The eggs are yellow, opaque, 3.5–4.0 mm in diameter, and coated with a jelly. Average egg number per female is 973 with a range of 767–1205 (Carlander 1969). Approximately 500 are laid in an adhesive mass and guarded by the male. Fish (1932) gave details of eggs and early development of young.

The young in Ohio in October were 1.2–3.2 inches (30–81 mm) (Trautman 1957). Average standard length at capture for various ages in Lake Erie and in Ohio streams was given by Gilbert (1953) as follows:

Age	Avg SL	
	(*inches*)	(*mm*)
1	2.1	53
2	3.0	77
3	3.5	89
4	3.8	98
5	4.2	107
6	4.9–8.1	126–207
7	8.2	209
8	–	–
9	9.1	233

Growth is slow but more rapid in lakes where food is more abundant. Average size is 6–8 inches (152–203 mm). Trautman (1957) gave maximum size in Ohio as 12.3 inches (312 mm) and 1 pound 1 ounce. They have been recorded in Alberta to 9 inches (229 mm) total length and to 12 inches (305 mm) in Ontario (Lake Erie). Maximum age is probably 8–10 years.

The stonecat prefers riffles or rapids of moderate or large streams with bottoms of large, loose rocks. It is present in lakes near sand and gravel bars where there is wave action. It may move into quiet water to feed. In the United States it is usually absent from streams of low gradient (but present in Red River, Man.) and disappears from streams which are impounded. Johnson (1965) found this species in streams near Toronto, Ont., in numbers per acre ranging from 23 to 164, representing standing crops of 0.3–2.3 pounds/acre. They were associated with suckers, a variety of minnows, rock bass, and two darters. Elsewhere they are found regularly with smallmouth bass. Hallam (1959) found them associated with trout in Ontario but only in the warmer trout habitats. They may occur from shore to 20 fathoms in the Great Lakes.

The food of the stonecat is primarily immature aquatic insects, largely mayflies, and, secondarily, molluscs, minnows, crayfish, and plant material. Much of its food is searched for along the bottom, probably by means of its sensitive barbels and probably at night.

This species is doubtless free of much predation but has been known to have been eaten by smallmouth bass and a watersnake. It is a competitor for bottom organisms with other bottom feeders, particularly smallmouth bass, which has similar habitat requirements.

The parasites of the stonecat were listed by Hoffman (1967) as: Trematoda (4), Cestoda (2), Nematoda (1), and Acanthocephala (4).

Relation to man This species is small, secretive, nocturnal, and not often seen by the layman. When seen, it is often mistaken for the young of the brown bullhead. It is of little commercial or sport-fish value, but Greeley (1929) said that the flesh was excellent. One interesting relation to man is that it is one of three freshwater fishes in Canada which can inflict a painful, but not dangerous, wound from the pectoral spine and the poison gland associated with it (*see* Reed 1907, 1924a, b).

Nomenclature

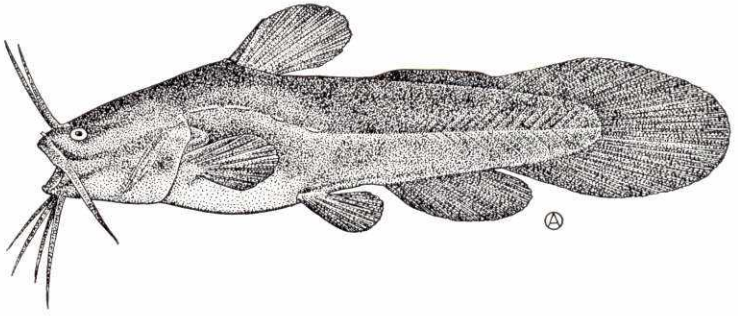
Noturus flavus	— Rafinesque 1818d: 41 (type locality Falls of the Ohio, neotype (Taylor 1969) USNM 202494)
Noturus platycephalus	— Günther 1864: 104
Noturus flavus Rafinesque	— Bailey et al. 1960: 18

Etymology *Noturus* — tail over the back in allusion to the connection between adipose and caudal fins; *flavus* — yellow.

Common names Stonecat, stone catfish, stonecat madtom, catfish, white cat, doogler, beetle-eye. French common name: *barbotte des rapides.*

TADPOLE MADTOM

Noturus gyrinus (Mitchill)



Description This species is the smallest of the catfishes in Canada and the smallest of the 3 species with an adnate adipose fin. It seldom exceeds 3.5 inches (90 mm) in length. Meristics given below involve specimens from Quebec to Saskatchewan but percentages are based on specimens from Ontario and Manitoba. Body very heavy and round forward, pot-bellied; greatest depth, at dorsal spine, 16.8–22.9% of total length; strongly laterally compressed behind origin of anal fin; steep angle from tip of snout to origin of dorsal fin; very tadpolelike in shape and colour; "caudal peduncle area" long, deep, depth 10.2–12.9% of total length. Head massive, deep but not long, length 22.5–26.5% of total length, wide, interorbital width 38.4–49.4% of head length, head naked, rounded to flat on top; eye very small, diameter 9.3–16.2% of head length, high on head, slightly protruding; snout moderate, length 35.1–42.0% of head length, broad, rounded to flat on top, does not overhang mouth, 1 pair long, broad, flattened barbels on snout; mouth terminal, horizontal, jaws equal in length, mouth short and wide, gape extending to posterior nostril, lips fleshy but not prominent, 1 pair long, flattened, maxillary barbels reach almost to head length; fine, cardiform teeth in several irregular rows on lower jaw and premaxillary, premaxillary patch short, wide, ends rounded and without rear extensions; undersurface of head broad, flat, with 2 pairs of heavy barbels often of little difference in length. Gill rakers usually 8, 6 or 7 on lower limb, 1 on upper limb. Branchiostegal rays usually 9, but rarely 8 on one side, (8–10 over whole range). Fins: dorsal 1, well ahead of midpoint of body, tip of snout to dorsal origin 27.8–31.6% of total length, soft rayed but first obvious ray modified to a stout spine, spine about $\frac{2}{3}$ height of fin, straight, sharply pointed, no barbs or serrae, height of fin greater than base length which is 9.5–12.6% of total length, edge rounded, 1 spine and 5–7, usually 6 rays, 5(1), 6(25), 7(2); adipose thin to fleshy, long, 14.5–17.0% of total length, low, adnate, no conspicuous ridge to insertion of dorsal fin, connected to long extension of caudal but slight notch between; caudal long, with long dorsal and ventral extensions of procurrent rays, broad, tip rounded; anal base long, 10.8–19.4% of total length, fin height at least $\frac{1}{2}$ base length, longest rays toward rear, edge rounded, 14–16 rays, usually 15, 14(7), 15(17), 16(3), (excluding anterior rudiment) but 2 very small specimens from Niagara River tributary appear to have 17 rays; pelvics abdominal, origin behind insertion of dorsal fin, low, very broad, and round, tips overlap origin of anal fin, usually 8, rarely 9, rays; pectorals appear high as result of potbelly, broad, edge straight, tip pointed, 1 spine and 6–9, usually 6, rays,

6(16), 7(8), 8(3), 9(1), spine heavy, sharply pointed, almost straight, at least $\frac{3}{5}$ length of fin, no barbs or serrae but sculptured and posterior surface deeply grooved, with associated poison gland (*see* Reed 1900, 1907, 1924a, b). Skin truly naked of scales; lateral line incomplete, short curved upward above pectoral fin; muscle blocks obviously outlined on compressed part of body. Peritoneum not pigmented, intestine well differentiated, no pyloric caeca. Vertebrae 33 or 34 (not counting fused anterior vertebrae), 32–37 over whole range.

No nuptial tubercles, but certain muscles on the head of males swell at spawning time.

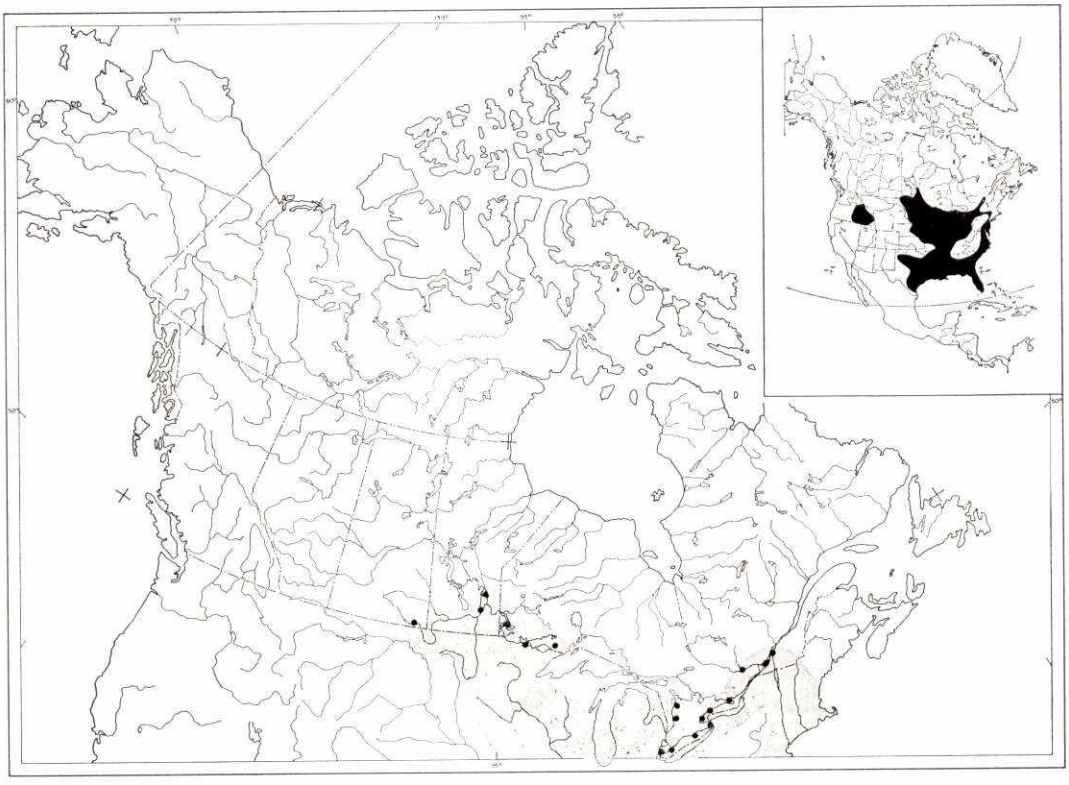
Colour Over the whole range colour varies from dull golden yellow to olive-grey, but preservation usually turns the animals grey, brown, or nearly black. Fins, barbels, and upper body are nearly uniform in pigmentation but barbels and fins may be darker or lighter than adjacent body. The tips only of the lower barbels are, at times, white. A dark grey streak is present along the position of the vertebral column and this branches into the dark lines outlining the muscle segments. The ventral surface of the body to the pelvic fins is always lighter or unpigmented in the young and lightly or irregularly pigmented in adults (mostly from Taylor 1969).

Systematic notes Records of this species are rather confusing as it was once known as *Noturus gyrinus,* then *Schilbeodes gyrinus,* then *Schilbeodes mollis* and now, once again, *Noturus gyrinus*. Taylor (1954, 1955, 1969) gave reasons for combining the genera *Schilbeodes* and *Noturus* and reversed the decision of Hubbs and Raney (1944) concerning the trivial names *gyrinus* and *mollis*. Because of the doubt, prior to the record of Stewart and Lindsey (1970), concerning the presence of *N. flavus* in Manitoba, Taylor tentatively placed in the synonymy of *N. gyrinus* the Manitoba records for *N. flavus* of Bissett (1927), Bajkov (1928), Jackson (1934), Hinks (1943), and Dymond (1947).

There is little variation in the Canadian specimens of this species examined, and the meristics appear to fit into the "strong north-south gradients" mentioned by Taylor. All counts fit within his total values. Two (of three) very small specimens from a tributary of the Niagara River appear to have 17 anal rays. This is within the total range (12–18) given by Taylor but outside his range for the Great Lakes (13–16), and is one more than the range in an adjacent Niagara River tributary.

Distribution The native distribution of this species is restricted to eastern and central North America. It occurs in fresh water, and the slightly brackish water of tidal areas, from the Hudson and Mohawk rivers, Finger Lakes, and Lake Ontario drainages of New York; south, east of the mountains, but below the fall line, to southern Florida; west through the southern half of Georgia and Alabama, through all of Mississippi and Louisiana, to the Nuecas River, Texas; north through eastern Texas, southern Oklahoma, eastern Arkansas; north in the Mississippi River and then spreading west in central Missouri; northwest through the eastern halves of the states from Kansas to North Dakota and into Saskatchewan; east through southern Manitoba, western Ontario, southern Wisconsin and Minnesota to extreme southern Ontario and Quebec. It has been introduced in New Hampshire, Connecticut, Idaho, Oregon, and possibly elsewhere where bullheads have been introduced.

In Canada, the tadpole madtom occurs in the St. Lawrence River and tributaries in Quebec at least as far downstream as the Richelieu River; at least the Nation and Castor rivers of the Ottawa system; lakes Ontario, Erie, St. Clair, Huron, and their tributaries; the Quetico–Rainy River portions of the Hudson Bay drainage in western Ontario; the Red River in Manitoba, downstream at least to Black Bear Island in Lake Winnipeg; and the Souris River in Saskatchewan. There seems no basis for the inclusion of Alberta by Scott (1967).



Biology There is no published study of the biology of this species in Canada, and very little from elsewhere. The following information was derived mainly from Bailey (1938), Hooper (1949), Trautman (1957), and Carlander (1969). Tadpole madtom spawn in summer, probably in late June and July in Canada, usually in rivers but to a lesser extent in lakes in shallow water. They probably build their nests in dark cavities, as many of the known egg clusters (and many specimens) have been removed from open tin cans seined off the bottoms of streams or lakes. Egg number varies and has been cited as an average of 50, or as high as 93. Since one nest in New Hampshire contained 117 eggs, either the number is higher than 93, or more than one female contributes to a brood. Eggs are light yellow, about 3.5 mm in diameter, including a gelatinous envelope. They adhere to each other and to the substrate, and the whole egg mass is surrounded by another gelatinous envelope. Mansueti and Hardy (1967) gave details of eggs and early development of young. In Iowa, the young are 0.9–1.3 inches (23–35 mm) long in July and 0.7–2.2 inches (18–56 mm) in September. Age–standard length relation (by vertebrae) for a lake in Minnesota was given as follows:

Age	SL			
	Average		Range	
	(*inches*)	(*mm*)	(*inches*)	(*mm*)
0	1	26	0.6–1.3	15–35
1	2.4	62	1.9–3.3	48–85
2	3.5	89	3.0–4.1	78–104

Maximum age would appear to be 2 or 3 years in Canada. Maximum size known in Canada is 4.3 inches (110 mm) total length, 3.5 inches (104 mm) standard length in Minnesota, and 4.4 inches (112 mm) in Ohio. The largest Canadian specimen is from the Hudson Bay drainage of Saskatchewan (Souris River).

The tadpole madtom is usually considered to inhabit quiet, slow moving, clear waters, shallows of lakes and their outlets, sloughs, ponds, backwaters, and stream mouths, with soft, muddy bottoms and extensive vegetation. It has been taken as deep as 81 feet (25 m). Habitat destruction and silting is restricting the distribution of this species and may be reducing its numbers in the United States. The tributaries of Lake Erie in Ontario in which it occurs are often turbid. It is active only at night, retiring in the daytime to the protection of cavities, cutbanks, debris, or vegetation.

Food of this species has been reported to be Cladocera, ostracods, *Hyalella*, chironomids, and other immature aquatic insects including dragonflies. It forages for these on the bottom, at night.

Although armed with "poisonous" spines, this madtom is eaten by other fishes and is used as bait for other fishes. There is a record of a tadpole madtom eaten by a gartersnake. They compete with other bottom feeders for food.

Hoffman (1967) listed the parasites as Protozoa (2), Trematoda (6), Cestoda (2), Nematoda (2), Acanthocephala (2), and Crustacea (1).

Hybrids between the tadpole madtom and the brindled madtom were described by Trautman (1948) and Taylor (1969).

Relation to man In Canada this fish is too small, too rare and too poorly known to be of any relation to man other than in its ecological role. Where abundant in the United States, they are food of more favoured fishes and are said to be excellent as bait for other fishes. Although little known in Canada, they are quite abundant in some areas in the United States. Hooper (1949) reported that they contributed more weight (88 of 251 pounds) than any other of the five species taken by poisoning a 12.5-acre lake in Minnesota. The lake contained over 4200 madtoms. It is probably often mistaken for the young of the commoner brown bullhead. Its secretive nature leads it to occupy empty tin cans on the bottom of streams and lakes and these should be examined in any search for this animal. It is of interest in that it is one of three freshwater fishes in Canada that can inflict a painful, but not dangerous, wound with its sharp pectoral spine and associated poison gland (*see* Reed 1900, 1907, 1924a, b).

This small fish, as a result of its size and habitat requirement, makes an interesting aquarium resident and, as such, was taken to Germany. It apparently never succeeded there in natural habitats.

Nomenclature

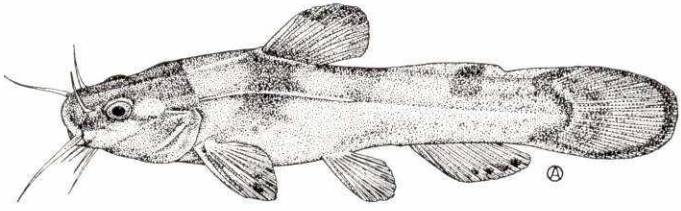
Silurus gyrinus	— Mitchill 1817: 289 (type locality Wallkill River, N.Y.)
Noturus sialis	— Jordan 1877a: 102
Noturus gyrinus	— Wright 1892: 443
Schilbeodes gyrinus	— Nash 1908: 24
Schilbeodes gyrinus sialis (Jordan)	— Greeley 1936: 36
Schilbeodes mollis (Hermann)	— Dymond 1947: 23
Noturus gyrinus (Mitchill)	— Taylor 1954: 44

Etymology *Noturus* — tail over back in allusion to the adipose fin joined to the caudal fin; *gyrinus* — tadpole.

Common names Tadpole madtom, mad tom, tadpole stonecat, tadpole cat. French common name: *chat-fou brun.*

BRINDLED MADTOM

Noturus miurus Jordan



Description This species, although not the smallest of the three catfishes in Canada with adnate fins, rarely grows to more than 2–3 inches (51–76 mm). Body heavy forward, but less potbellied than *N. gyrinus*, angle from tip of snout to dorsal origin not steep, greatest depth at dorsal spine 8.3–20.0% of total length, strongly laterally compressed behind origin of anal fin; caudal peduncle tapers backward, short and only moderately deep, depth 8.6–10.1% of total length. Head less massive, not long nor deep, length 22.6–23.5% of total length, wide, interorbital width 23.3–31.1% of head length, flat to slightly rounded, rounded above but slight depression in older specimens, naked; eye larger, diameter 16.1–25.0% of head length, high on head, protruding; snout short, 31.0–39.2% of head length, flat to rounded on top, overhangs mouth slightly, 1 pair of long, flattened barbels on snout, much closer to eye than in *N. gyrinus*; mouth slightly subterminal, lower jaw included, mouth horizontal, wide but short, gape reaching to posterior nostril, lips not conspicuous; 1 pair of long, flattened maxillary barbels reaching almost to head length; fine, cardiform teeth in several, irregular rows on lower jaw and premaxillary, premaxillary patch sharp or slightly rounded on corners, without backward extensions; undersurface of head broad, flat, with 2 pairs of barbels of nearly equal length. Gill rakers 6–8, usually with 6 on lower limb and 1 or 2 on upper limb. Branchiostegal rays usually 9. Fins: dorsal 1, well ahead of midpoint of body, snout to dorsal origin 28.9–32.5% of total length, soft rayed but first obvious ray modified to stout spine, spine about $\frac{2}{3}$ height of fin, almost straight, sharply pointed, no barbs or serrae, height of fin almost twice length of base, which is 10.0–12.7% of total length, edge quite round, 1 spine and 6 rays (5–7, usually 6 over whole range); adipose thin, long, 19.8–24.5% of total length, low, adnate, widely connected to long extension of caudal fin, but moderate notch between; caudal long, with long dorsal and ventral extensions anteriorly of procurrent rays, broad, tip rounded; anal base long, 13.3–16.7% of total length, fin height more than $\frac{1}{2}$ base length, edge rounded, 13–15 rays, not including anterior rudiments (13–17 total rays over whole range); pelvics abdominal, origin just behind insertion of dorsal fin, low, broad and rounded, tips do not quite touch origin of anal fin, usually 8 or 9 rays (8–10 over whole range); pectorals appear lower than *N. gyrinus*, broad, edge straight, tip bluntly pointed, 1 spine and usually 8 rays but sometimes 7 (7–9 over

whole range), spine heavy, sharply pointed, curved, spine almost equal to fin length, fine anterior serrae and several strong, posterior barbs easily felt, spine with associated poison gland (*see* Reed 1907, 1924a). Skin truly naked of scales; lateral line incomplete, short, shallowly curved upward above pectoral fin. Peritoneum not pigmented, intestine well

differentiated, no pyloric caeca. Vertebrae 34 or 35 (not including fused anterior vertebrae), 32–37 over whole range.

No nuptial tubercles, but, in spawning males, head broadens, flattens, and muscle masses on back, head behind eye, and on cheeks become enlarged as do lips and bases of maxillary barbels (Taylor 1969).

Colour Very conspicuously marked, hence, the common name. In life, yellow, brown, light red-orange or pink, with four dark saddle marks on the back. The sides are lightly and irregularly mottled, the undersurface to pelvic fins white to pale yellow. One saddle mark involves most of head except two large, postorbital light patches, a second is at base of dorsal fin, the third is between dorsal and adipose fin, the fourth crosses highest point of adipose fin. Dorsal fin with black submarginal blotch and dusky base; caudal fin and peduncle ringed with a black band and then white band, centre of caudal fin with one or more radiating bands of speckles; anal fin dusky at base, with row of spots in from edge; pelvic fins clear, ventrally pigmented at upper base; pectoral fins sometimes with vague, irregular spots near tip and pigment along spine heaviest on dorsal surface; all barbels light to speckled.

Systematic notes This species, originally in the genus *Noturus*, was later called *Schilbeodes*, and returned to *Noturus* by Taylor (1955, 1969).

Taylor stated that the brindled madtom showed remarkable uniformity of characters considering its wide latitudinal range. The chief geographic difference was that southern specimens were paler and more emaciated and northern ones darker and fatter.

The northern madtom, *N. stigmosus* Taylor, is known to occur in the Detroit River in the United States. It is very similar in colour, and almost identical in meristic characters (dorsal with 1 spine and 5–7 rays, anal 13–16, pelvic 9 or 10, pectoral 7 or 8, vertebrae 31–35) to *N. miurus*. This species should be watched for in collections of *N. miurus* in southwestern Ontario. The Detroit River collection has been included by various authors under the names *S. eleutherus* (Hubbs and Lagler 1941, 1947), *N. eleutherus* (Scott 1967), *S. furiosus* (Hubbs and Lagler 1958, 1964), and *N. furiosus* (Trautman 1957).

Distribution The brindled madtom occurs only in the fresh waters of east-central North America. Its range extends south from the Finger Lakes and Lake Ontario drainages of New York, west of the mountains, to the western halves of the states of Tennessee and Mississippi, west to central Louisiana, north through Arkansas to northeastern Oklahoma and southeastern Kansas, southeastern Missouri, northeast from southern Indiana to southern Michigan and southwestern Ontario and into New York.

In Canada, it occurs only in Ontario, is rarely seen, and is known only from the Sydenham River, a tributary of Lake St. Clair, tributaries of Lake Erie, and the Niagara River. It was first recorded in Canada by Hubbs and Brown (1929). It had been earlier listed for Lake Erie by Dymond (1922) but on the basis of a United States record.

Biology Nothing is known of the biology of this species in Canada. Taylor (1969) gave details of spawning in Michigan. It spawns in Michigan in July to early August, at a water temperature of 78° F (25.6° C), in rivers where current is slow, with a bottom of silt, mud and scattered emergent vegetation. Almost invariably, the brooding pair were found in tin cans in which the top was open or which had a $\frac{3}{4}$–1 inch (18–25 mm) hole in the end. The male guards the nest. The number of eggs in a cluster varied from 34–46. Eggs were large, amber, and adhered to one another. Some incomplete broods (in addition to unhatched eggs) consisted of 28–38 young. Newly hatched young are 9.5–11 mm in total length. *See* Taylor (1969) for details of early development.

Trautman (1957) reported that young-of-the-year, in October in Ohio, are 1.0–2.2 inches (25–56 mm) total length, at one year 1.4–2.5 inches (36–64 mm) total length, and as adults (2–3 years?) usually 2.2–3.8 inches (56–97 mm). They are sexually mature at

2.0–2.8 inches (51–71 mm). The largest specimen examined by Taylor was 3.4 inches (88 mm) standard length but Trautman gave maximum size as 5.2 inches (132 mm). The largest Canadian specimen in our collection is 3.3 inches (85 mm) total length and came from the Niagara River.

Specimens taken in Ontario were from clear, fast-flowing streams with gravel bottoms. Taylor said that in the United States it seems to avoid that type of habitat and that it lives in pools below riffles in lowland streams with some current, and in lakes, in areas over a soft bottom often with an abundance of leaves and twigs.

Feeding doubtless takes place at night, and food is probably immature aquatic insects, other invertebrates, and plants. *See* Baker (1916) for food of this species in Oneida Lake, N.Y.

Little is known of its predators but there is a record of it in the food of a gar. Its secretive nature and nocturnal habits may make predation difficult. It probably competes for food with other bottom feeders.

The brindled madtom seems comparatively free of parasites. Hoffman (1967) listed only four trematodes. Bangham and Hunter (1939) studied the parasites of this species in Lake Erie and cited the trematodes *Megalogonia ictaluri*, *Neascus* sp., and the cestodes *Corallobothrium fimbriatum*, and *Bothriocephalus* sp.

Schwartz (1956) described a case of death from the parasite *Clinostomum marginatum*.

Trautman (1948) described hybrids between *N. miurus* and *N. gyrinus* and Taylor (1969) added one between *N. miurus* and *N. exilis*.

Relation to man This secretive fish, rare in Canada, bears no relation to man other than in its unknown ecological role. It is interesting as one of the three Canadian freshwater species which can inflict a painful, but not dangerous, wound with its sharp pectoral spines and associated poison gland (*see* Reed 1907, 1924a).

Nomenclature

Noturus miurus	— Jordan 1877b: 370 (type locality White River at Indianapolis, Ind.)
Schilbeodes miurus (Jordan)	— Dymond 1922: 62
Noturus miurus Jordan	— Taylor 1955: 375

Etymology *Noturus* — tail over back, in allusion to connection of caudal and adipose fins; *miurus* — curtailed, possibly referring to the short appearance of this fish.

Common names Brindled madtom, mad tom, brindled stone-cat. French common name: *chat-fou tacheté*.

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THE EELS — Order Anguilliformes (Apodes)

The body shape of the true eel is so characteristic and well known that expressions such as "eel-like" and "eel-shaped" have entered the language as adjectives to describe creatures that are not eels.

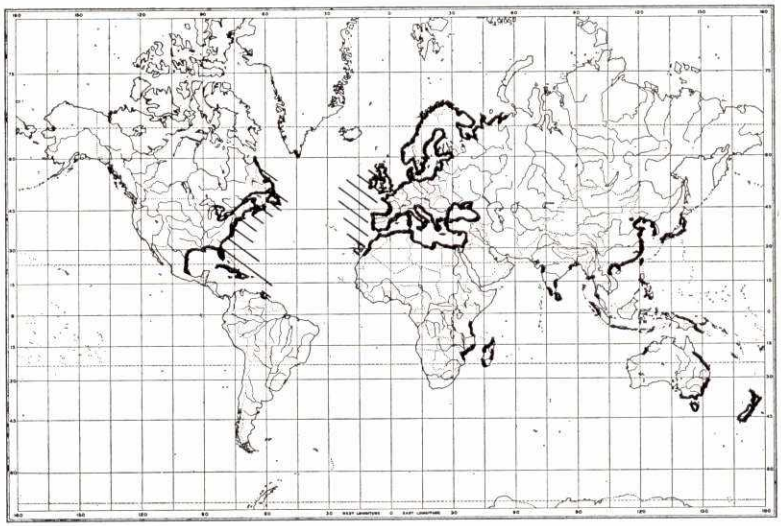
Body excessively elongate and often almost round in cross section. Skull elongated, some bony elements fused and consolidated; jaws well developed, toothed; gill opening usually small, restricted. Branchiostegal rays 6-22. Fins all soft rayed, dorsal often long, caudal, when present, ending in a point; and anal long, of many rays, but usually shorter than dorsal; pelvic fins (and pelvic girdle) absent; pectoral fins, when present, somewhat elevated to a midpoint position on sides, the bases approaching vertical orientation. Scales, when present, small, cycloid, and embedded. Physostomes. Vertebrae numerous.

The eels are primarily marine fishes widely distributed throughout the warmer seas of the world. There are about 20 families and several hundred species. Only one species enters eastern Canadian waters. Upper Cretaceous to Recent.

Freshwater Eel Family — Anguillidae

The freshwater eels exhibit all the structural characteristics of the order, but differ in that all species leave the sea and enter fresh water early in their development and remain in fresh water throughout their lives, returning to the sea to spawn (i.e. catadromous) and presumably to die.

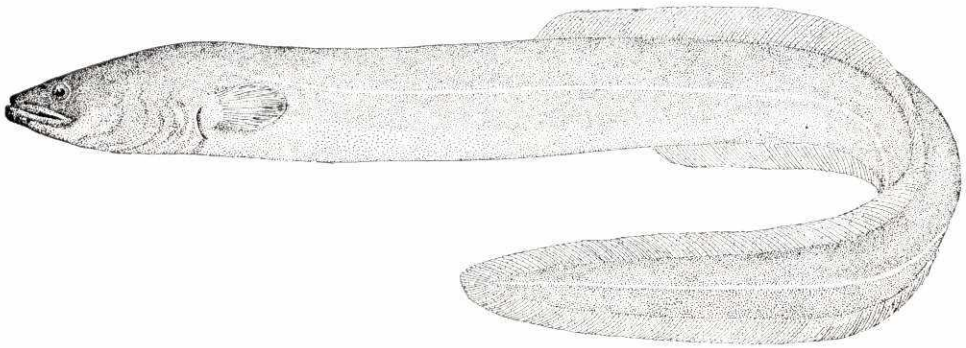
There are about 16 species, all in the single genus *Anguilla*, occurring widely throughout the world, particularly in the region of southeast Asia and the southwestern Pacific Ocean, including Australia and New Zealand. Only one species occurs in North American waters. A thorough review of the genus was prepared by Ege (1939).



World Distribution of the Freshwater Eels

AMERICAN EEL

Anguilla rostrata (Lesueur)

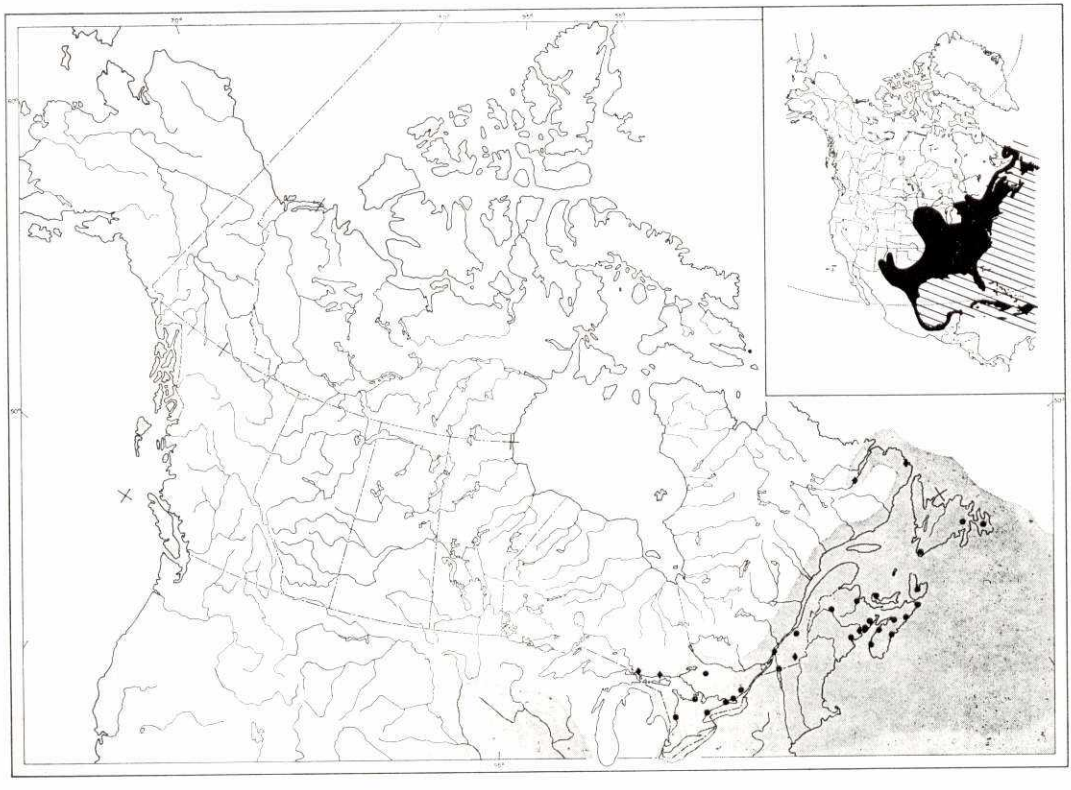


Description A full morphometric description of the American eel, in addition to the details in order and family accounts, will probably serve little purpose. The shape of the eel is so well known that words such as "eel-like" and expressions such as "slippery as an eel" are commonplace. The most characteristic features are: protruding lower jaw, gape extending to below eye or beyond; small gill opening in front of pectoral fins, which are located high on sides; dorsal fin beginning far behind head and in front of anal fin; pelvic fins absent; dorsal, anal, and caudal fins continuous; caudal bluntly rounded. Vertebrae 103–111.

Colour Colouration varies according to the developmental stage. A larval eel, called a leptocephalus, is elongate and rather lanceolate in shape, somewhat leaflike, and is transparent. Young eels, just before reaching the seashore, have the general shape of an eel, and the eyes are dark, but the body is still as transparent as glass, as in the leptocephalus stage. At this stage they are usually called "glass eels." On reaching brackish or fresh water they become greyish green and are known as "elvers." After several years in fresh water, the sexually immature adult eel is yellowish, greenish, or olive-brown in colour, sometimes with tinges of yellow, yellow-green, or orange-pink on the sides. The back is darker, the belly lighter (yellow eels). When sexually mature, in their seaward migratory state, the eels take on a metallic shine, the back is bronze or almost black, the belly is light or silvery (silver eels). For this stage, Vladykov (1955c) proposed the name "bronze eel" to correspond with the name "black eel" used by the fishermen. Eales (1968), in his study of eel fisheries in eastern Canada, says that colouration of adult eels is variable between the yellow eel and silver eel phases and states ". . . in response to changing illumination, eels can alter their skin colouration by pigment redistribution within hours."

Systematic notes Two species of eels are considered to exist in the North Atlantic region, the American eel, *Anguilla rostrata*, and the European eel, *Anguilla anguilla*. The two species are exceedingly similar but differ quantitatively in the number of vertebrae (103–111 for *A. rostrata* and 110–119 for *A. anguilla*), supposedly in the duration of the larval stage, in the larger size of North American eels, in colour, and in a few additional features.

Distribution The American eel occurs from southwest Greenland, where a few specimens were reported by Jensen (1937),



along the coast of North America, from the northernmost continental limit of range in the Hamilton Inlet–Lake Melville estuary on the coast of Labrador, south through the Strait of Belle Isle, the Gulf of St. Lawrence, and Newfoundland, occasionally off Bermuda, to the Gulf of Mexico, Panama, and the West Indies. The American eel ranges from 5° to 62°18′N lat. It is found in coastal areas and fresh waters inland to the Great Lakes, and up the Mississippi River. It is occasionally taken off the northern coast of South America. No eels exist in the south Atlantic Ocean or on the Pacific coast of North America.

In Canada the eel is abundant in the fresh and salt waters of Newfoundland, the Maritime Provinces, the Gulf of St. Lawrence and the St. Lawrence River, and all Quebec and New Brunswick rivers flowing into the St. Lawrence basin. It is also found in the Ottawa River drainage and in Lake Ontario. Relatively rare in lakes Erie, Huron, and Superior, it is considered to have gained access to these lakes through the Welland Canal rather than through the Trent Waterway, in fact there is no evidence that it ever made use of this latter route. It occurs in many inland lakes in Ontario and Quebec, tributary to the Lake Ontario–St. Lawrence River system.

Biology Few fishes have attracted the attention of North Atlantic peoples as have the eels and the salmon, dissimilar as they are in so many ways. On attaining sexual maturity, adult eels move downstream, that is, seaward, eventually to spawn in salt water. Such fishes are said to be catadromous. Salmon, on the other hand, spawn in fresh water, but move to salt water to feed and grow, returning to fresh water to spawn. They are said to be anadromous. The upstream migration of young eels in spring (mainly May and June in New Brunswick) and the downstream movement of large adults in autumn was well known, but previous to Schmidt's (1922)

discoveries their life at sea was a complete mystery. Where the adults spawned, or from whence came the swarms of young eels or elvers, were unknown and subject to centuries of speculation and countless myths. Then, in 1922, after many years of intensive study, Johannes Schmidt published his classical account of the breeding places of the eel, his particular interest being the European eel. He concluded that both European and North American eels spawned in the southwest part of the North Atlantic.

But before considering the implications of Schmidt's conclusions, some biological details are in order. Unlike many other fishes, eels have a true larval stage, in which the young eel does not resemble the adult, but on hatching becomes a transparent ribbonlike creature, the eyes alone being conspicuous. At this stage, the larval eel is sometimes called a leptocephalus. By planned searching for *Anguilla* larvae at sea, using special nets to catch the fragile creatures, and plotting the lengths of larvae caught, Schmidt was able to show that the smallest larvae occurred in that region of the North Atlantic east of the Bahamas and southwest of Bermuda, an area often called the Sargasso Sea. Incidental to his search for larvae of the European eel, Schmidt caught larvae of the American eel, and concluded that its spawning ground was south and west of that of its European counterpart. It is presumed that the adults die after spawning. Larvae of European eels are thought to require up to 3 years to reach the European coast. American eel larvae arrive off our coastal waters in 1 year, and since both metamorphose, or assume the adult form, when 2.4–2.6 inches (60–65 mm) long, it is reasoned that the American larvae grow much faster than the European. For the American eel, metamorphosis apparently takes place during winter on approaching, or in, inshore waters. The larvae or leptocephalus becomes a small, transparent eel (glass eel), then pigmentation develops, and by the time it reaches streams and rivers of the coast it has become completely pigmented, is now 2.5–3.5 inches (65–90 mm) long, and is called an elver. Elvers sometimes occur in great numbers.

Despite increased oceanographic investigations, neither Schmidt nor subsequent workers have found eggs (except four eggs reported by Fish (1927) and discounted by Danish authors), concentrations of small (7 mm) larvae, or spawning adult eels at sea. Repetition or "recirculation" of Schmidt's original work has resulted in a number of authoritative-sounding statements such as: "Its spawning area is strictly confined to depths of 400 metres with the temperature of 17° C . . ."; "Each female is said to produce 15–20 million eggs. These eggs are about 1 mm in diameter"; "There, at a place where the water temperature varies between 59 and 61 degrees F. and the salinity between 36 and 37 parts per thousand, each female sheds her 10 to 20 million eggs. While the adult eels die, the larvae hatch from the eggs, turn into glass eels and, guided by an unerring instinct head for the continent from whence their parents came . . ." Many more examples could be cited, but the point is that such statements cannot be proven and were not made by Schmidt.

Recently there has been a resurgence of interest in the early life history of the eel, sparked, in large measure, by a paper by Tucker (1959). He postulated that there is only one species of *Anguilla* in the North Atlantic, that European eels never reach their spawning ground, and that European eel populations are recruited from spawning by American eels. Such revolutionary concepts beg attention. However, the current situation has been most rationally reviewed and summarized by Vladykov (1964) who explained why more data are required and suggested that the spawning grounds of *A. rostrata* may be much further south than has been considered heretofore. Obviously, much remains to be learned about the life history of the Atlantic eels.

Growth of eels in Canadian waters has not been intensively studied and accurate age–length–weight figures are not available. Smith and Saunders (1955) suggested that, although the scales are small and embedded, they can be used for age determination. In Europe, age determinations are usually made from otolith examination. The life span of the

American eel is not known for certain, but Smith and Saunders recognized nine year-classes in their study in New Brunswick lakes. In Canada large females may be 30–40 inches (762–1016 mm) long and weigh 2.5–3.5 pounds. Eales (1968) noted that females 48 inches (1220 mm) long and 16 pounds in weight have been recorded. Males seldom exceed 24 inches (610 mm) in length. North American eels are generally larger than those in Europe. The longevity of the European eel, at least in captivity, has been well attested. Vladykov (1955c) reported the case of an individual kept in captivity from 1863, when 3 years old, to 1948, a life span of 88 years! No similar authentic records are known for North American eels.

The behaviour of eels in fresh water extends the air of mystery surrounding them. They move freely into muddy, silty bottoms of lakes, lying buried in the daylight hours in summer. They apparently spend the winter buried in mud and are sought by spear fishermen who probe the bottom with specially constructed spears. Medcof (1966), reporting on a series of observations on eels, attributed to eels a chirping or sucking noise often heard on warm August evenings at Scotsville Creek, Cape Breton Island.

Eels are voracious carnivores, feeding mainly at night and consuming a wide variety of fishes and invertebrate creatures. Contrary to earlier thinking, eels seek living rather than dead creatures and are not habitual eaters of carrion, although they do attack and partly consume fishes gilled in nets.

Godfrey (1957) studied food of 300 eels in four New Brunswick streams and concluded that larger eels (i.e., over 6 inches or 152 mm long) were important predators of young salmon. But Smith and Saunders (1955), in a comprehensive study in New Brunswick waters, concluded that eels tend to avoid cool spring-fed waters, which are most important to young salmon and brook trout. Blacknose dace were the most abundant fish in the region studied by Godfrey and the fish consumed most often by eels. Although 10% of the eels examined had consumed fish, 90% contained larval insects, particularly mayfly, stonefly, and dragonfly nymphs, and chironomid larvae. Other food items included crayfish, snails, and earthworms. Laboratory studies by Perlmutter (1951) suggested that eels may be effective predators on larval lampreys.

Elsewhere eels are known to eat a variety of fishes and invertebrates, although detailed food studies have not been published. As noted by Smith and Saunders (1955) the large organic intake by eels, their large numbers, their lengthy stay in fresh water, and their subsequent seaward migration, represent a considerable loss to the nutrient cycles of lakes and streams, a loss that should be better understood and, hopefully, managed.

In fresh water eels would seem to have relatively few enemies because of their nocturnal habits. However, there is little doubt that young eels contribute to the diet of larger fishes and, occurring as they do in exceedingly large numbers when first arriving from the sea, must be vulnerable to attack at this time. Needler (1929) reported up to 12 elvers per stomach in haddock caught off Cape Breton in May. We have observed a large migrating eel attacked and caught by an osprey and doubtless migrating adult eels fall prey to a variety of large marine species such as sharks and swordfish.

Little has been published regarding the parasites of the American eel in Canadian waters. Van Cleave (1921), working in the eastern United States, examined four species of Acanthocephala from the intestine: *Tanaorhamphus ambiguus* n.sp., *Neoechinorhynchus cylindratus, Echinorhynchus coregoni* (originally described from the Great Lakes), and *Echinorhynchus thecatus*. Van Cleave noted that there was no evidence of marine species of Acanthocephala inhabiting the intestine of *A. rostrata*. In 1923 the same author reported relatively large numbers of *E. thecatus* in the digestive tract of the American eel in Oneida Lake, N.Y., and noted that *N. cylindratus* was also present.

In a further study of the parasites in Oneida Lake fishes, Van Cleave and Mueller (1934) stated that the eel was the most important host of the trematode *Azygia longa* found in the stomach, and was also the only significant host of the cestode *Bothriocephalus claviceps*.

The cestode *Proteocephalus macrocephalus* and the nematode *Haplonema* sp. were also reported present in the digestive tract.

Hoffman (1967) listed many species of parasites infecting the freshwater eel in North American waters, including protozoans, trematodes, cestodes, nematodes, acanthocephalans, and crustaceans.

Relation to man Yellow and silver eels are fished commercially in Canada, the most successful fisheries existing along the St. Lawrence River between Trois-Rivières and Cap-Chat in Quebec. The Quebec fishery constitutes about 70% of the eels taken in Canada and these are mainly the prized silver (or bronze) eel. There are smaller fisheries on Lake Ontario around the Bay of Quinte, the northeast shore of New Brunswick, and the southwest coast of Nova Scotia (Eales 1968). Prince Edward Island has a very small fishery and, although attempts were made in Newfoundland to promote a fishery for export of eels to European countries, catches declined and the fishery has been discontinued.

Dr F. M. Atton (personal communication) has drawn to our attention an interesting experiment conducted in 1952. Drs A. G. Huntsman and V. Davidson arranged for the transport of elvers to Saskatchewan by air. About 30 or 40 1.5-inch (40-mm) long elvers were moistened with a tablespoon of water and placed in a pint ice cream box. The ice cream boxes were stacked in a large carton and shipped without temperature control. The elvers were in transit for about 24 hours before release in Saskatchewan. They were planted in a saline lake (461 ppm), (Lac Pelletier, near Swift Current). Dr Atton reported that the young eels survived well, for a number were recaptured 7, 8, and 9 years later, not in the lake but in the water supply reservoir at Swift Current. Others were caught in the South Saskatchewan River, and one was taken in the river at Saskatoon.

In Quebec, eels are taken mainly in weirs; in Ontario baited setlines and fykenets are used, and in the Maritimes they are captured in baited pots, hoops, and occasionally by weirs. The eels in Prince Edward Island are primarily speared. Smith and Saunders (1955) suggested that seaward migrations of eels may have represented major losses of organic matter to lakes.

The 1967 landings for Canada totalled 1,645,000 pounds with a value of $400,000 (Fisheries Statistics of Canada 1967). When exported most eels are shipped frozen.

Large eels find a ready market in England where they are desired alive for jellied eel, and some, cooked in olive oil and vinegar, are preferred by the Italians (Bruemmer 1967). Smoked eel, however, is by far the most acceptable in most countries, and is considered a connoisseur's item.

Eales (1968) gave a detailed account of the Canadian eel fisheries in the various provinces and the export markets.

Nomenclature

Muraena rostrata — LeSueur 1817a: 81 (type locality Cayuga Lake)
Muraena Bostoniensis — LeSueur 1817a: 81
Muraena serpentina — LeSueur 1817a: 81
Muraena argentea — LeSueur 1817a: 82
Muraena macrocephala — LeSueur 1817a: 82
Anguilla chrysypa — Rafinesque 1817b: 120
Anguilla vulgaris — Perley 1852: 219
Anguilla punctatissima — Kaup 1856: 44
Anguilla novaeterrae — Kaup 1856: 45
Muraena anguilla — Fortin 1863: 118
Anguilla Bostoniensis Les. — Adams 1873: 256
Anguilla tenuirostris DeKay — Adams 1873: 256
Anguilla muraena — Montpetit 1897: 261
Leptocephalus grassii — Eigenmann and Kennedy 1902: 84
Anguilla rostrata (LeSueur) — Bailey et al. 1960: 19

Etymology *Anguilla* — the eel; *rostrata* — from *rostratus*, meaning long-nosed.

Common names American eel, Atlantic eel, eel, common eel, freshwater eel, silver eel, easgann, elver. French common name: *anguille d'Amérique*.

Suggested Reading — Anguillidae

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THE KILLIFISHES — Order Cyprinodontiformes (Microcyprini)

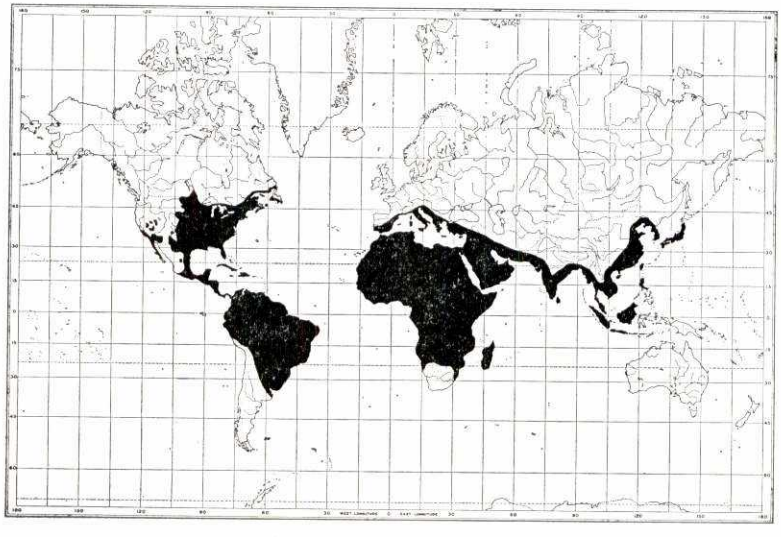
Small, stout-bodied fishes, moderately compressed laterally. Mouth small, terminal, lower jaw often projecting beyond upper; upper jaw bordered by premaxillae; jaws with well-developed teeth; orbitosphenoid and mesocoracoid bones absent. All fins soft rayed, single dorsal often located posteriorly; anal variously modified as an intromittent organ in some groups; pelvics, when present, abdominal; pectorals located in elevated position on sides, the bases approaching vertical orientation; scales cycloid, rarely ctenoid, or absent, on head and body; typically without pored scales of lateral line. Physoclists.

These small fishes are characteristic of tropical or subtropical, marine, brackish, or fresh waters of all continents except Australia. The order contains 8 families and about 400 species. One family, the Poeciliidae, includes many well known live-bearing aquarium fishes. The family Cyprinodontidae occurs naturally in eastern Canadian waters but the family Poeciliidae has been introduced in some restricted localities in Alberta. Oligocene to Recent.

KILLIFISH FAMILY — Cyprinodontidae

Small fishes exhibiting the principal characters of the order. Head often adapted for surface feeding, flattened above; mouth small, terminal, protractile. Branchiostegals 5–7. Gill membranes free from isthmus. Caudal fin squarish or rounded; anal fin not conspicuously modified. Scales cycloid.

Most species of killifishes inhabit freshwater shallows, but many move freely into brackish water and even sea water. They occur in southern Europe, Africa, southeast Asia, and the East Indies but attain greatest development and are most speciose in southeastern United States. The family contains about 45 genera and some 300 species of which two occur in Canadian waters. From Oligocene to Recent.



World Distribution of the Killifishes

KEY TO SPECIES[1]

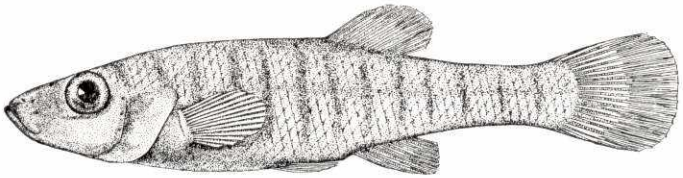
1 Gill rakers usually 5, widely spaced and obvious; branchiostegal rays 6,6, never 5,5; distance from origin of dorsal to end of vertebral column, when stepped forward from dorsal fin origin, reaches a point about middle of eye. ..... BANDED KILLIFISH, *Fundulus diaphanus* (p. 631)

Gill rakers usually 9 or more, crowded and not obvious; branchiostegal rays 5,5, rarely 6,6; distance from origin of dorsal fin to end of vertebral column, when stepped forward from dorsal fin origin, reaches to posterior half of operculum..... MUMMICHOG, *Fundulus heteroclitus* (p. 635)

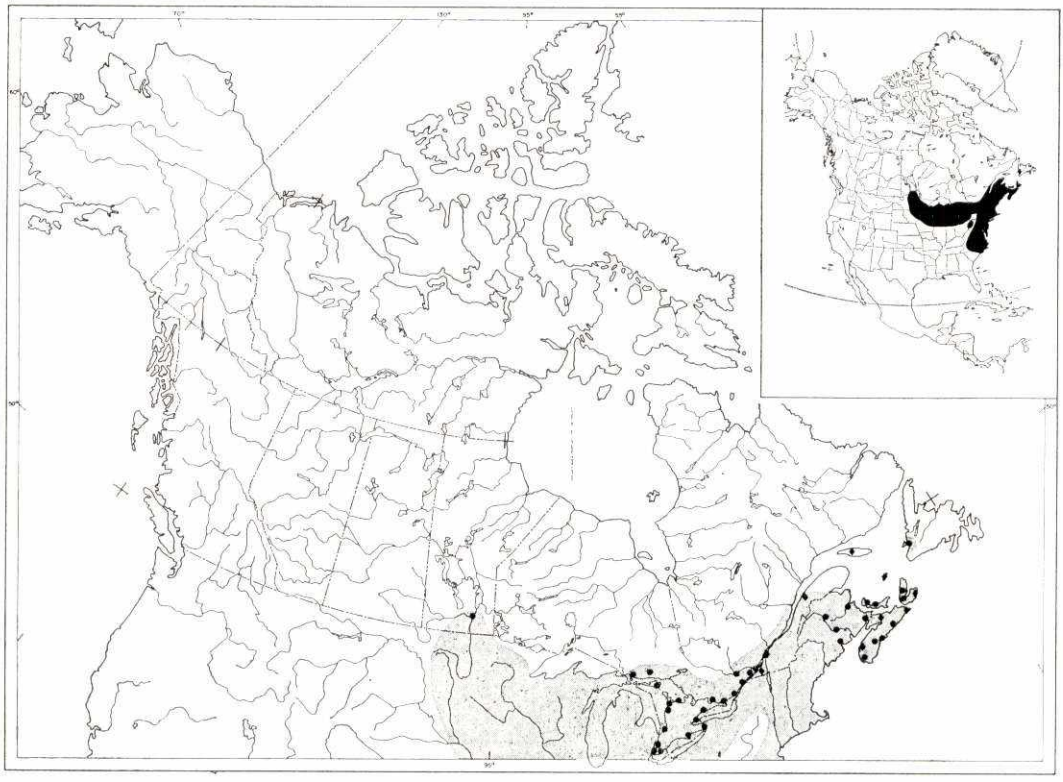
[1]*Fundulus notatus* was reportedly caught in Sydenham River, Ontario in late 1972, after this manuscript had gone to press.

BANDED KILLIFISH

Fundulus diaphanus (Lesueur)



Description Body elongate and slender, somewhat flattened at back of head and nape region, average length about 3 inches (76 mm), greatest body depth 12.9–17.2% of total length. Head bluntly triangular and broad, its length moderate, 21.3–24.2% of total length; eye moderate, its diameter 23.6–31.7% of head length; snout bluntly rounded, its length 30.3–35.7% of head length; interorbital width 29.4–34.9% of head length; mouth opening small and directed upward, lower jaw protruding when mouth closed, teeth on upper and lower jaws only, teeth in outer rows larger than those of inner row, tooth size decreases posteriorly; premaxillaries protractile. Gill rakers small, 4–7 usually 5 or 6. Branchiostegal rays usually 6,6(24), but sometimes 5,6(3), 6,7(1), or 7,7(1). Fins: dorsal 1, its origin distinctly in advance of anal fin origin, rays usually 13(18), sometimes 12(6), 14(8), or 15(2), larger on males than on females; caudal rounded, rays usually 16(38), sometimes 14(3), 15(4), or 17(3); anal 1, its origin distinctly posterior to dorsal fin origin, rays 11(19), 12(13), or 13(1), larger on males than on females; pelvics abdominal, small, rounded, rays 6(52); pectorals rounded, paddle-like, rays variable but usually 16(23), sometimes 14(6), 15(4), 18(2), or 19(1). Scales cycloid, in 40–51 rows on body, counting from upper end of gill opening, variable



but usually 43–49; lateral line pores on head only, none on body (see *F. heteroclitus*). Peritoneum silvery and lightly speckled, not uniformly black; intestine with single loop, about one-half body length. Vertebrae usually 34(14), but sometimes 33(2), 35(5), or 36(4).

Colour The overall colouration is brown or dark brown to olive-green on the back, becoming silvery or yellow-silvery on the sides and white or yellowish white below. There are usually 12–20 vertical bars on the sides (fewer and more widely spaced on females), which are quite apparent on dead or preserved specimens but may be rather inconspicuous on living ones. The overall colouration, including the vertical bars, dorsal, and anal fins, is enhanced on males during spawning. The dorsal fin, in particular, may exhibit green-gold iridescence and a suggestion of a band or two of black pigment.

Systematic notes Two subspecies have been described, both of which occur in Canada. The eastern banded killifish *F. d. diaphanus,* occurs in the Atlantic drainage of Canada westward to eastern Lake Ontario and the upper St. Lawrence River, where it intergrades with the western form *F. d. menona.*

Hybridization is apparently rare, but Hubbs et al. (1943) described a single specimen, a hybrid, apparently the product of a mating between *Fundulus diaphanus* and *F. heteroclitus*, caught in Lake of Shining Waters, P.E.I., by M. W. Smith in 1939. Breder and Rosen (1966) noted that Newman (1914) had more success experimentally hybridizing *F. diaphanus* and *F. heteroclitus* than any other *Fundulus* spp.

Distribution The banded killifish occurs from South Carolina north to the Maritime Provinces and Newfoundland; west through New York, Pennsylvania, and south-

ern Canada in the Great Lakes basin, to the Yellowstone River in eastern Montana.

In Canada, it is rather widely distributed in the Maritime Provinces but is known from only a few localities in southwestern Newfoundland; through the St. Lawrence valley of Quebec in suitable habitats; through the Great Lakes watershed of southern Ontario, excluding Lake Superior (excepting extreme eastern Lake Superior in Michigan waters). It was reported only once from the Red River of Manitoba (Stewart-Hay 1954), but there apparently have been no subsequent captures.

Biology One of the few observers to record the spawning behaviour of the banded killifish was Richardson (1939), whose observations were made on a tributary of the Richelieu River near Iberville, Que. Richardson's fish spawned in aquaria during the last week of May, 1935, at a temperature of 73.4° F (23° C), although prespawning activities became apparent at 69.8° F (21° C).

In the wild, the males selected breeding areas in the quiet waters of weedy pools. These areas were defended vigorously. Fights between rival males were common, but Richardson described them as not vicious nor damaging. The males assumed their most intensive bluish-green colouration, but the females remained pale. In aquaria, males and females eventually paired off according to size, each male pursuing an individual female. The genital papilla of the female enlarged and protruded obviously during the pursuit, and after several minutes the female extruded a single egg. The single egg remained suspended by a fine translucent thread, about an inch below the papilla. The male then pursued even more vigorously, driving the female into a cluster of weeds, pressing his body closely against hers and holding her in this position by using the dorsal and anal fins, rather in the manner described for *F. heteroclitus*. The female exuded additional eggs, in clusters of 5–10. The male's body quivered rapidly and assumed a bow shape, and it was at this time that milt was released and fertilization occurred. Richardson noted that on fertilization the eggs usually separated from the cluster, became detached from the thread, and, falling into the weeds, became entangled by their individual threads which appeared to be quite adhesive. If the egg cluster failed to break up, it was usually caught in the weeds and pulled free of the female as she swam away. The whole mating performance required 15–30 seconds and was repeated several times over a period of about 5 minutes until about 50 eggs were deposited by each of the pairs under observation in the aquaria.

Egg diameters were not noted by Richardson (1939) but Cooper (1936a) gave a diameter of 2.0 mm for eggs taken in a hatchery pond in Michigan. These latter hatched in 11–12 days at water temperatures of 72°–80° F (22.2°–26.7° C), yielding fry 6–7 mm long. Cooper (1936a) found eggs only among filamentous algae. Larval stages of 7.1 mm and 12.3 mm, total length were described and illustrated for Lake Erie specimens by Fish (1932).

Critical growth studies appear to be unavailable. From a length of 6–7 mm, on hatching, young banded killifish may attain a total length of 0.8–2.3 inches (20–58 mm) by October of their first year in Ohio (Trautman 1957); or total lengths of 1.3–2.5 inches (33–64 mm) at age 1 in Gibson Lake, N.B., (Smith 1952). Adult sizes usually range from 2.5–3.0 inches (64–76 mm) total length in inland waters, but larger sizes are common in the Maritime Provinces. In Wheaton Lake, N.B., adult females over 3 inches (76 mm) are common, and from Lake O'Law, Inverness County, N.S., there are specimens in the ROM collection over 4 inches (102 mm) total length, and one measured 4.5 inches (114 mm) total length. This is possibly the largest size reported for the species in Canada.

The banded killifish prefers the quiet waters of lakes and ponds. Small schools are usually found over sand, gravel, or detritus-covered bottom where there are patches of submerged aquatic plants. The schools tend to stay in sand-bottomed shallows.

Keast and Webb (1966) worked on Lake Opinicon, Ont., and noted that the species fed as a member of a school. The individuals are versatile feeders, are rather generalized in their food and feeding habits, and feed effectively

at all levels despite the dorsal position of the mouth. Small killifish of 1.2–1.6 inches (30–40 mm) total length ate mainly chironomid larvae (at times up to 60% by volume), ostracods (to 35%), cladocerans (to 25%), copepods (to 30%), and smaller amounts of amphipods and flying insects. Adults of 2.4–3.2 inches (60–80 mm) total length ate the same items as the smaller fish but in addition consumed newly hatched Odonata and Ephemeroptera nymphs, molluscs, and turbellarians. It was the only species in the lake to feed on ostracods to a significant degree.

The banded killifish may serve as an important food of game fish, whenever it occurs in sufficient numbers. It also formed an important part of the diet of the kingfisher and the American merganser in the Maritime Provinces (White 1953, 1957).

Bangham and Hunter (1939) examined 31 specimens of *F. d. menona*, and found 13 infected. Parasites listed were the trematode *Neascus vancleavei*, nematodes *Agamonema* sp., and *Rhabdochona* sp., protozoan Myxosporidia, and the larval or immature forms of the cestode *Proteocephalus* sp., and of the acanthocephalan *Neoechinorhynchus* sp.

Hoffman (1967) listed protozoans (1), trematodes (14), cestodes (1), nematodes (1), and acanthocephalans (2), from the banded killifish in North American waters.

Relation to man Banded killifish are sometimes used as live bait in parts of Nova Scotia and New Brunswick, for it is hardy and may survive for many hours in a minnow pail. It is also said to live for many hours packed in leaves in a tin can. Livingstone (1953) reported that it could live this way, without water, for several days. It must indeed be a hardy species!

Nomenclature

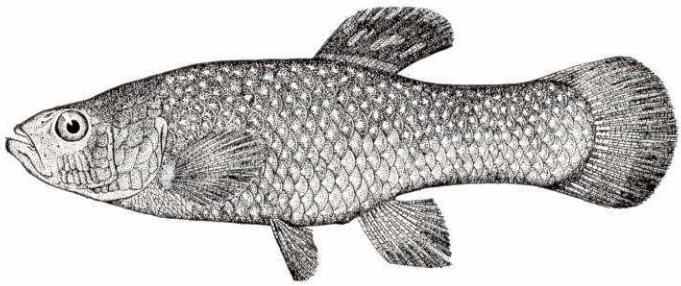
Hydrargira diaphana	— LeSueur 1817e: 130 (type locality Saratoga Lake, N.Y.)
Hydrargira Multifasciata	— Small 1865: 35 (abundant in the St. Lawrence River)
Zygonectus diaphanus (LeSueur)	— Jordan, Evermann, and Clark 1930: 178
Fundulus extensus	— Hubbs 1931: 3
Fundulus diaphanus	— Nash 1908: 71

Etymology *Fundulus* — *fundus*, meaning bottom, the abode of the "Fundulus mudfish"; *diaphanus* — transparent.

Common names Banded killifish, eastern and/or western banded killifish, freshwater mummichog, fresh-water killy, grayback, freshwater killifish, killifish, topminnow, minnow, menona killifish, barred minnow. French common name: *fondule barré*.

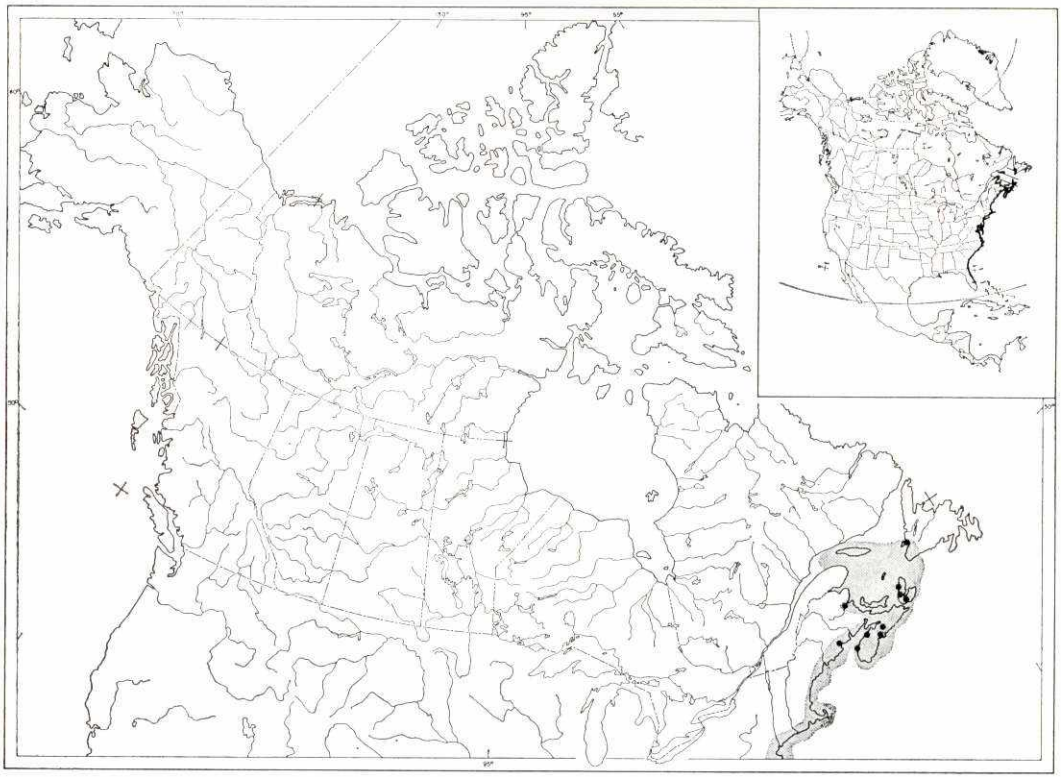
MUMMICHOG

Fundulus heteroclitus (Linnaeus)



Description Body generally robust and rather thick but elongate, somewhat flattened at back of head and nape region, size small, average length about 3 inches (76 mm), with a deep caudal peduncle, greatest body depth 15.8–20.0% of total length. Head moderate, bluntly triangular, and broad, its length 20.6–25.0% of total length; eye moderate, its diameter 21.6–28.3% of head length; snout bluntly rounded, its length 26.6–34.1% of head length; interorbital width 33.3–44.0% of head length; mouth opening small and directed upward, lower jaw protruding when mouth closed; teeth on upper and lower jaws only, teeth in outer row longer, those of inner row shorter, longest teeth at median position of upper jaw, becoming shorter posteriorly; premaxillaries protractile. Gill rakers small, 8–12, usually 9–11. Branchiostegal rays usually 5,5(26), but some variability, 5,4(1); 4,5(1); 6,6(8); 5,6(3). Fins: dorsal 1, its origin slightly in advance of anal fin origin, rays 11(26) or 12(37), seldom 10(1) or 13(5), larger in males than females; caudal rounded, rays usually 18–20(37), sometimes 17(2), 21(10), or 22(5); anal 1, its origin slightly posterior to dorsal fin origin, rays usually 11(21), sometimes 9(2), 10(15), or 12(1), larger on males than females; pelvics abdominal, small, rounded, rays usually 6(56), sometimes 7(12); pectorals rounded, short, paddle-like, rays usually 18(32) or 19(29), sometimes 16(1), 17(4), or 20(3), (for details of fin regeneration, *see* results of experimental work by Goss and Stagg 1957). Scales cycloid, in 32–38 rows on body, counting from upper end of gill opening usually 34–36; scales on males with contact organs during mating season (*see* Newman 1907); lateral line pores on head only, no lateral line on body (*see* Denny 1938; and Van Bergeijk and Alexander 1962). Peritoneum uniformly black. Vertebrae usually 33(25) but sometimes 32(7), 34(6), or 35(1).

Colour Highly variable depending on age, sex of individuals, and local conditions, but overall colour is olive-brown, olive-green to pale green or almost tan. Young fish are usually lighter in colour with few vertical bars, while older ones are darker, with numerous but often poorly defined silvery vertical bars. Males colourful, especially in spring spawning dress, with olive-green over the back and upper parts of sides, about 15 wavy, silvery, vertical bars on sides, more distinct posteriorly, steel-blue hue on sides, ventral surfaces are strongly yellow or orange-yellow. The ventral surface of head and body, including pectoral, pelvic, and anal fins suffused with yellow; dorsal fin with mottled appearance (*see* Parker and Brower 1935) and often with an oblong black blotch, with a whitish margin on upper portion of posterior rays of dorsal fin; mature males have also a



small yellow spot on the back at the origin of the dorsal fin. Adult females are more uniformly olive-green to light olive in colour and lack the intense yellow on ventral surface, and the dorsal fin is uniformly pigmented but never with mottled or black markings.

Many authors have remarked upon the unusual ability of the killifishes, especially *F. heteroclitus,* to change colour in response to changes in background colour.

Systematic notes A number of subspecies of *F. heteroclitus* have been described but their present status is not clear. The typical subspecies, *F. h. heteroclitus,* is said to range from northeastern Florida to about Virginia. *F. h. macrolepidotus* ranges from Virginia north to the Gulf of St. Lawrence and southern Newfoundland, and is, therefore, the form occurring in Canadian waters.

Examples of hybridization involving *F. heteroclitus* are rare but Hubbs et al. (1943), described in detail a single, adult female, *Fundulus diaphanus diaphanus* × *F. h. macrolepidotus* taken in Lake of Shining Waters, P.E.I., by M. W. Smith in 1939.

Sexual dimorphism is exhibited by both colour and size of dorsal and anal fins; the male is the more colourful and has a variously mottled dorsal fin and both dorsal and anal fins of males are larger and better developed than those of females.

Babkin and Bowie (1928) demonstrated that the species does not have a stomach in the classical sense; that is, it does not have an organ that secretes pepsin–hydrochloric acid, but has the intestine (duodenum) joined directly to the oesophagus, a situation similar to that found in the Cyprinidae.

Distribution The mummichog occurs in Atlantic coastal and brackish waters from northeastern Florida to the Gulf of St. Lawrence region. It occasionally enters freshwater streams and rivers.

In Canada it occurs throughout the shore

waters of all of the Maritime Provinces to the Port au Port Bay region of southwestern Newfoundland, in all suitable waters but particularly in estuaries and salt marshes, west in the Gulf of St. Lawrence to Anticosti Island and both shores of Quebec, upriver to about the head of tide.

Biology Many observers have reported on the spawning activities of the mummichog but one of the earliest and most comprehensive accounts was that of Newman (1907), based on populations in the vicinity of Woods Hole, Mass. Spawning takes place in the spring and summer but the commencement and duration of spawning is significantly affected by temperature (Brummett 1966). In the New England region it is said to spawn in June, July, and early August, although Brummett noted that spawning at Woods Hole was usually limited to June and the first 2 weeks of July.

Courtship and spawning behaviour were also described in detail by Newman (1907) who noted that the male was active and aggressive in courtship, but that females also attracted males by turning on their sides near bottom and flicking their tails. No nest was prepared. Pairs of males and females swim about, the female slightly above, the male below and slightly behind the female. He observed that a spawning male will eventually crowd a ripe female against a reasonably solid object such as a rock or stone, his whole body in contact with hers, head to head, and tail to tail. It is presumably at this time that the contact organs function. These are fingerlike processes on the scale margins which Newman described and illustrated. The female's body was so curved that only the head and a central portion of the body were in contact with the object. The male held the female in this position by using his larger dorsal and anal fins as claspers, sliding them under the homologous fins of the female and folding them around her body. This position was usually assumed near bottom and the female was often supported from the bottom by her anal fin which sometimes became inflamed from frequent contact with the bottom substrate. The male was usually in contact with the female for one to two seconds during which time a quivering vibration occurred and both eggs and sperm were extruded by the spawning pair. Newman believed the vibration originated with the female since he observed females in aquaria exhibiting vibrations during the emission of eggs in the absence of males. The eggs are extruded through a tube on the anterior margin of the anal fin (Bertrand 1893) and appear to drop off the anterior tip of the fin. The eggs are usually pale yellow in colour and about 2 mm in diameter. Katz (1954) recorded 460 eggs from one female. On extrusion, they become adhesive and may stick together or become attached to bottom materials. They are said to hatch in 24 days at 55°–63° F (12.8–17.2° C), according to Ryder (1886), and in 9–18 days, depending on temperature (Bigelow and Schroeder 1953). The larvae are 7.0–7.7 mm long on hatching, according to Bigelow and Schroeder, who noted further that the dorsal and anal fins are fully developed at lengths of 11 mm, the pelvic fins at 16 mm, and that by 20 mm the young resemble their parents. Scales first appear about the pectoral fins when young are 12.4–12.7 mm long.

The remarkable hardiness of the eggs has been discussed at length by Stockard (1909, 1910), and Chidester (1916).

Although the mummichog has been widely used in experimental studies, little attention has been paid to growth and, hence, data on rates of growth are not available. Maximum size attained in the Canadian area is about 5.1 inches (130 mm). Fish of this size have been reported by Needler (1939) from Prince Edward Island, and we have specimens of this size from the Magdalen Islands, both localities in the Gulf of St. Lawrence. Possibly mummichogs grow larger in the Gulf of St. Lawrence than elsewhere in the Canadian region for Bigelow and Schroeder (1953) reported that adults seldom exceed 3.5—4.0 inches (89–102 mm) in length in the Gulf of Maine.

Mummichogs occur most commonly in salt marsh flats, estuaries, and tidal areas, especially where there is submerged or emergent vegetation. Although it is primarily a salt and brackish water form (Needler 1939, reported

that it was one of the most abundant species in Malpeque Bay, P.E.I.), it may also occur in freshwater. Klawe (1957) reported such a population in a freshwater lake on Digby Neck, N.S. It appears to be tolerant of a wide range of salinities and also temperatures. Garside and Jordan (1968) presented comparative lethal temperature data indicating that the upper lethal temperature for the mummichog was 93.0° F (33.9° C) at 14‰ salinity.

The mummichog, in common with other cyprinodont fishes, has a flattened head and a mouth that opens dorsally, which are adaptations for surface feeding. Nevertheless, available information indicates that this is an omnivorous feeder, but detailed food studies are unavailable, at least for the Canadian region. Among the items found in their digestive tracts are diatoms, amphipods, and other crustaceans, molluscs, fish eggs and small fishes, and also vegetation such as eel grass. Newman observed that females would quickly devour their own eggs, or those of other females, given the opportunity.

The scattered records available suggest that a variety of other creatures prey on mummichogs, due in part to the availability of this species in schools in shallow inshore waters. Dr M. W. Smith reported that freshwater mummichogs were found in the stomachs of otter, mink, brook trout, and bullfrogs (White et al. 1965). Mummichogs were also reported as food of kingfishers by White (1953) particularly in Northumberland Strait and Prince Edward Island region. Mention has already been made of cannibalistic tactics of females devouring their own eggs.

White el al. (1965) raised the question of the toxicity of mummichogs when eaten by other animals, suggesting that there are grounds for suspicion, but to our knowledge, no further work has been attempted.

An unidentified species of the endoparasitic trematode *Distomum* was reported from the stomach and intestine by Stafford (1907), who worked at St. Andrews, N.B. A monogenetic trematode, *Gyrodactylus* sp., (family Gyrodactylidae) was described as a serious parasite of the mummichog in the region of St. Andrews, N.B., and Halifax, N.S., by Gowanlock (1927).

Hoffman (1967) listed the following parasites from the mummichog in North American waters: protozoans (10), trematodes (8), nematodes (1), acanthocephalans (1), and crustaceans (2).

Relation to man The mummichog has been a popular laboratory animal for embryological, and a wide variety of physiological, studies for many years, and was first used for experimental work in the late 1800's. Its hardiness, when held under artificial conditions, and the relative ease with which it can be captured, have contributed to its popularity. For the same reasons, the species is used to some extent as live bait by anglers, being known as "salt water minnows." Livingstone (1953) reported that successful air shipments of mummichogs from Halifax to central Canada have been made by commercial bait dealers.

As noted previously, White et al. (1965) drew attention to the possibility that mummichogs may be poisonous when eaten by other animals but the suspicion has not been investigated.

Nomenclature

Cobitis heteroclita	— Linnaeus 1766: 500 (type locality Charleston, S.C.)
Fundulus fasciatus	— Perley 1852: 194
Fundulus pisculentus Val.	— Adams 1873: 306
Fundulus nigrofasciatus (LeSueur)	— Cox 1896b: 67
Fundulus heteroclitis (Linnaeus)	— Jordan and Evermann 1896–1900: 640

Etymology *Fundulus* — *fundus*, meaning bottom, the abode of the "Fundulus mudfish"; *heteroclitus* — irregular or unusual.

Common names Mummichog, common killifish, salt water minnow, mummy, chub (Miramichi River and environs), common mummichog. French common name: *choquemort.*

Suggested Reading — Cyprinodontidae

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SCOTT, W. B. 1967. Freshwater fishes of eastern Canada. 2nd ed. Univ. Toronto Press, Toronto, Ont. 137 p.

SMITH, M. W. 1952. Limnology and trout angling in Charlotte County lakes, New Brunswick. J. Fish. Res. Bd. Canada 8: 383–452.

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THE CODLIKE FISHES — Order Gadiformes (Anacanthini)

The gadiforms are stout-bodied, elongate fishes, only moderately laterally compressed; the head is relatively large, the skull elongate, low, and composed of thin bones; the numerous small teeth are set in weak jaws, the upper jaw bordered by premaxillary only. A median, mental (or chin) barbel is often present. Branchiostegal rays 5–8. The fins are all soft rayed; there may be 1, 2, or 3 dorsal fins and 1 or 2 anal fins; the caudal fin is supported by the neural and haemal spines of the posterior vertebrae, not by an expanded hypural plate; pelvic fins of 5–17 rays, thoracic, or jugular in position, sometimes filamentous, and located below or in advance of the pectoral fins, the pelvic bones being attached to the cleithra by ligaments only or directly. Physoclists. Caudal vertebrae becoming smaller posteriorly; posterior vertebrae not upturned.

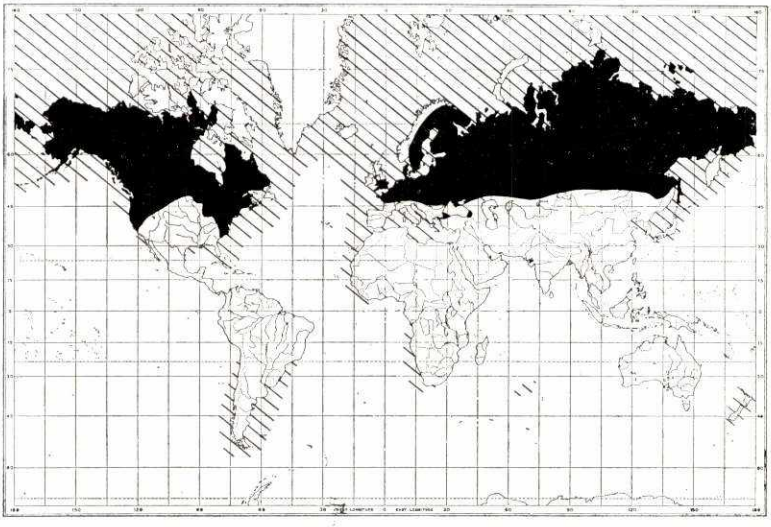
The gadiform fishes are widely distributed in cool seas. The order is classified in 5 families and about 400 species. Only one family, Gadidae, is represented in Canadian fresh waters.

Cod Family — Gadidae

The cods have large heads, wide gill openings, jaws terminal or nearly so, both jaws and vomer equipped with numerous small teeth in wide bands; a slender barbel located at tip of chin. Scales small, cycloid. Swim bladder with projections anteriorly. First vertebra attached to skull.

The Gadidae are primarily marine, bottom-dwelling fishes occurring in cool seas principally in northern latitudes but a few species are known to occur in the seas of the southern hemisphere.

The family is classified in 3 subfamilies, Lotinae, Merluccinae, and Gadinae, which contain approximately 60 species. Two species have been recorded from Canadian fresh waters — *Lota lota*, which has a circumpolar distribution, the only truly freshwater species, and *Microgradus tomcod*, a marine species that seasonally invades fresh waters on the eastern seaboard and has become landlocked in a few lakes in the Atlantic Provinces.



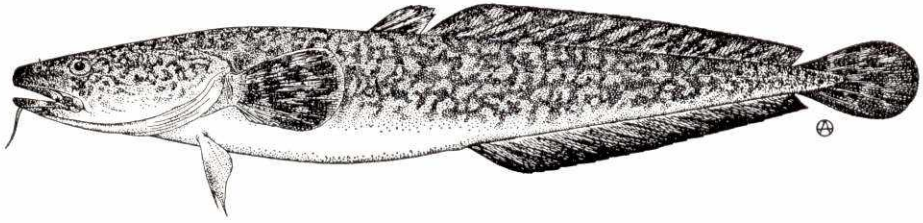
World Distribution of the Cods

1 Two dorsal fins, base of first short, length of base of second 6 or more times that of the first; 1 anal fin ..... BURBOT, *Lota lota* (p. 641)

Three dorsal fins, bases of near equal length; 2 anal fins ..... ATLANTIC TOMCOD, *Microgadus tomcod* (p. 646)

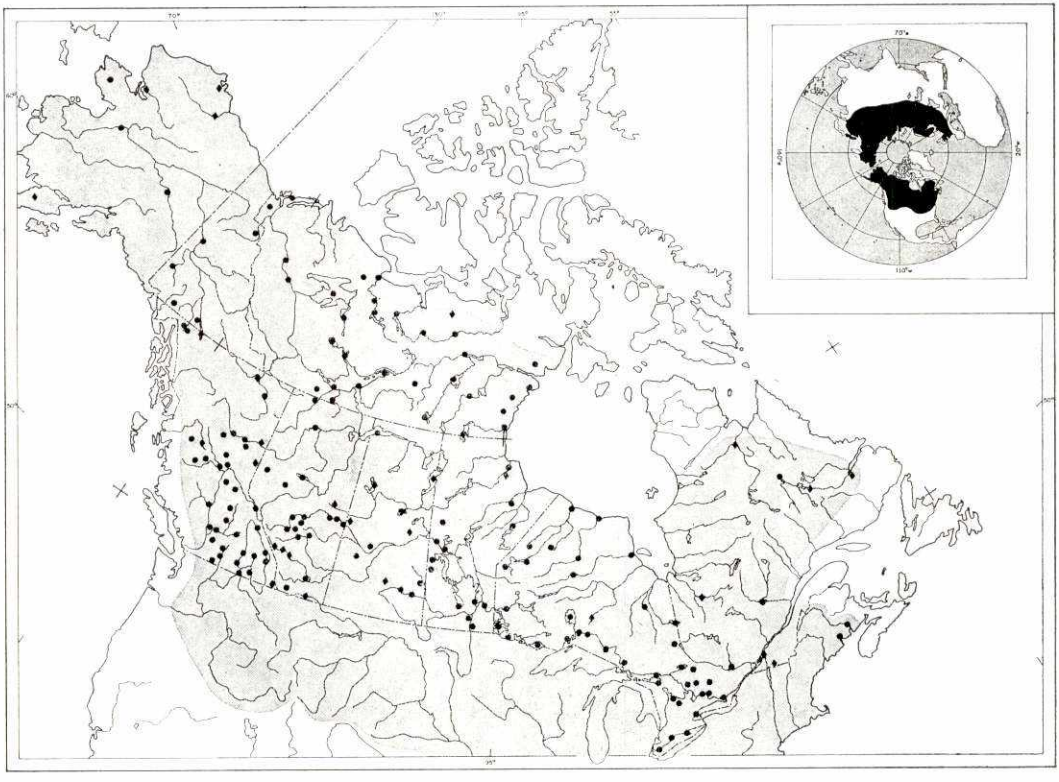
BURBOT

Lota lota (Linnaeus)



Description Body elongate, robust, average length about 15 inches (381 mm); anterior to anus it is nearly round in cross section, the body width to body depth ratio about 1:1, sometimes wider than deep for large adults; posterior to anus body distinctly compressed laterally. Head triangular, broad, depressed, its length 19.2–19.9% of total length; eye small, its diameter 11.2–16.4% of head length; snout projecting, of moderate length 27.5–32.5% of head length; one tube or barbel-like extension for each nostril opening, each about $\frac{1}{4}$ the length of chin barbel; interorbital broad, its width 27.9–31.9% of head length; mouth rather large, slightly subterminal, maxillary extending to below orbit; teeth in jaws and vomer slender, and in many rows, no teeth on tongue or maxillaries; a slender barbel on tip of chin, its length 12.5–29.9% of head length, higher values for large fish. Gill rakers 7–12. Branchiostegal rays 7, rarely 8. Fins: dorsals 2; first dorsal low, short, rays 8–16; second dorsal low, base long, extending onto caudal peduncle and joined to caudal fin, rays 60–79; height of first dorsal and second dorsal about 25% of head length; caudal rounded, joined to second dorsal and anal fins, a deep notch separating fins, but there is no free caudal peduncle; anal long and low, lower than dorsals, rays 59–76; pelvic fins jugular, inserted in advance of pectorals, rays 5–8, second ray prolonged; pectoral fins rounded, short, paddle-like, rays 17–21. Scales cycloid, small, embedded, 27–29 between second dorsal and lateral line, embedded scales on integument on base of fins; lateral line complete. Pyloric caeca 31–150. Vertebrae 50–66.

Colour In the lower Great Lakes region overall colouration of adults yellow, light brown, or tan, becoming darker northward; the background colour is overlaid by a



lacelike pattern of dark brown or black; at times, especially in inland lakes, adults may be uniformly dark brown or black. On young fish, 1.6–3.6 inches (40–90 mm), the speckled pattern is conspicuous and a dark pigmented margin may occur on the posterior portion of the second dorsal and sometimes on the anal, whereas on the caudal the pigmentation does not extend to the outer margin of the fin.

Systematic notes Hubbs and Schultz (1941), in a study of northwestern North American fishes, described *Lota lota leptura* as a new subspecies, found in northwestern North America and western Siberia, distinct from *Lota lota lota* of Eurasia and *Lota lota maculosa* of eastern North America. Subsequently, the name *L. l. maculosa* was reversed to *L. l. lacustris* (Speirs 1952). Studies by Lindsey (1956), Lawler (1963), and McPhail and Lindsey (1970) have shown some evidence of clinal variation. Hence, in the present state of our knowledge, the recognition of subspecies seems unwarranted.

Distribution The burbot is generally distributed, in all suitable habitats, in the fresh waters of continental Eurasia and North America, southward to about 40°N. It is absent from the Kamchatka Peninsula of eastern USSR, from Scotland, Ireland, and most islands, and from the west coast of Norway. It is present in southern England and on Kodiak Island, Alaska.

In Canada this species occurs in New Brunswick, Labrador, Quebec, throughout Ontario, Manitoba, Saskatchewan, Alberta, and the continental portion of the Northwest and Yukon territories, exclusive of the northernmost tips, to central and eastern British Columbia. It is absent from Nova Scotia and the Atlantic islands.

Biology The burbot is one of the few Canadian freshwater fishes that spawns in

midwinter, under the ice. It spawns from November to May over the whole of its world distribution, but mainly from January to March in Canada. There is circumstantial evidence that burbot spawn in deep water in some areas but the spawning site is usually in 1–4 feet of water over sand or gravel bottom in shallow bays, or on gravel shoals 5–10 feet deep. Although they usually spawn in the lake they are also known to move into rivers to spawn. Male burbot arrive on the spawning grounds first, followed in 3 or 4 days by the females. The actual spawning activity is said to take place in a writhing ball about 2 feet in diameter, which moves over the bottom and is made up of 10–12 intertwined and constantly moving individuals. This activity takes place only at night and the grounds are deserted in the daytime. Surface temperature of the water during the spawning period is usually 33°–35° F (0.6°–1.7° C); no nest is built by this species and no care is given the young. Average diameter for the semipelagic eggs of burbot has been recorded as 0.5 mm in Manitoba (before extrusion) but 1.25 mm in Minnesota and 1.77 mm in Ontario. Egg number (calculated) increases from about 45,600, in a 343-mm female, to 1,362,077, for a 643-mm female weighing 6.1 pounds. Eggs hatch in 30 days at 43° F and the young, therefore, appear from late February to June.

Growth in the first 4 years of the burbot's life is relatively rapid but after that time there is a gradual decrease in length increment and increase in weight. The young attain a length of 3.0–8.25 inches (76–210 mm) by the end of the first growing season. At age 5 (by otoliths) burbot in Lake Simcoe, Ont., average about 21.5 inches (546 mm) long and weigh 2–3 pounds. The maximum size in that lake was a 13-year-old female, 32.9 inches (838 mm) total length and 9.5 pounds. There is a growth differential between the sexes and at 4 years of age females become significantly longer than males; this condition prevails. The length–weight relation in Manitoba is log W=2.52+3.164 log L, where W=weight in ounces and L=total length in inches. Sexual maturity in the burbot is usually attained during the third or fourth year between 11.0 and 18.9 inches (280–480 mm), but males often mature at a smaller size.

The following comparison of age–length relations reveals that growth rate for the species increases from Manitoba through Ontario to its highest in Lake Erie.

	Heming L., Man. (Lawler 1963)	L. Simcoe, Ont. (McCrimmon & Devitt 1954)	L. Erie, Ont. (Clemens 1951b)
Age	Avg TL (*mm*)	Avg TL (*mm*)	Avg SL (*mm*)
1	147	165	210.0
2	246	305	322.7
3	279	432	376.5
4	323	483	424.0
5	366	546	492.1
6	399	572	539.9
7	429	635	557.8
8	465	673	579.1
9	–	737	590.6
10	–	762	616.0
11	–	787	–
12	–	812	–
13	–	837	–

It would appear that the maximum size known for burbot in Canada is 38.3 inches (937 mm) fork length and 18.5 pounds from Great Slave Lake. Elsewhere in the world, the species is reported to attain lengths in excess of 46 inches (1200 mm) and a weight of 75 pounds. Maximum age in Canada is probably between 10 and 15 years.

In central and southern Canada the burbot is usually a resident of the deep waters of lakes whereas in northern Canada it is also present in large, cool rivers. It has been taken as deep as 700 feet and throughout the summer is restricted to the hypolimnion. Optimum temperature for this species is 60°–65° F (15.6°–18.3° C) and 74° F (23.3° C) would appear to be its upper limit. Burbot move into shallower water during summer nights when they are active and in certain areas they definitely move into shallower water to spawn. Also, there is often a post-spawning movement into tributary rivers during late winter and early spring. During this period of concentration they are sometimes readily caught in large numbers. In the north, summer habitat is often in the river channels of lakes and young-of-the-year and yearling burbot are frequently found along