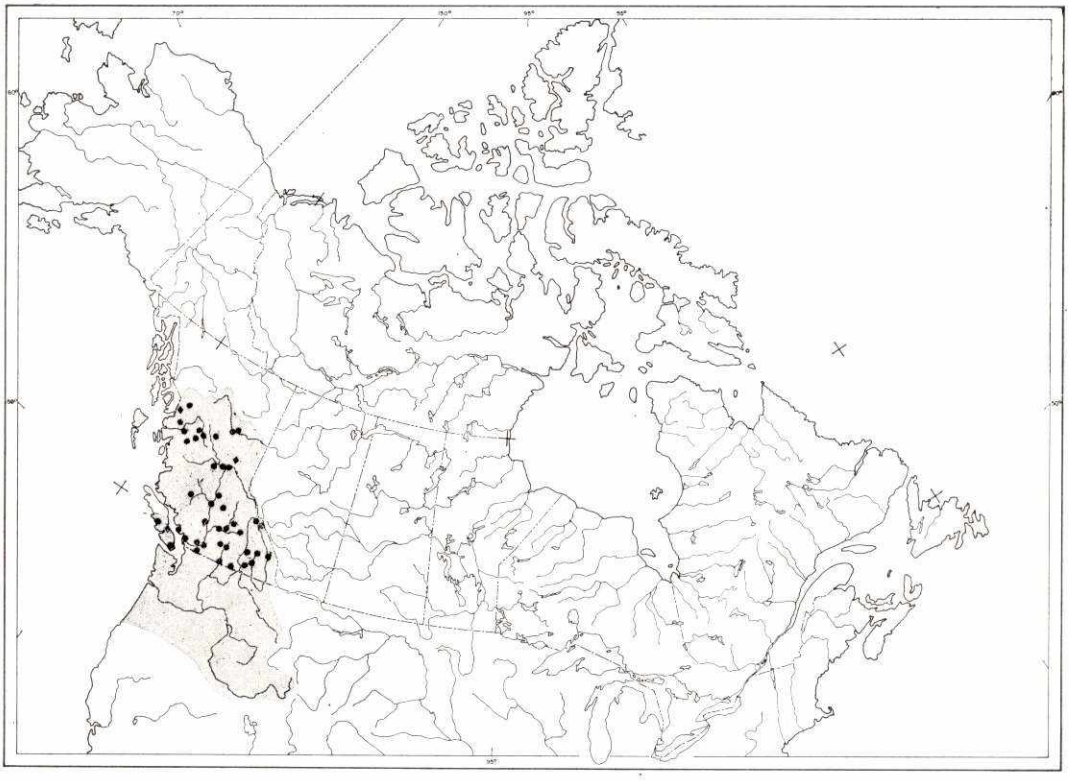


length; mouth slightly inferior because of overhanging snout; a small barbel at each corner of the mouth; premaxillary protractile; pharyngeal teeth usually 1,5–5,1, with distinct grinding surfaces in adults, but hooked in young fish. Fins: dorsal 1, its origin slightly in advance of pelvic fin origin, rays always 8; caudal deeply forked; anal 1, originating clearly behind dorsal insertion, rays usually 8, occasionally 9; pelvics originating slightly posterior to dorsal fin origin, rays usually 9, occasionally 10; pectoral fin rays 15–18, usually 16 or 17. Scales cycloid, 68–79 in lateral line; lateral line complete. Peritoneum dusky. Vertebrae 44(1), 45(17), or 46(3).

Nuptial tubercles on breeding males, on head, including gill covers, and extending onto back.

Colour A brightly coloured minnow, with localized areas of red at the angles of the mouth, sometimes extending along the cheek and opercle to pectoral fin, and also along sides; breeding fish of both sexes are highly coloured, with red lower lips and the lateral red stripes well developed, but males have a green back, females a brown back. Immature or nonspawning fish are generally silvery with a dark back and two distinct lateral bands, one extending from behind the dorsal part of the operculum posteriorly to the caudal base, the lower or ventral one extending from end of operculum to above anal base.

Systematic notes For a review of the scientific nomenclature *see* Hubbs and Schultz (1931). The peamouth hybridizes with *Ptychocheilus oregonensis*, and the resultant hybrid, which is intermediate in most characters between the two parents, has been described in detail by Weisel (1954, 1955a, b).

Distribution The peamouth chub occurs in rivers and lakes in northwestern North America. It is found in Alberta; in British

Columbia; Vancouver Island and some smaller inland islands. Reported from Washington, Oregon, Idaho, and Montana.

In Canada this species has been reported in Alberta from the Athabasca River at Athabasca. It is widespread in lakes and rivers in British Columbia; from the upper Peace River system, in waters near Hudson Hope, rivers on the Pacific slope from the Nass River in the north to the Columbia River system, and in the Fraser and Skeena River systems. On Vancouver Island peamouth chub are found in Holden and Fishhook lakes near Nanaimo, and in Kennedy and Cecilia lakes on the west coast. Known from Nelson Island off Jarvis Inlet, and from a lake on Bowen Island. Occasionally taken at sea at Spanish Banks (Carl et al. 1967).

Biology The spawning behaviour of the peamouth chub in shallow, shore waters of lakes was described at length by Schultz (1935) whose observations were made June 1, 1935, at Lake Washington, near Seattle, Wash. The spawners crowded into shallow water near shore, often in groups of 50–400 fish, the centre of each group separated from the centre of an adjacent group by 25–100 feet. The females were crowded by two or more males into an inch or two of water at shoreline where the eggs and sperm were emitted. The eggs are grey-green, adhesive, and settle to the bottom and become attached to stones and rubble. Schultz stated that the water temperature at time of spawning was 54° F (12.2° C). Carl et al. (1967) noted that in British Columbia, spawning took place in May or June. They noted further that ripe fish have been taken in streams near lakes but did not present evidence of stream spawning. They also observed that the newly hatched young remained in schools along shore, apparently moving into deeper water in late summer.

Rates of growth, fork length (in millimeters) at ages 1-5, have been reported by Clemens (1939) for Okanagan Lake, B.C., as follows: age 1 (51); age 2 (107); age 3 (142); age 4 (170); age 5 (198).

Clemens noted one fish, 9.75 inches (247 mm) long, in its 6th summer. Dymond (1936) reported the largest specimen encountered during his work in Cultus Lake had a fork length of 12.5 inches (318 mm).

In general, females grow faster than males and attain a larger size. Schultz said spawning females averaged 1.1 inches (28 mm) longer than breeding males; the females averaged 8.8 inches (224.6 mm) standard length and weighed 203.6 grams whereas males averaged 7.8 inches (197.8 mm) and weighed 123.8 grams.

This is a fish of the weedy shallows of lakes and rivers where it tends to form schools. It is unusual among cyprinids in that it has a limited tolerance to dilute sea water and is known to withstand brackish waters for a limited time. This special ability has probably enabled it to extend its range to Vancouver Island.

The peamouth is considered to be mainly insectivorous (Munro and Clemens 1937) and feeds on a wide variety of aquatic insects and their larvae such as chironomids, mayflies and caddisflies and some terrestrial insects (Clemens et al. 1939); it consumes a wide variety of planktonic crustaceans, molluscs, and occasionally small fishes (in some cases, sculpins).

The inshore spawning habits of the peamouth certainly expose it to easy predation by fish-eating birds and mammals. Munro and Clemens noted 13 occurrences of this species in American merganser stomachs.

Bangham and Adams (1954) examined 391 specimens of the peamouth chub from 23 locations in British Columbia, and found 370 parasitized. Parasites included trematodes, nemotodes, cestodes, acanthocephalans, and crustaceans. The degree of infection of individual fish was often quite high with acanthocephalans *Neoechinorhynchus rutili* and *Pomphorhynchus bulbocolli*, the cestode *Eubothrium salvelini*, and the trematode *Proteocephalus ptychocheilus*.

Hoffman (1967) listed trematodes, cestodes, nematodes, acanthocephalans, 1 crustacean, and glochidia (Mollusca) from this species in North American waters.

Relation to man We hear little about the angling and food qualities of the pea-

mouth chub today but at one time, at least, it was utilized. Jordan and Evermann (1908) noted that in the Snake River and Flathead Lake regions it was called, erroneously, freshwater herring and whitefish and that in some areas of the Columbia basin it was served in hotels as whitefish. It was also said to have fair game qualities, to fight well when hooked, and to bite readily on a variety of baits such as salmon eggs and grasshoppers. Its large numbers further enhanced its importance.

Nomenclature

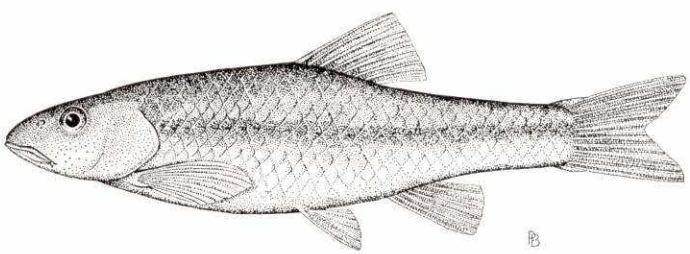
Cyprinus (*Leuciscus*) *caurinus* (Rich.) — Richardson 1836: 304 (type locality Columbia River at Fort Vancouver)
Mylocheilus lateralis Agass. & Pick. — Agassiz 1855: 231
Mylocheilus caurinus (Richardson) — Jordan and Evermann 1896–1900: 219
Clarkina caurina (Richardson) — Jordan, Evermann, and Clark 1930: 118

Etymology *Mylocheilus* — grinder; lip; *caurinus* — *caurus*, the northwest wind, hence *caurinus* — north western.

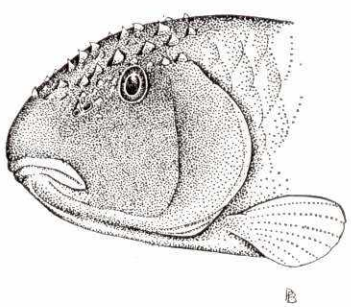
Common names Peamouth, peamouth chub, northwest dace. French common name: *méné deux-barres.*

HORNYHEAD CHUB

Nocomis biguttatus (Kirtland)



Description Body stout, heavy forward, elongate, average length about 3.5 inches (89 mm), deepest in front of pelvic fins, belly gently rounded, greatest body depth 19.6–24.6% of total length. Head bluntly triangular and wide, its length 21.8–24.1% of total length; eye diameter 21.0–37.5% of head length, small in large specimens; snout bluntly rounded, long, 29.1–42.1% of head length; interorbital width



24.1–50.0% of head length; mouth moderate, and terminal, or nearly so, snout not projecting beyond upper lip but lower lip included by upper lip; a distinct terminal barbel at the angle of upper and lower jaw, upper jaw not reaching to anterior margin of eye; pharyngeal teeth, 1,4–4,1 said to be usual but we have found at least one-third of specimens examined have only one row of teeth, i.e., 4–4, or 4–3. Fins: dorsal 1, opaque, its origin over or slightly behind pelvic fin origin, slightly pigmented, rays 8(44), rarely 7(1); caudal with shallow fork, tips rounded; anal 1, its origin behind dorsal insertion, rays 7(45), rarely 6(1); pelvics rather small, origin under or slightly in advance of dorsal fin origin, rays 8(30); pectorals well developed, rounded, rays usually 15(14) or 16(11), but sometimes 14(3) or 17(2). Scales cycloid, large, margin accentuated with melanophores, the angle subtended by the scale radii less than 90°, usually 70–75°; lateral line complete, almost straight, scales in lateral line 40–48. Peritoneum more or less uniformly brown but with darker speckles overlaid; intestine short. Vertebrae usually 38, sometimes 37 or 39.

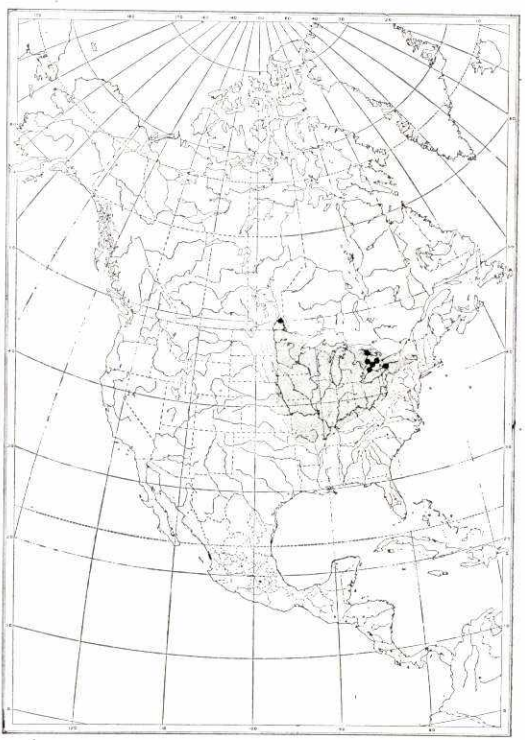
Nuptial tubercles well developed and obvious, usually more than 45, on head, extending from posterior snout through interorbital region to nape. Some pointing forward. Tubercles also developed on first few rays of pectoral fins.

Colour Overall colouration olive-brown on the back, silvery on sides, becoming creamy white below. Lateral band inconspicuous on living specimens but rather distinct on preserved ones. A caudal spot distinct on young fish but becoming vague on fish 3.5 inches (89 mm) long and over. Breeding males with a pronounced light red postocular spot and orange on dorsal and anal fins. Lachner (1952) noted an intense black lateral band present on breeding males but not present on specimens preserved several hours. Young fish with reddish caudal fin.

Systematic notes Members of this genus were placed in the genus *Hybopsis* in many recent publications, in particular the 1960 issue of the American Fisheries Society's *Checklist of Common and Scientific Names*, but the genus *Nocomis* was reinstated in the 1970 issue of the checklist.

Prior to 1925, hornyhead and river chubs were not recognized as distinct species and hence the early literature is confusing (Hubbs 1926; Trautman 1957).

See Lachner (1952) and, in particular, Lachner and Jenkins (1967) for a discussion of the systematics of fishes in the genus *Nocomis*. Hybridization has been noted with other species, such as *Notropis cornutus* (Trautman 1957), but hybrids between species of the genus *Nocomis* are rare.



Distribution The hornyhead chub occurs chiefly in clear, gravelly creeks from New York and Ohio west to Colorado and Wyoming, south to Tennessee, Arkansas, and Oklahoma. (*See* Lachner 1952, for detailed distribution in northeastern United States.)

In Canada, the species has a limited distribution and occurs only in Ontario and

Manitoba. In Ontario, it is restricted to streams of lakes Erie and St. Clair, and southern Lake Huron drainage, north to Huron County, but not in Lake Ontario drainage. Reported from southeastern Manitoba in the Birch River (49°49′N lat, 95°53′W long) and in Whitemouth River, the northernmost limit of range (49°57′N lat, 95°59′W long).

Biology The biology of the hornyhead chub has been rather thoroughly documented as a result of studies in the eastern United States (Lachner 1952). Although studies have been conducted in Ontario waters, none have been published. Of particular interest is the work of A. H. Carter, whose reports provided much of the following information. His work was undertaken during the summers of 1934–1939, in the Maitland and Bayfield rivers, Lake Huron drainage, Ont., while he was engaged in undergraduate and graduate studies at the University of Toronto.

Spawning takes place in the spring of the year, probably when water temperatures reach about 65° F (23.9° C). Nests of stones and pebbles are built by the males on a fine gravel or pebble bottom, often below a riffle, and in relatively shallow water. The depth of water is such that the top of a completed nest is 6–18 inches below the surface. Nest building is usually begun after May 15. As construction progresses, females may approach the nest and be enticed or driven over it by the male. Spawning takes place in a few seconds and the female moves quickly downstream. The released eggs settle among the stones and the male continues to add more stones to the nest, thus ensuring additional protection for the eggs. The nest building consists of carrying stones in his mouth or rolling or pushing them with lips and snout. Both Carter (1940) and Lachner (1952) suggested that females probably retained in the ovaries a maximum of about 1000 eggs. Lachner made egg counts for four females of 80–89 mm standard length and found the egg number to range from 460 to 725. The total egg complement is not deposited in one nest at one time, since at each spawning an individual female deposits only some of the total number, that is, only those that are ripe. Carter believed that as many as 10 females spawned in one nest under observation. The nest mound increases in size as more stones are added by the male after successive spawnings. The sizes of nests are irregular and vary from 12 inches (305 mm) to 36 inches (914 mm) across, and from 24 inches (610 mm) to 36 inches (914 mm) long (with current), and from 2 to 6 inches (51–152 mm) deep, according to Hubbs and Cooper (1936).

The nesting sites may be used as spawning grounds by other species of minnows (Lachner and others), but Carter did not observe this phenomenon. However, he did observe that other species, especially centrarchids, nested nearby. *Notropis cornutus* and *N. rubellus* are among the species that have been reported to use the nests of *Nocomis* spp., and do so while the *Nocomis* are also using the nest.

Information on the rate of development is apparently not available, especially in Ontario waters, but there is some data to indicate the size range (standard length) from young-of-the-year to 4-year-olds: age 0 (24–36 mm); age 1 (44–58 mm); age 2 (64–83 mm); age 3 (86–100 mm); age 4 (131 mm).

Carter concluded that males grow more rapidly than females, reach a larger size, and that age 4 is the maximum age attained for either sex. The maximum size attained in Carter's study area was 6.1 inches (155 mm) for males and 4.4 inches (112 mm) for females. The largest specimen in the Royal Ontario Museum collections is a male, 6.3 inches (161 mm) in total length, from the Bayfield River, Lake Huron drainage, Ont.

The hornyhead chub seems to prefer clear, slow-moving, gravelly streams, more often in the tributaries of large rivers, and the young seek out areas having aquatic vegetation.

The food consists of both plant and animal tissues, herbivorous material being more important in the diet of young fish. Stomachs were sometimes full of filamentous algae, but diatoms were also taken. Young fish also eat cladocerans and aquatic insect larvae, such as chironomids. As they grow larger, snails, aquatic insect larvae (including caddisflies), annelids, crayfish, and fish assume greater

importance, especially snails. Snails become quite important in the diet of 1-year-old fish and older.

We have no information on predators on the species in our waters although young chub must undoubtedly fall prey to such centrarchids as rock and smallmouth basses, when present.

Carter noted that the hornyhead chubs in his study area were relatively free of parasites and possessed only a few black-spot parasites, (*Neascus* sp.).

Hoffman (1967) listed the following parasites from the hornyhead chub in North American waters: Protozoa (2), Trematoda (9), Cestoda (1), Nematoda (2), Acanthocephala (2).

Relation to man This chub was highly regarded in the northern United States as a bait fish, especially for northern pike, because it attained a large size, was hardy, and could withstand the rough treatment afforded by storage tanks and minnow pails (Dobie et al. 1956; Harlan and Speaker 1969). Trautman (1957) noted that it was once widespread in Ohio and was widely used for food and bait, but that by 1950 it existed only in widely scattered relict populations.

In Canada, it is not an important bait species primarily because it has such a limited distribution and it is probably much less common now than formerly. It is seldom, if ever, distinguished by fishermen from the creek chub, which is much more common.

Nomenclature

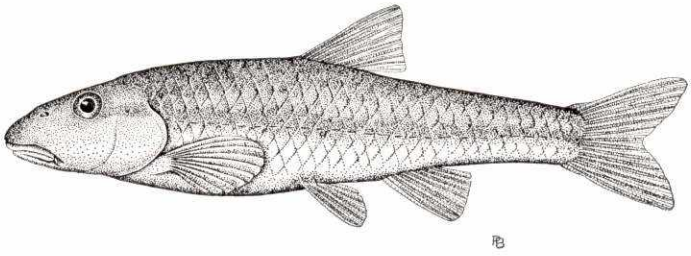
Semotilus biguttatus	— Kirtland 1841b: 344 (type locality Yellow Creek, tributary of Mahoning, Ohio)
Hybopsis kentuckiensis (Rafinesque)	— Jordan and Evermann 1896–1900: 322
Nocomis biguttatus Kirtland	— Hubbs 1926: 28
Nocomis kentuckiensis (Rafinesque)	— Jordan, Evermann, and Clark 1930: 137
Hybopsis biguttata (Kirtland)	— Scott 1967: 64

Etymology *Nocomis* — an Indian name, applied by Girard to a group of fishes; *biguttatus* — two-spotted.

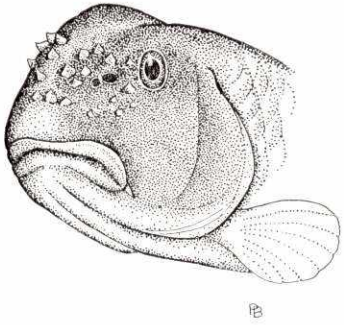
Common names Hornyhead chub. French common name: *tête à taches rouges.*

RIVER CHUB

Nocomis micropogon (Cope)



Description Body stout, heavy anteriorly, elongate, average length about 4 inches (102 mm), deepest in front of pelvic fins, greatest body depth 18.5–24.6% of total length.



Head bluntly triangular, and wide, its length 20.8–24.6% of total length; eye diameter 15.6–30.0% of head length, smallest in large specimens; snout bluntly rounded, long, 36.3–50.0% of head length, slightly protruding beyond upper lip when mouth closed; interorbital width 35.0–45.4% of head width; mouth moderate and nearly terminal, the snout slightly projecting, lower lip included by upper lip, a distinct terminal barbel at the angle of upper and lower jaw, upper jaw not reaching anterior margin of eye; pharyngeal teeth usually 4–4, sometimes 3–4. Fins: dorsal 1, opaque, its origin over pelvic fin origin, rays 8(19), rarely 7(1); caudal with shallow fork, tips rounded; anal 1, its origin behind dorsal insertion, rays 7(19), rarely 8(1); pelvics small, origin under dorsal fin origin, rays 8(20); pectorals well developed, rounded, rays usually 16(10), or 17(7), sometimes 15(3). Scales cycloid, large, margins somewhat accentuated with melanophores, the angle subtended by scale radii greater than 90°, usually 95°–105°; lateral line complete, nearly straight, only slightly decurved, scales 39–43. Peritoneum uniformly brown or black, with darker speckles; intestine short. Vertebrae 38 or 39.

Nuptial tubercles well developed and large, usually less than 40, on anterior part of head, from tip of snout to anterior edge of orbit but not extending dorsally to the midinterorbital region; a pronounced swelling develops on top of head of large males, in occipital and interorbital region.

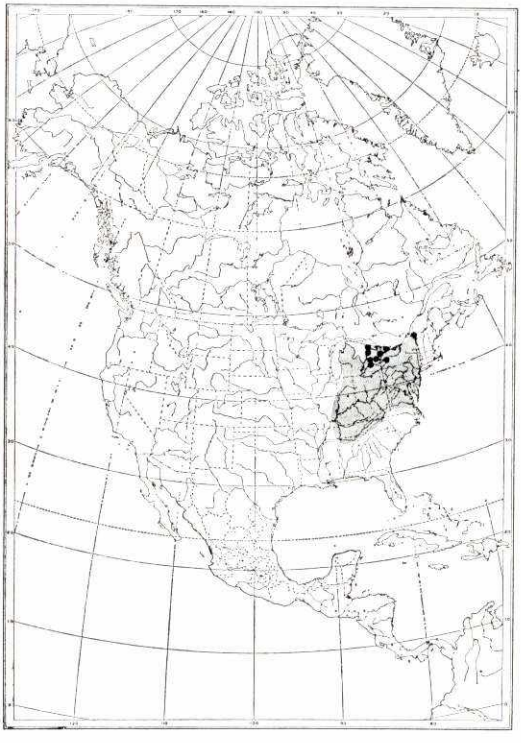
Colour Overall colour olive-brown on back, silvery on sides, becoming creamy white below. Lateral band inconspicuous and vague in life; well defined on young, when preserved, to a length of about 2.5 inches (64 mm), becoming less conspicuous on larger specimens. Breeding males without a red postocular spot, but large males (not small ones) may have a rosy hue on flanks, and the dorsal and caudal fins are olive or yellowish.

Systematic notes Members of this genus were placed in the genus *Hybopsis* in many recent publications, in particular the

1960 issue of the American Fisheries Society's *Checklist of Common and Scientific Names* but the genus *Nocomis* was re-instated in the 1970 issue of the checklist.

Prior to 1925, hornyhead and river chubs were not recognized as distinct species and hence the early literature is confusing (Hubbs 1926; Trautman 1957).

See Lachner (1952) and, in particular, Lachner and Jenkins (1967) for a discussion of the systematics of fishes in the genus *Nocomis*. Hybridization has been noted with other species, such as *Notropis cornutus* (Trautman 1957), but hybrids between species of the genus *Nocomis* are rare. A discussion of associated species on river chub nests was given by Reighard (1943).



Distribution The river chub has a smaller general range than the hornyhead chub. It occurs in clear creeks and rivers from Lake Champlain and the Lake Ontario basin, west through southern Michigan and Indiana in the Wabash system; south on the Atlantic slope from the Susquehanna River in New York to Virginia, North Carolina, Tennessee, and Georgia. Scattered records from Big Bend tributaries in Alabama and Tennessee. (For discussion of distribution in United States waters, *see* Lachner and Jenkins 1967.)

In Canada the species is found only in the drainage system of Lake Ontario from the Humber River westward, Lake Erie tributaries, including the Grand River and Catfish Creek, Lake St. Clair tributaries, including the Thames River and Medway Creek, and southern Lake Huron tributaries, including the Ausable, Maitland, and Saugeen rivers.

Biology As was noted for the hornyhead chub, the biology of this and related members of the genus has been rather thoroughly documented by workers in the United States, in particular by Reighard (1943), Lachner (1952), and Lachner and Jenkins (1967). Unfortunately, few observations on Ontario populations have been reported, but spawning behaviour in general is similar to that given for the hornyhead chub as reported for Ontario streams by Carter (1940) (*see* hornyhead chub). Spawning occurs in gravelly streams in spring, over a nest of stones built by the male who first excavates a channel or depression, removes all sand and fine gravel, and then fills the depression with newly gathered stones. Reighard reported that each individual spawning act took place in a shallow trough constructed on the nest pile for the purpose by the male, and immediately filled in with small stones and pebbles on completion of the spawning act.

As in the case of the hornyhead chub, each female probably deposits 1000 eggs or fewer. Lachner (1952) reported egg counts of 400–625 in four females ranging in standard length from 92 to 100 mm.

Dimensions of nests (the stone piles) in Michigan streams were given by Reighard and were of the order of 36 inches (914 mm) across (across current), and 48 inches (1219 mm) in long axis (with current). The use of the nests as spawning grounds by other species was also discussed by Reighard, and we believe that *Notropis cornutus* and *N. ru-*

bellus at least may use river chub nests for spawning sites.

Information on rate of development is not available but the following figures on standard lengths at various ages were gathered for specimens from Lake Huron drainage: age 0 (44–49 mm); age 1 (55–74 mm); age 2 (76–94 mm); age 3 (104–116 mm); age 4 (131–148 mm); age 5 (148–162 mm).

The sample sizes were small but it is evident that the river chub grows faster, attains a larger size, and may live at least 1 year longer than the hornyhead chub. The males attain a larger size than females; the largest specimen in the ROM collection is a male, 8.3 inches (210 mm) total length, from the Nith River, Lake Erie drainage.

The river chub frequents large gravel-bottomed or rocky rivers, rather than creeks, but it requires clean, clear water. It may be absent from much of its former range in western Lake Ontario tributaries.

The diet of this large chub is not well known and we assume that it is similar to that of the hornyhead. It possibly consumes algae and zooplankton when young, taking progressively larger items, such as aquatic insect larvae, and other aquatic invertebrates, such as snails, crayfish, and possibly some fish. No food studies have been conducted on Ontario populations.

Bangham and Hunter (1939) examined 18 specimens of river chub from the east end of Lake Erie and found 9 fish with parasites, identified as trematodes *Neascus vancleavei*, *Neascus* sp., and a nematode *Agamonema* sp. Hoffman (1967) listed 3 trematodes (*Gyrodactylus* sp., and the larval forms of *Neascus* sp., and *Posthodiplostomum minimum*) from river chub in North American waters.

Relation to man The river chub was possibly as important a bait minnow in United States waters as the hornyhead chub but both are now less abundant because of watershed deterioration. It is a large chub, growing to over 8 inches (203 mm) long even in Ontario waters, and was probably used for food here as it was in parts of the United States, but we have no supporting data or observations. When used as a bait species, it is probably not distinguished by dealers and anglers from the more common creek chub.

Nomenclature

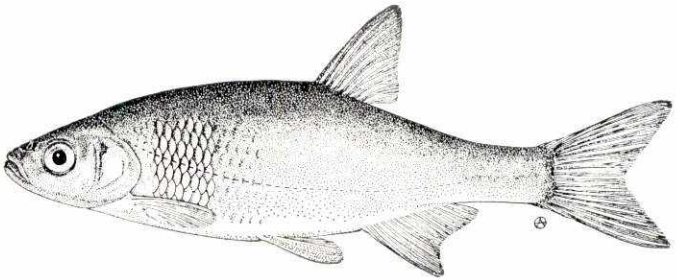
Ceratichthys micropogon	— Cope 1864: 277 (type locality Conestoga River, Pa.)
Nocomis micropogon (Cope)	— Hubbs 1926: 29
Hybopsis micropogon (Cope)	— Scott 1967: 64

Etymology *Nocomis* — Indian name applied by Girard to group of fishes; *micropogon* — small; beard.

Common names River chub, eastern river chub, crested chub. French common name: *méné bâton.*

GOLDEN SHINER

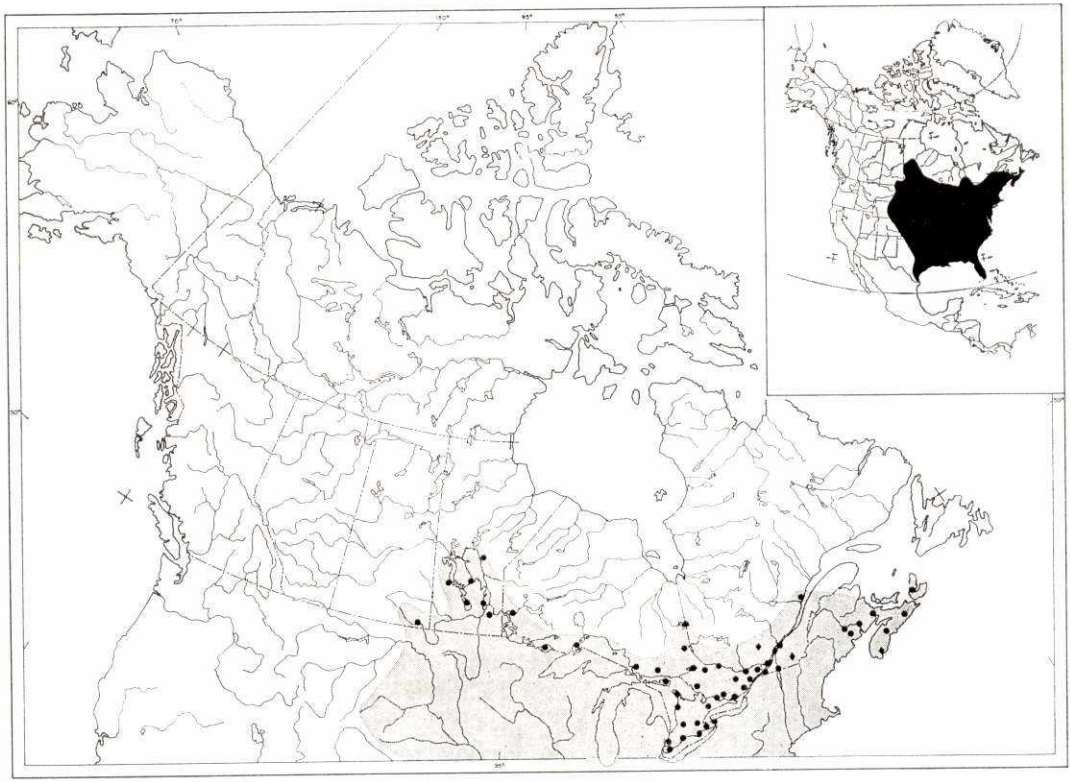
Notemigonus crysoleucas (Mitchill)



Description Body deep, strongly compressed laterally, average length 3–5 inches (76–127 mm) depending on locality, greatest body depth in front of pelvic fins, 17.4–26.4% of total length; a pronounced fleshy keel between pelvic fins and anal origin, the scales extend to but do not pass over this keel, which is apparent on fish as small as 25 mm; caudal peduncle relatively long and slender. Head triangular, small, its length 17.1–20.0% of total length; eye moderate, its diameter 23.9–33.3% of head length; snout relatively short, 26.3–34.4% of head length; interorbital arched, its width 33.3–45.4% of head length; mouth oblique, opening narrow, lower jaw projecting, upper jaw extending to a point below nostril; pharyngeal teeth 0,5–5,0, hooked, with distinct grinding surface. Fins: dorsal 1, its origin distinctly posterior to pelvic fin origin, posterior edge straight or slightly falcate, rays usually 8(48), rarely 7(2), or 9(1); caudal distinctly forked, lobes pointed; anal 1, origin approximately below dorsal fin insertion, posterior edge falcate, rays highly variable, usually 12–14 in Quebec, New Brunswick, and Nova Scotia, 12 or 13 (rarely 11), in Ontario, Manitoba, and Saskatchewan, but throughout its total range, rays vary from 8–19 (*see* section on *Systematic notes*); pelvics originate distinctly in advance of dorsal fin origin, rays usually 9(34), rarely 8(2); pelvic axillary process present or absent; pectorals rather short, never reaching pelvic fin origin, rays 16(17), 17(18), or 18(1). Scales cycloid, persistent; lateral line complete, and characteristically decurved, often accentuated with pigmentation around the pores, lateral line scales 44–54. Peritoneum dusky; intestine short, body length or slightly longer, 1.0–1.3 (Bensley 1915). Vertebrae 37(5), 38(10), or 39(1).

Colour Overall colouration golden. On adults, the back is olive-green to dark brown and sides have distinct brassy colouration. The fins are yellowish; young fish do not have the strong yellowish colouration of the adult but are silvery with transparent fins, and have a strongly pigmented and conspicuous lateral band, particularly obvious on preserved specimens. The lateral band is apparent on preserved specimens to lengths of about 4 inches (102 mm) but becomes increasingly vague and ill defined with increase in length. Fish (1932) noted that young, 18 mm long, were heavily pigmented.

Systematic notes The high degree of variability, particularly in anal fin ray number, of the golden shiner throughout its range has long been recognized. Hubbs (1921b) first drew attention to the regional nature of the variability. This was later interpreted by Schultz (1926) as clinal. The total range in anal ray counts was shown by him to be



8–19. The range in Canada is at least 10–15, as shown in the following table:

Locality	Anal rays					
	10	11	12	13	14	15
N.S.	–	–	1	5	4	–
N.B.	–	–	4	4	2	–
Que.	–	–	1	2	7	–
Ont.	–	1	7	8	–	–
Sask.	–	–	4	2	–	–
"Ont., Canada, vicinity"	1	2	39	20	1	1

Some authorities recognized subspecies (Hubbs and Lagler 1958) although others did not (Bailey and Allum 1962). We are not recognizing subspecies in this work, but three subspecies have been described: the typical one *N. c. crysoleucas*, the eastern golden shiner, which occurs in the Maritime Provinces and Quebec to the eastern Ontario basin, south along the Atlantic coast to Virginia; *N. c. auratus*, the western golden shiner, which occurs from the Lake Ontario basin west through all the Great Lakes to Saskatchewan, south to Arkansas and Oklahoma; and *N. c. bosci*, the southern golden shiner of the Atlantic drainage of the Carolinas, south and west to the Gulf states drainages.

Distribution On the east coast of North America from the Maritime Provinces south to Florida; west to the Dakotas and Texas (Hubbs and Cooper 1936). Because of its wide use as bait, it has been introduced into many parts of the western United States to which it is not native. *See* Miller (1952) for details.

In Canada the golden shiner occurs widely in Nova Scotia, where Livingstone (1953) stated it was the most common minnow, occurring in all regions except isolated areas of the Cape Breton Plateau and Digby Neck. In New Brunswick it is present in many of the major river systems (for details *see* Scott and

Crossman 1959), probably resulting from invasion from coastal areas. In Quebec it ranges from Gaspé, southwest through the eastern townships to Lake Champlain; on the north shore of the St. Lawrence it extends from near Escoumains southwest in the St. Lawrence drainage, north to Lake Abitibi. In Ontario it is found in all the Great Lakes drainages, north to Lake Abitibi in the James Bay drainage. In Manitoba, it is found frequently at the mouths of rivers and on sandy beaches of Lake Winnipeg, extending north to Mukutawa River (53°09′N lat, 97°25′W long), its northern limit of range in North America (Keleher 1956); Keleher and Kooyman (1957) reported collections from the Whiteshell Forest Reserve, Lake Manitoba, and a tributary of Lake Winnipegosis. In Saskatchewan, Atton and Johnson (1955) recorded a collection in the Souris River at Oxbow on July 27, 1954, the first record of the species in that province.

It has been introduced into Prince Edward Island, but is absent from Newfoundland, and the provinces west of Saskatchewan.

Biology The time of spawning and rate of growth of the golden shiner in the northern United States, particularly in New York and Michigan, have received considerable attention, but few Canadian studies have been undertaken and even fewer published.

Spawning has been observed in Michigan from June to August and in New York from May to July, suggesting a prolonged spawning period. In eastern Ontario, in the Gananoque River of the St. Lawrence drainage area, Toner (1943) considered spawning about to commence as early as June 11, and in Nova Scotia, Smith (1939) considered that golden shiners were in the midst of spawning on August 3. In spite of the paucity of direct observations, it is reasonable to assume that spawning in many parts of the Canadian range takes place about the same time as that described for northern New York or Michigan populations; undoubtedly the precise dates of spawning are different in different parts of the Canadian range.

The adhesive eggs are deposited over filamentous algae. Sometimes rooted aquatic plants will serve, but aquatic vegetation is essential for spawning (Cooper 1935, 1936b). Spawning commences when water temperature is about 68° F (20° C) according to Dobie et al. (1956). The eggs, each measuring 1 mm in diameter, are scattered and abandoned by the spawning fish. Deviation from this apparently normal behaviour was reported by Kramer and Smith (1960a), who noted that golden shiners used active largemouth bass nests for spawning in Lake George, Minn., even while the male bass was guarding the nest.

Despite the active interest in pond culturing this species, there seems to be only minimal information on breeding behaviour, embryology, and development. The 18 mm stage was described and illustrated by Fish (1932) for Lake Erie, and Mansueti and Hardy (1967) published information on prejuvenile stages in the Chesapeake Bay region.

The rate of growth varies greatly from place to place depending on temperature and availability of food and it is to be expected that considerable variation would be exhibited throughout the Canadian range. Faster rates of growth would be expected in southern Ontario, in Lake Erie, for example, than in Lake Abitibi, although growth data have not been published for either region. Dymond and Hart (1927) did note that the largest specimen caught in Lake Abitibi was 2.5 inches (64 mm) long, although we have specimens from Lake Erie measuring 8 inches (203 mm) long.

Age was determined, using scales, by Cooper (1936b), but Smith (1939) was unable to age Nova Scotia specimens by this method. On the basis of Michigan studies, Cooper noted that a length of about 3 inches (76 mm) was reached during the second summer, 4 inches (102 mm) during the third, 4.5 inches (114 mm) during the fourth, and 5.5 inches (140 mm) during the fifth summer. In some nutrient-rich waters, this shiner attained 3 inches (76 mm) in length in its first summer. Maturity is reached usually at lengths of 2.5–3.5 inches (64–89 mm), usually in their second summer, but maturity

will be delayed until their third summer in regions of slow growth. The oldest fish recorded by Cooper was in its eighth summer. A fish, 10.5 inches (267 mm) long, weighing 12 ounces (340 g) was reported by Trautman (1957). The largest Canadian specimen known to us is one 9.2 inches (234 mm) long taken near Granby, Que.

The golden shiner prefers clear, weedy, quiet, waters, with extensive shallow areas. It is a lake species rather than a river form, an actively swimming fish that moves in schools, off bottom, over wide areas.

Food studies of the golden shiner have been conducted by Keast and Webb (1966) in Lake Opinicon, Ont., where the main foods were found to be as follows: Cladocera 20–90% by volume (depending on the month), flying insects 20%, chironomid pupae 10–30%, and filamentous algae (important in late summer); small numbers of dragonfly nymphs, beetles, and water mites may also be eaten. In another lake, molluscs were consumed. In general, however, the diet was consistent from lake to lake and there was little significant difference in the diet of adults and young. They concluded that the species was a midwater and surface feeder.

The golden shiner is a most important forage fish and figures prominently in the diet during the early life of many of our game fishes, such as largemouth bass and muskellunge.

Bangham and Hunter (1939) found trematodes, *Neascus* sp.; nematodes, *Agamonema* sp., protozoans and myxosporidians in specimens examined from Lake Erie. Bangham and Venard (1946) examined seven specimens in lakes in Algonquin Park and found no parasites. Four golden shiners from Lily Lake on Manitoulin Island were examined by Bangham (1955) and all were infected with trematodes *Diplostomulum* sp., one with Gyrodactyloidea, and one with the nematode *Contracaecum brachyurum*. In an examination of this species from a commercial bait hatchery in Illinois, Summerfelt (1964) found a microsporidian (sporozoan) parasite in the ovaries of the golden shiner, and suggested that the presence of this parasite could be of importance to the bait industry since it is known to reduce fecundity.

A new species of acanthocephalan, *Neoechinorhynchus notemigoni*, was described from the intestine of golden shiners caught in Lake Ontario by Dechtiar (1967a).

Hoffman (1967) listed the following parasites from this species in North American waters: protozoans (2), trematodes (15), cestodes (3), nematodes (3), acanthocephalans (3), leeches (3), and crustaceans (3).

Relation to man The golden shiner may well be the most popular of all bait fishes in North America. Its use as a bait or forage minnow is not restricted to its native range in eastern and central North America for it has been introduced to many waters in the western part of the continent as well (Miller 1952).

In Nova Scotia, New Brunswick and parts of Quebec, it is the most common bait fish offered for sale. In Ontario it is also a popular bait fish in some areas but does not dominate the market as it does in the east.

The golden shiner has been cultivated successfully in ponds for many years in various parts of the United States from Michigan to Mississippi. Fish are pond cultured for sale as bait, or by fish hatcheries as food for pond-cultured bass, especially the largemouth (Regier 1963a). With the increase in demand for live bait and rapid destruction of natural water areas by pollution and careless construction practices, the attractiveness of pond culturing bait minnows increases. And few species offer greater promise than the golden shiner. In a review of bait fish production in ponds in New York, Forney (1957) noted that the yield from 10 fertilized ponds for a 2-year period averaged 420 pounds/acre. For detailed information on pond cultivation of golden shiners, *see* Cooper (1936b), Dobie et al. (1956), and Forney (1957).

Nomenclature

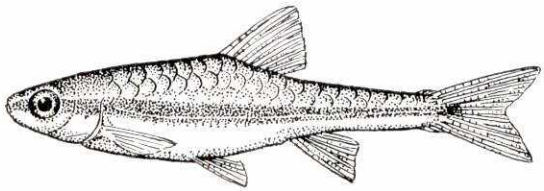
Cyprinus Crysoleucas	— Mitchill 1814: 23 (type locality New York)
Cyprinus (*Leuciscus*) *chrysoleucas* (Mitchill?)	— Richardson 1836: 122
Leuciscus chrysoleucas	— Perley 1852: 193
Leucosomus Americanus Storer	— Adams 1873: 305 (probably in error for *Leuciscus Americanus*)
Notemigonus chrysoleucas (Mitchill)	— Kendall 1895: 54
Notemigonus chrysoleucas Mitchill	— Cox 1896b: 65
Abramis crysoleucas (Mitchill)	— Jordan and Evermann 1896–1900: 250
Notemigonus crysoleucas (Mitchill)	— Dymond and Hart 1927: 15

Etymology *Notemigonus* — back; half; angle; the back being almost carinated; *crysoleucas* — gold; white.

Common names Golden shiner, roach, bream, butterfish, eastern golden shiner, American roach, American bream, sunfish, dace, bitterhead, chub, gudgeon, young shad, windfish, goldfish. French common name: *chatte de l'est.*

PUGNOSE SHINER

Notropis anogenus Forbes



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Description Body fragile, slender, small, 1.5–2.0 inches (38–51 mm) long, somewhat compressed laterally, especially the posterior portion, body depth 16.6–22.0% of total length. Head length 18.9–21.6% of total length; eye diameter relatively large, 26.6–37.5% of head length; snout length somewhat smaller than eye diameter, 23.5–31.2% of head length; interorbital wide, its width 29.4–42.8% of head length; mouth extremely small, terminal or nearly so, oblique, upper jaw extending backward only to below nostrils; pharyngeal teeth 0,4–4,0, slightly hooked at tip. Fins: all transparent, dorsal 1, rays usually 8(19), occasionally 7(1); caudal forked; anal 1, rays usually 8(19), occasionally 7(1); pelvics originate slightly in advance of dorsal fin origin, rays 8(19), rarely 7(1); pectorals well developed, rays usually 12(13), occasionally 11(4) or 13(3). Scales cycloid, large, 34–38 in lateral line; lateral line complete. Peritoneum dark. Vertebrae 32–36.

Nuptial tubercles, not observed in speci-

mens from our region, but Trautman (1957) noted that breeding males had microscopic tubercles on top of head, and dorsal surfaces of pectoral rays and sometimes pelvic rays were thickened and roughened.

Colour Overall colouration silvery with pale yellow or straw-coloured tints on back and silvery below. All fins are transparent. There is a distinct, dark lateral band that extends around the snout (but not on central part of upper jaw), including the lower jaw (chin pigmented), through the eye and thence midlaterally to end of caudal peduncle, but weakening posteriorly; a small dark spot is evident at caudal base.

Systematic notes Bailey (1959) noted that the species was described by Forbes (1885) from a collection of 24 specimens collected in the Fox River at McHenry in the lake district of northeastern Illinois. Of the 8 specimens still in the collection of the Illinois State Natural History Survey, 6 are *Notropis anogenus* and 2 *Notropis heterodon*, which emphasizes the similarity of these two species.

Distribution The pugnose shiner is restricted to the Great Lakes basin, particularly in the United States. It is known to occur in waters of the following states: New York, Ohio (formerly), Michigan, Indiana, Illinois, Wisconsin, Minnesota, and North Dakota.

In Canada it has been reported to occur only in two regions of Ontario: at the extreme eastern outflow of Lake Ontario at Gananoque, and in western Lake Erie at Rondeau Bay and the ponds on the eastern side of Long Point. It has been reported from the United States, but not the Canadian, waters of Lake St. Clair. The kind of habitat required, i.e., clear, weedy lakes and quiet streams with clean sand or marl bottoms, and the extreme sensitivity to turbidity, leads us to conclude that it has a diminishing range in Ontario. It seems probable that it once occurred in suitable waters along the north shores of lakes Ontario and Erie, between the two widely separated areas where it lives at present. Trautman (1957) noted that it has completely disappeared from Ohio waters. *See* Bailey (1959) for a comprehensive review of the distribution and taxonomy of the species. He also suggested that increased agricultural use of land and water has had a detrimental effect on its occurrence.

Biology Few critical studies of this species have been made, none in Canada. It presumably spawns in the spring, probably in June in Ontario waters. A small collection made at Point Pelee, Lake Erie, on June 13, 1941, contained one female with a few large eggs, suggesting that she was partly spent and that spawning was in progress at time of capture.

The extremely small mouth must restrict its diet to minute plant and animal organisms, and organic detritus, but actual observations are not available.

According to Hoffman (1967) the pugnose shiner is infected with only two species of Protozoa, and no other parasites are recorded. There are no records of parasitic infestation in Canadian populations.

Relation to man The pugnose shiner is of no known significance in the economy of our waters because of its fragility, small size, and restricted distribution. It seems probable that its Ontario range is being continually reduced by environmental change.

Nomenclature

Notropis anogenus — Forbes 1885: 138 (type locality Fox River, McHenry, Ill.)

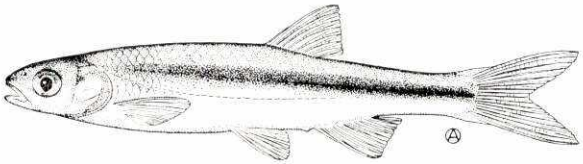
Hybopsis anogenus (Forbes) — Jordan, Evermann, and Clark 1930: 136

Etymology *Notropis* — back; keel; *anogenus* — without; chin.

Common names Pugnose shiner. French common name: *méné camus.*

EMERALD SHINER

Notropis atherinoides Rafinesque



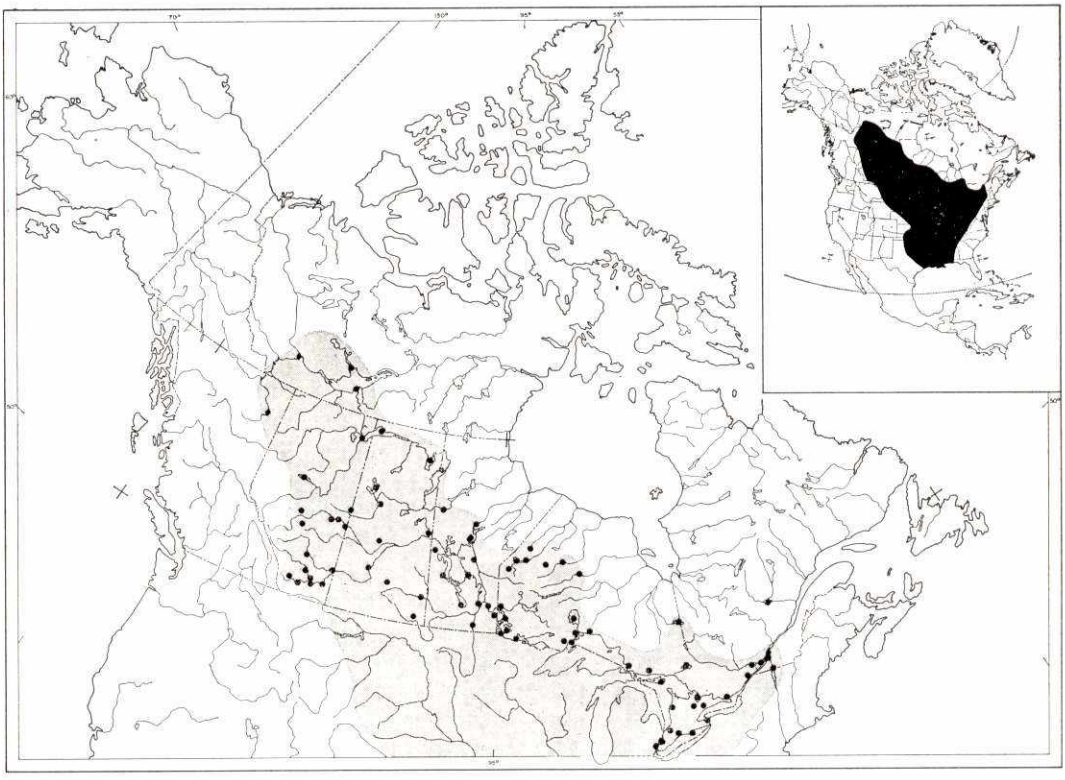
Description Body slender, even fragile, elongate, averaging 2–3 inches (51–76 mm) long, strongly compressed laterally, its greatest depth 14.2–20.0% of total length. Head generally triangular, its length 17.2–21.4% of total length; eye relatively large, its diameter 26.6–34.6% of head length; snout bluntly pointed, its length about equal to eye diameter, 26.6–33.3% of head length; interorbital width also about equal to eye diameter, 26.6–34.6% of head length; mouth relatively large, terminal, but gape extends only to a point below nostrils; pharyngeal teeth sturdy, hooked, usually 2,4–4,2, occasionally 1,4–4,2 or 2,4–3,2. Fins: generally clear; dorsal 1, its origin clearly posterior to pelvic origin, rays usually 8(72), rarely 7(1 only, from Lake Winnipeg); caudal forked; anal 1, rays usually 11(56), occasionally 10(21), or 12(16), but rarely 13(1); pelvics originating distinctly in advance of dorsal origin, rays usually 8(56), occasionally 9(6), small pelvic axillary process present; pectorals usually 14–16, rarely 13 or 17. Scales cycloid, deciduous, of moderate size, 38–43 in lateral line; lateral line complete. Peritoneum silvery and speckled. Vertebrae 38–41, usually 39 or 40.

Nuptial tubercles on breeding males very small, restricted to upper surface of pectoral fins.

Colour Overall colouration silvery, with blue-green or green iridescence on the back, silvery on sides and silvery white below. The young are rather translucent. The scales are lost even with the most careful handling, resulting in a dark blue or blue-green appearance. The fins are clear and no brilliant colours are displayed during spawning. Preserved specimens exhibit a characteristic dark lateral band which is darkest posteriorly becoming vague and ill-defined anteriorly, and the melanophores are restricted mainly to the region above the lateral line.

Systematic notes At least two subspecies of emerald shiner have been said to occur in the Great Lakes region (Hubbs and Lagler 1964): the typical subspecies, the so-called river emerald shiner, *N. a. atherinoides*, (the form said to occur through most of Canada) and the lake emerald shiner, *N. a. acutus*, which is said to occur at least in lakes Huron and Superior. However, some recent authors (Bailey and Allum 1962; Flittner 1964) indicated that the species is highly variable in meristic and morphometric values throughout its range (an observation with which we concur) and concluded that, since variations in certain characters such as some body proportions and vertebral numbers exhibited clinal variations, the recognition of subspecies at this state of our knowledge was unwarranted. The following vertebrae counts from three Canadian regions will serve only to illustrate the need for further study.

	No. vertebrae			
	38	39	40	41
Vaudreuil, Que.	3	5	4	–
L. Erie, Ont.	–	6	5	1
L. Winnipeg, Man.	–	2	7	–



Distribution The emerald shiner occurs in large open lakes and rivers in many parts of Canada, and in the Mississippi valley south to the Gulf coast in Alabama and in Trinity River, Texas.

In Canada, the species inhabits the upper St. Lawrence River in Quebec, at least to Trois Rivières, and Lake Champlain, and west through all of the Great Lakes. North in Ontario the range extends at least to lakes Attawapiskat and Abitibi, and to the headwaters of the Severn River. It is common west through Manitoba, Saskatchewan, Alberta, and British Columbia. Recorded also from tributaries of the Mackenzie River south from the junction of the Mackenzie and Liard rivers, including Fort Nelson River in British Columbia, but has not been recorded from the Peace River (McPhail and Lindsey 1970).

It has not been reported from the Maritime Provinces, nor from Newfoundland.

Biology The emerald shiner is of considerable importance to the Canadian freshwater fishery but few, if any, definitive studies have been conducted on any aspect of its biology in the Canadian range. Hence, much of the following information is derived from studies in northern United States waters.

Factual reports of spawning in Canadian waters are lacking but Dymond (1926) observed females distended with nearly ripe eggs when caught on July 12, 1922, in the Sturgeon River, Lake Nipigon, Ont. Similar observations suggest that the emerald shiner spawns in late spring or early summer in most Canadian localities, probably in midwater. Indirect evidence suggests a prolonged spawning season since Fish (1932) noted that 1–500 larvae were caught in Lake Erie in every tow made between July 2 and August 30, 1929. Langlois (1954) also suggested that spawning continued in Lake Erie until at least mid-August. Some authors stated that

spawning occurred at 75.2° F (24° C), and that hatching occurred in less than 24 hours. Flittner (1964) reported that hatching occurred 24–32 hours after fertilization, at a size of 4.0 mm; in 30 hours fry were 4.9 mm long; in 90–96 hours, 6.1 mm; and in 11 days, 8.9 mm. Fish (1932) described and illustrated larval stages from 4.9 to 13.5 mm.

In Lake Simcoe, Ont., McCrimmon (1956) reported that young-of-the-year averaged nearly 2 inches (51 mm) long and a weight of 0.3 ounces by mid-November, and by the following autumn were 3 inches (76 mm) long and weighed nearly 1 ounce (28.0 g). He noted that few survived until the autumn of the third year, but some were collected, 3.3 inches (84 mm) long, weighing 1.2 ounces (33.6 g). McCrimmon also presented a growth curve.

It appears that emerald shiners do not usually live beyond 3 years; Fuchs (1967) had only four specimens beyond age 3, but Canadian data are lacking. Emerald shiners may attain total length of about 4 inches (102 mm). Specimens in the ROM collections from Rainy River region in Ontario (a male) measured about 4 inches (103 mm) and from Lake Athabasca, Sask. (a female), about 4 inches (101 mm) total length.

The emerald shiner is a pelagic or open-water species, inhabiting lakes or large rivers. It is a schooling species, staying offshore during summer months, usually near the surface, but moving inshore in autumn, sometimes aggregating off docks, piers, and river mouths in countless numbers, but apparently with less frequency in the Great Lakes and Lake Simcoe than in former years. These large schools in inshore waters are usually composed of young-of-the-year. As the season advances they move into deeper water for overwintering. In early spring they move into surface waters at night, dropping down to deeper waters during the day.

Available evidence suggests that emerald shiner populations fluctuate widely in abundance from year to year. For example, routine sampling by seine in the vicinity of Port Dover, Lake Erie, Ont., during 1946–49, using comparable methods, yielded the following numbers of emerald shiners: 1946, 6307; 1947, 541; 1948, 1225; 1949, 300. Periodically biologists and commercial fishermen become concerned with the relative scarcity of emerald shiners in Lake Erie, but conversations with retired fishermen lead one to conclude that periods of scarcity followed by great abundance have been characteristic of the populations for over 50 years.

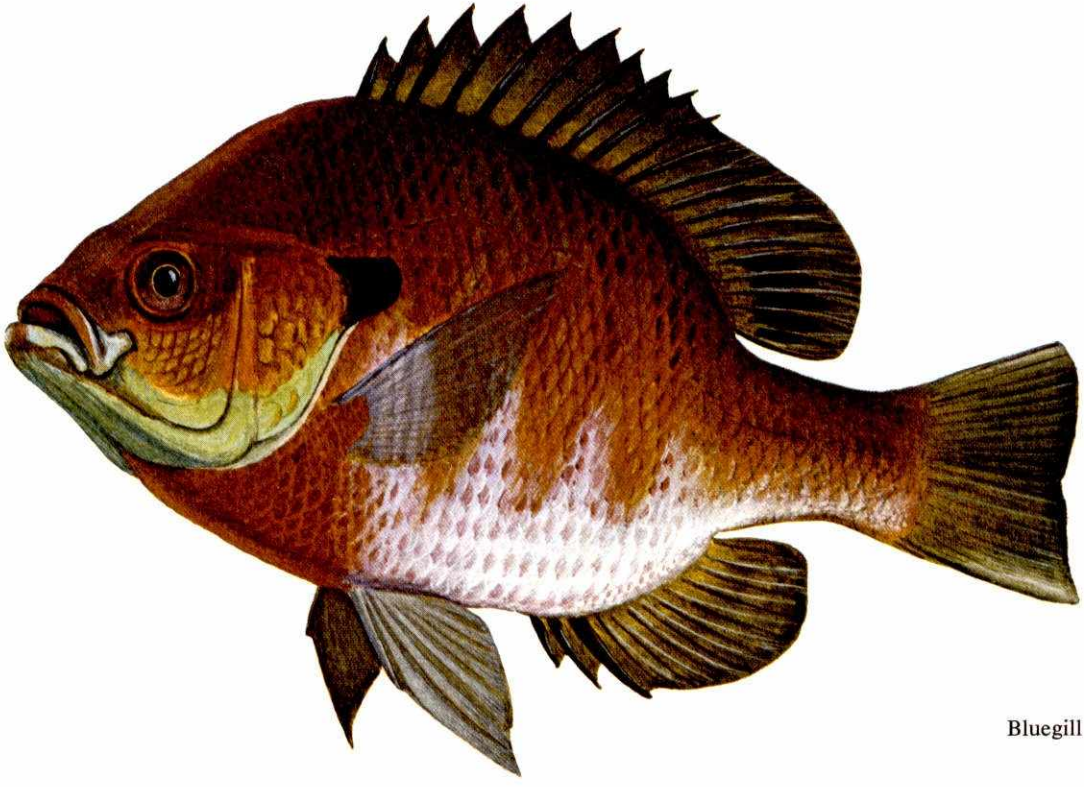
It is an important forage species and since it is not a commercial nor a sport fish, we do not have regularly gathered catch records, but some method should be devised for monitoring the state of the population from year to year.

In South Dakota, Fuchs (1967) concluded that high mortality rates caused drastic changes in age-class structure of populations. He also noted that during the second and third year of life males had a higher mortality rate than females.

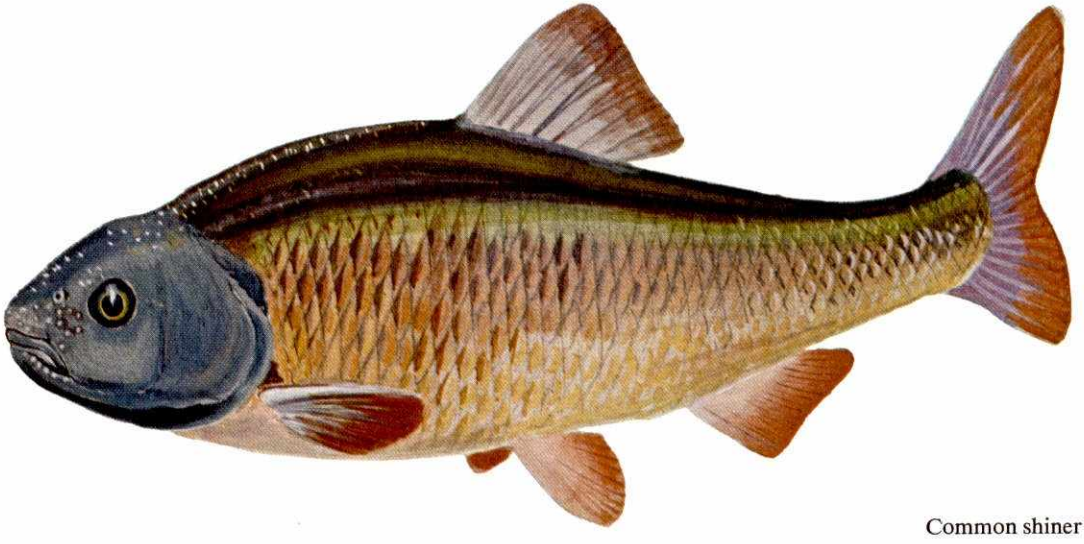
Emerald shiners feed heavily on microcrustaceans, some midge larvae, and algae, and tend to move with this planktonic food supply toward the surface at dusk, and descend again at daybreak. Evidence gathered by Gray (1942) in Lake Erie during December indicated that the evening feeding period was most important. He found *Diaptomus*, *Daphnia*, *Cyclops*, and *Bosmina* all important in the diet but at different times of the day, and concluded that size selection of prey was important, but that the pattern of vertical migration of the prey may also be significant.

In South Dakota, Fuchs found that blue-green algae and ciliated Protozoa were important in the diet up to the 1-inch (25-mm) length stage, then green algae was consumed in addition, and at 1.6–1.8 inches (41–45 mm) *Daphnia* became increasingly important, but *Leptodora* and *Diaptomus* were also taken, as well as small quantities of blue-green algae and diatoms. In the diet of adults, zooplankton (*Daphnia*, *Diaptomus*, and *Leptodora*) was of greatest importance, followed by insects (Diptera).

So many creatures prey upon emerald shiners it would be impossible to list them all. In Lake Erie, Langlois (1954), reported a count of 373 emerald shiners in the stomach of a burbot caught in October. During the peak of Lake Erie blue pike fishing in the



Bluegill



Common shiner

1950's, millions of pounds of fall-caught fish had stomachs literally crammed with emerald shiners. In Green Bay, Lake Michigan, Van Oosten and Deason (1938) noted that emerald shiners made up about 64% of the food of lake trout, especially in spring. In a study of the smallmouth bass in Lake Erie, Doan (1940) listed the emerald shiner as the chief food fish. The importance of the emerald shiner to the Lake Erie fishery before 1970 has been well documented, and the story is similar in other lakes where studies have been conducted. In Lake Simcoe, McCrimmon (1956) noted that the emerald shiner was the most common minnow and served as an important food item of most sport fishes at some season of the year. Emerald shiners are eaten extensively by burbot, rainbow trout, and northern pike and to a lesser extent by other species. MacKay (1963) reported 87 individuals in the stomach of a single Atlantic salmon from Trout Lake, Ont.

Many fish-eating birds, such as gulls, terns, mergansers, and cormorants feed heavily upon emerald shiners, whose surface swimming habits makes them particularly susceptible to this kind of predator,

Man, of course, is an exceedingly influential predator taking many thousands of fish for use as bait.

The identification of ingested small fishes in general, and minnows in particular, is usually very difficult. Undoubtedly, emerald shiners are eaten much more extensively in other Canadian lakes than our meagre evidence indicates.

Bangham (1955) examined for parasites five fish from Providence Bay and South Bay, Manitoulin Island, Ont., and found all five lightly infected. Bangham and Hunter (1939) listed trematodes, cestodes, nematodes, and the protozoan Myxosporidia from lake shiners in Lake Erie. Hoffman (1967) noted that trematodes and cestodes have been recovered, but the number of species was comparatively small.

Relation to man The emerald shiner is probably used more often as bait, largely because of availability, than any other single species. It is also pickled and bottled and sold as preserved or pickled minnows for bait. The most intensive use is in connection with the Lake Simcoe winter ice fishery for whitefish and the spring fishery for yellow perch. The role of the emerald shiner in the Lake Simcoe fishery, particularly its use fresh, frozen and salted, as bait for lake whitefish, has been thoroughly discussed by McCrimmon (1956).

Nomenclature

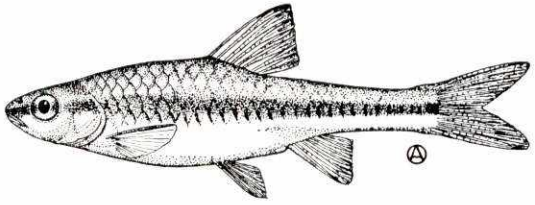
Notropis atherinoides	— Rafinesque 1818a: 204 (type locality Lake Erie)
Alburnus rubellus	— Agassiz 1850: 364
Alburnus nitidus	— Kirtland 1854a: 44
Alburnellus jaculus	— Cope 1869: 387
Notropis atherinoides (Rafinesque)	— Evermann and Goldsborough 1907a: 97
Leuciscus copii Günther	— Jordan, Evermann, and Clark 1930: 123

Etymology *Notropis* — back; keel; *atherinoides* — from *atherina,* the silverside; resemblance.

Common names Emerald shiner, lake shiner, lake emerald shiner, common emerald shiner, shiner. French common name: *méné émeraude.*

BRIDLE SHINER

Notropis bifrenatus (Cope)



Description Body slender, small, seldom exceeds 2 inches (51 mm) total length, somewhat compressed laterally, body slightly deeper than wide, its depth 15–22% of total length. Head length 20–23% of total length; eye relatively large, its diameter 31.2–38.8% of head length; snout length usually smaller than eye diameter, 26.6–33.3% of head length; interorbital width 33.3–44.4% of head length; mouth small, terminal, angle rather oblique, upper jaw extending backward almost to anterior margin of eye; pharyngeal teeth short, slightly hooked, 0,4–4,0. Fins: dorsal 1, rays usually 8(23) or 7(12), caudal forked; anal 1, rays usually 7(19), occasionally 8(6); pelvics thoracic, originating directly beneath origin of dorsal fin, rays 8(16), occasionally 7(4); pectorals moderate, the rays usually 12(13), but occasionally 11(2) or 13(5). Scales, cycloid, large, 32–35 in lateral series; lateral line incomplete. Peritoneum silvery and lightly speckled. Vertebrae 34–36.

Nuptial tubercles not conspicuous, but fine tubercles develop on males on pectoral fins and sometimes on head and nape.

Colour A straw-coloured minnow, silvery above and silvery white on the underparts, all fins transparent; spawning males always bright yellow-gold below the black lateral band, females without yellow colouring but are white below; rays of dorsal, caudal, and anal fins take on a yellow tint on both males and females; anterior pectoral rays of males become a more intense brown than on females.

Distribution The bridle shiner occurs in the Atlantic drainage of eastern North America from southern Maine to Virginia, west through Lake Champlain to New York State and the Lake Ontario basin.

In Canada its range extends from the upper St. Lawrence River, in the vicinity of Trois-Rivières, west through the St. Lawrence system including lakes Saint-Pierre and Saint-Louis (Cuerrier et al. 1946), to Lake Ontario where it extends only to the Bay of Quinte.

Radforth (1944) considered that the species survived glaciation in the Atlantic coastal plain and entered Canada in relatively recent times and that it might well be in the process of expanding its range here. Unfortunately, the region in which it occurs is either heavily industrialized, heavily populated, or both, creating sewage disposal problems that will probably prevent the manifestation of such potential.

Biology Many studies of the life story and structure of the bridle shiner have been made by R. W. Harrington (1947a, 1948a, b, 1955), who worked with New England populations. We could find no evidence that Canadian populations have been studied.

Spawning may extend from late May to mid-July in New Hampshire, and from early May to August in New York State. In New

Hampshire, spawning groups were observed by Harrington (1948a) to consist of few females (3) and many males (29). The eggs were of the order of 0.03 inches (0.8 mm) in diameter; they appeared to mature progressively in accord with the prolonged spawning period. Mansueti and Hardy (1967) illustrated and described larval stages in the Chesapeake Bay region.

Food of the bridle shiner in New Hampshire has been thoroughly investigated by Harrington (1948a). It is primarily a predaceous species eating small planktonic animals of various kinds, whereas plant materials make up only a small part of the diet. Among the animals consumed were aquatic insect larvae, especially chironomids and entomostracans, notably cladocerans and copepods.

Bridle shiners are characteristic of clear quiet streams or lagoons that have an abundance of submerged aquatic vegetation, and where the bottom is composed of silt, or silt and sand. In such situations they may be very numerous.

Their small size and relatively weak swimming ability make them an ideal forage fish. In the eastern United States they are regarded as one of the principal foods of the pickerel, *Esox niger*. In Canadian waters they undoubtedly perform a similar role, although we have no supporting evidence. It seems safe to presume, however, that they form, or did form, an important food item in the diet of black crappies, smallmouth bass, yellow perch, and white perch in eastern Lake Ontario waters. It would be interesting to know if the explosive numbers of white perch in eastern Lake Ontario have seriously affected bridle shiner populations.

Hoffman (1967) listed the larval form of only one parasite, the trematode *Centrovarium lobotes*, from the bridle shiner. There are no Canadian records of infestation of this species.

Relation to man Like all forage fishes, the bridle shiner is an important food item for other fishes whenever it occurs in sufficient numbers to be a significant food source. It can be used as a bait minnow for anglers, but its small size and delicate structure limit its usefulness for this purpose.

Nomenclature

Hybopsis bifrenatus — Cope 1869: 382, 384 (type locality tributary Schuylkill River, Conshohocken, Pa.)

Notropis kendalli — Evermann and Cockerell 1909: 186

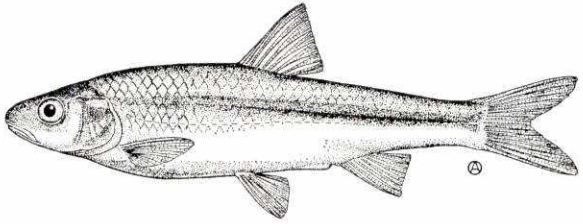
Notropis bifrenatus (Cope) — Jordan and Evermann 1896–1900: 258

Etymology *Notropis* — back; keel; *bifrenatus* — *bis* — two; *frenatus* — bridled.

Common names Bridle shiner, bridled shiner. French common name: *méné d'herbe*.

RIVER SHINER

Notropis blennius (Girard)



Description Body stout, average length 2.5–3.0 inches (64–76 mm), moderately compressed laterally, its greatest depth 15.9–19.4% of total length. Head bluntly triangular, large, its length 19.4–22.6% of total length; eye relatively large, its diameter 25.8–33.3% of head length; snout rounded and slightly overhanging the mouth, snout length 26.0–35.7% of head length; interorbital wide, its width 30.4–42.8% of head length; mouth large, subterminal, premaxillary terminating below anterior margin of eye; pharyngeal teeth stout, with slight hook, 2,4–4,2; but may be 2,4–4,1; 1,4–4,1; 3,4–4,1. Fins: all transparent; dorsal 1, its origin more or less directly over pelvic fin origin, rays almost always 8(30), rarely 7(1); caudal distinctly forked; anal 1, originating at a point below tip of depressed dorsal, rays 7(31); pelvics small, originating about directly below dorsal fin origin, pelvic axillary process present but very inconspicuous, rays 8(25); pectorals moderate in size, rays usually 14(16), sometimes 13(8) or 15(6). Scales cycloid, large, 38–45 in lateral line; lateral line complete, only slightly decurved, almost straight. Peritoneum silvery; intestine short. Vertebrae 36(18) or 37(3).

Nuptial tubercles on breeding males on snout, top of head, on rays of pectoral fins, and on leading edges of dorsal and anal fins.

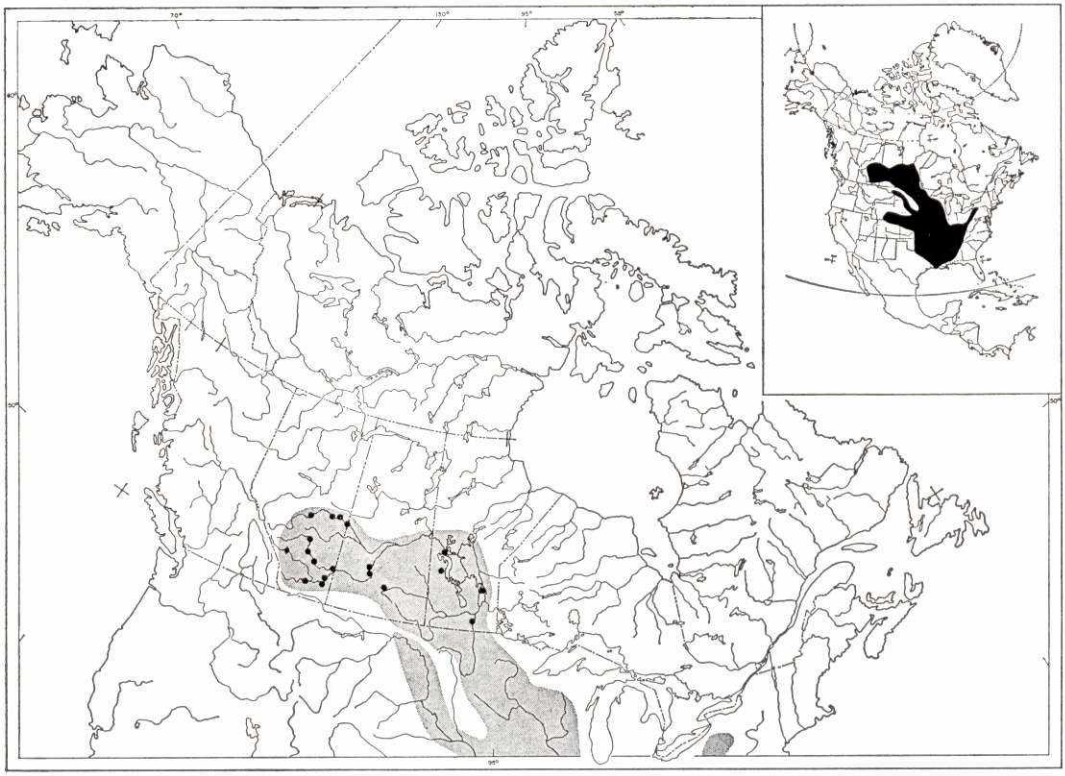
Colour General overall colouration is silvery but light brown to straw-coloured dorsally. Mid-dorsal stripe well developed, surrounding base of dorsal fin. Midlateral stripe indistinct, lateral line pores not outlined. Spawning adults not brightly coloured.

Systematic notes Hubbs and Lagler (1964) referred the northwestern North American populations, including the Canadian populations, to the subspecies *N. b. jejunus*. In the absence of definite studies, it seems advisable only to state the characteristics of the Canadian populations. A discussion of the zoogeopraphy of the species and morphometrics of some United States populations were presented by Metcalf (1966).

Distribution A central North American minnow, occurring from eastern Texas and Alabama north to southern Ohio on the east and the Prairie Provinces on the northwest.

In Canada the river shiner occurs from the Red River system of southern Manitoba, westward, especially in the South and North Saskatchewan River systems, through Saskatchewan to southeastern Alberta.

Biology Few detailed studies have been made of the river shiner in either the United States or Canada. Consequently, we have little knowledge of its biology. Trautman (1957) discussed the species in Ohio and remarked that it spawned throughout the summer until late August, over a sand and gravel bottom.



Hoffman (1967) listed three species of Protozoa as parasites of the river shiner. There are no Canadian records of infestation of the species.

Relation to man So far as we are aware, the role of the river shiner in the biological economy of Canadian fresh waters is unknown.

Nomenclature

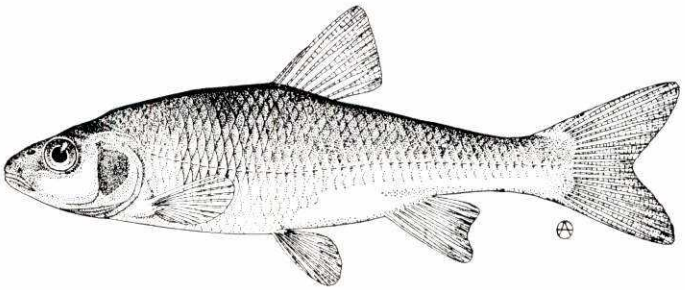
Alburnops blennius	— Girard 1857a: 194 (type locality Arkansas River)
Episema jejuna	— Forbes 1878: 60
Notropis reticulatus	— Eigenmann and Eigenmann 1893a: 152
Notropis blennius (Girard)	— Jordan and Evermann 1896–1900: 261
Hybognathus stramineus Cope	— Jordan and Evermann 1896–1900: 262
Notropis deliciosus (Girard) (as used by Eigenmann 1895: 110)	— Evermann and Goldsborough 1907a: 96
Notropis jejunus Forbes	— Halkett 1913: 64
Hybopsis blennius (Girard)	— Jordan, Evermann, and Clark 1930: 133
Paranotropis jejunus (Forbes)	— Jordan, Evermann, and Clark 1930: 125

Etymology *Notropis* — back; keel; *blennius* — from *blennos*, the blenny which has mucus on its scales.

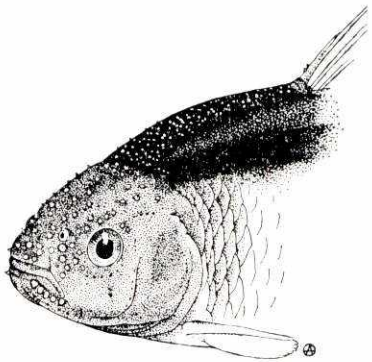
Common names River shiner, poor minnow, straw-coloured minnow. French common name: *méné de rivière*.

COMMON SHINER

Notropis cornutus (Mitchill)



Description Body stout, average length 2.5–4.0 inches (64–102 mm), distinctly compressed laterally, greatest depth 15.8–23.4% of total length; head triangular, its length 18.8–23.3% of total length; eye relatively large, its diameter 23.0–35.7% of head length; snout pointed, its length 28.5–35.2% of head length; interorbital wide, its width 33.3–46.1% of head length; mouth large, terminal, premaxillary terminating below anterior margin of eye; pharyngeal teeth, hooked, 2,4–4,2; 2,4–4,0; 1,4–4,1. Fins: dorsal 1, its origin over pelvic fin origin, rays always 8(65); caudal distinctly forked; anal 1, originating below tip of depressed dorsal fin, rays usually 9(54), sometimes 8(19), rarely 10(1), the latter in New Brunswick; pelvics small, originating under dorsal fin origin, rays usually 8(47), rarely 9(3); pectorals relatively small, rays usually 16(25), sometimes 15(11) or 17(14). Scales cycloid, those along flanks elevated, higher than wide, 40–44 in lateral line; lateral line decurved, complete. Peritoneum black; intestine short. Vertebrae 38–43, usually 39 or 40.

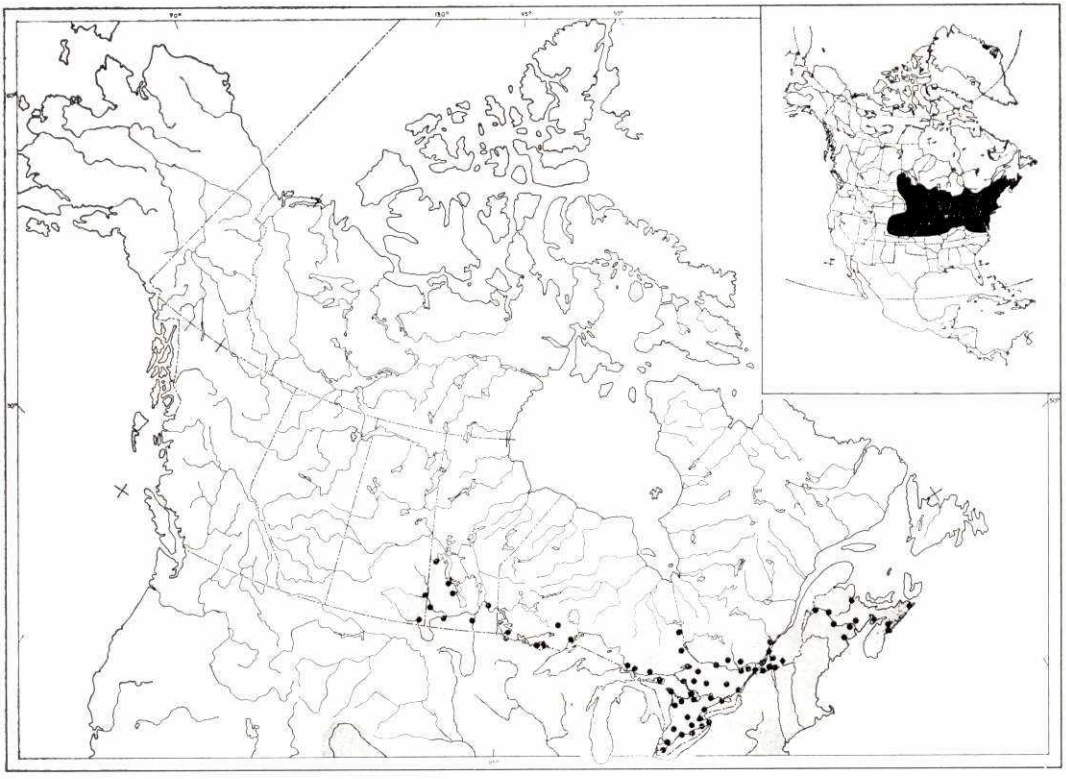


Nuptial tubercles on breeding males dense on snout, less dense on top of head, extending on nape to leading edge of dorsal fin, a single row on each side of mandible.

Colour Overall colouration silvery with bronze tints, but back is olive-green with a purple or gray-blue dorsal stripe, silvery on sides and silvery white below. Small specimens, under 2.5 inches (64 mm), usually silvery without bronze tint and with clear fins; mature males often with darkened dorsal fin.

Breeding males are brightly coloured, with pink or red on the outer third of all fins and a pink tint to anterior flanks and head. In addition to the mid-dorsal stripe, another golden stripe, particularly bright on spawning males, extends along the length of the body on each side, a few scale rows down from the centre stripe. *See* colour illustration facing p. 442.

Systematic notes A most thorough review of *N. cornutus* and closely related species was published by Gilbert (1964), which included meristic values for the species throughout its range. In the figures given



below, the vertebral number was calculated differently from ours. Gilbert included the urostylar vertebrae whereas we did not, and so Gilbert's values were adjusted accordingly. The frequency of occurrence of vertebrae number and anal fin ray count for *Notropis cornutus* throughout its range (from Gilbert) compared with values from various Canadian localities are as follows:

Vertebrae	Gilbert	Canada
35	2	–
36	–	–
37	2	–
38	36	2
39	136	10
40	55	14
41	6	3
Anal rays		
8	100	19
9	749	54
10	20	1

Gilbert included southern Ontario, in particular the Thames River, in the range of *Notropis chrysocephalus*. However, although the Thames populations exhibit the characters of *chrysocephalus*, the distinctions are not clear cut and we decided not to attempt to write an account for *chrysocephalus*. If Gilbert is correct in his assessment of *chrysocephalus*, i.e., that it tolerates warmer, more turbid waters than *cornutus* and is replacing it in areas where such conditions exist, then *chrysocephalus* should extend its range in Ontario and replace *cornutus* in many southern Ontario streams.

Distribution The common shiner is widely distributed in clear lakes and streams from Nova Scotia on the Atlantic coast south to the James River system in Virginia, west through the southern Great Lakes drainage region to Saskatchewan, and south throughout most of the Mississippi valley. Metcalf (1966) noted that its range, particularly in the Kansas River basin where it was once widely distributed, has been reduced because

of turbidity resulting from agricultural practices in that area, and other similarly utilized regions in Iowa.

In Canada the common shiner has been reported to occur in Nova Scotia from Goshen Lake, Guysborough County, to Pockwock Lake, Halifax County, and northwest to Gilbert Lake, Cumberland County; in New Brunswick widely distributed throughout the province; in southern Quebec; in Ontario in southern parts of the Great Lakes–St. Lawrence River drainage occurring north to Lake Temiskaming and west to Lake of the Woods. Radforth (1944) noted that its Ontario distribution appeared to be related to the 65° F July isotherm. In Manitoba it is recorded from Whitemouth and Cypress rivers, and some of the western tributaries of Lake Dauphin, Swan Lake, and the Red River (Keleher and Kooyman 1957). Atton and Johnson (1955) reported a single large specimen from Whitesand River at Canora on June 16, 1954, and a number of smaller specimens from the Souris River at Oxbow on July 27, 1954. These specimens from Saskatchewan represent the western extent of the range.

It is absent from Newfoundland, Prince Edward Island, Alberta, British Columbia, the Northwest Territories, and the Yukon Territory. Gilbert (1964: 148) noted a specimen in the United States National Museum collection (USNM 86211) bearing the locality data of Medicine Hat, Alta. Since the collection also contained specimens of other eastern cyprinids, such as *Semotilus corporalis* and *Pimephales notatus*, the author concluded that the locality data had been transposed.

Biology The reproductive phase of the life history of the common or creek shiner has been fully described by Raney (1940a) and most recent accounts refer to this classical work. Raney's own observations were made near Ithaca, N.Y. Published observations of spawning or other activities of this species in Canadian waters are exceedingly rare.

This is, perhaps, exclusively a stream-spawning species, but it is sometimes so abundant in lakes as to suggest that it may spawn on gravelly shoals. In spring, usually in May, lake populations move inshore in preparation for spawning.

The actual date of spawning is apparently related to water temperature but there seems to be wide variation of temperature at which spawning begins, throughout its United States range at least. Raney reviewed the temperature data presented by various authors, and it seems likely that spawning usually begins when water temperatures reach 60°–65° F (15.6°–18.3° C), usually in May or June. As noted earlier, its northern distribution in Ontario seems to bear a relation to the 65° F (18.3° C) isotherm, which corresponds with the required 60°–65° F temperature for spawning. Greeley (1929) observed spawning in the Lake Erie drainage of New York State at a temperature of 83° F (28.3° C) as late as July 9.

Spawning may occur over gravel beds in flowing water; the fish may excavate shallow nests in gravel in flowing water, or they may use the nests made by other fishes, even though such nests lack a current flow. They often spawn at the head of a gravelly riffle, a site probably used frequently in our waters. In such situations, the male establishes a territory, usually consisting of a few square inches, may effect some cleaning of the gravel by dislodging stones with his head, and is frequently involved in fights with other males in defense of his territory. The usefulness of the nuptial tubercles is apparent during these activities. The females stay on the gravel below the males until ready to spawn, then they move upstream and eventually the spawning act is completed. The male encloses the female within the curve of his body, and exerting pressure on the body of the female, he forces the extrusion of the eggs. This spawning act takes place in a fraction of a second and is repeated many times, often within a few minutes, and there may be a constant succession of males and females moving onto the spawning site, spawning, and dropping back. Raney suggested that few eggs, probably not more than 50, were released at each spawning. The habit of spawning over the nests of other minnows, or in riffles up-

stream from spawning sites of other minnows, and the subsequent mixing of sex products, results in the production of many natural hybrid forms of which *N. cornutus* is one parent. Hybrid combinations with *N. rubellus*, *Semotilus atromaculatus*, and *S. corporalis* have been reported, some as new species (*see* Hubbs and Brown 1929: 37).

The eggs, each about 1.5 mm in diameter, are demersal, become adhesive after about 2 minutes of water hardening, and lodge among the gravel. Fish (1932) described the development and figured the egg and three larval stages to a length of 13.2 mm. Few studies on rates of growth have been published. This is the largest member of the genus *Notropis*; males may grow to lengths of 6.9–7.9 inches (175–201 mm) total length. The largest specimen known to us is one from Lake Bernard, Que., 7.9 inches (201 mm), but one from the Whitesand River, Sask., near the western limit of the Canadian range, measured 7.5 inches (190 mm). These large fish were all males.

Although principally a stream fish through most of its range, the common shiner frequently occurs in the shore waters of clear-water lakes, particularly in the central portion of its Canadian range.

The food of common shiners has received much attention. Aquatic insects, adults and larvae, may figure prominently in the diet and so also may algae and other aquatic plants. Protozoans, desmids, and small fishes have also been reported. Although it usually feeds at the surface, it will also take food off the bottom. Gilbert (1964) suggested that its versatility in feeding habits probably partly accounts for its considerable success as a species.

The common shiner is preyed upon by a variety of other creatures, but because streams are its preferred habitat it avoids predation by many game species except in the lower reaches where deeper water affords protection to smallmouth bass, northern pike, and other large fish. White (1957) discovered that the common shiner could constitute up to 40% of the diet of American mergansers in streams in New Brunswick and other parts of the Maritime Provinces. Kingfishers are also predators on shiners.

Parasites of the common shiner have been reported by Bangham and Hunter (1939) for Lake Erie and Bangham (1955) for Lake Huron, but the degree of parasitism appeared to be comparatively light. *See* Bangham (1955) for details. Local populations sometimes exhibit *Ligula intestinalis* infections and such a case was reported by Dence (1958) for the Adirondack region of New York.

Hoffman (1967) gave a lengthy list of parasites found in this species, including protozoans, trematodes, cestodes, nematodes, acanthocephalans, molluscs, and crustaceans.

Relation to man The common or creek shiner is a very commonly used bait species. Its large size and silvery appearance make it particularly attractive for northern pike and walleye fishing, although shiners caught in cool, clear streams do not live for long in the confines of a neglected minnow pail.

Because of its need of gravelly riffles for spawning, it is not usually regarded as well suited to pond culture; also Dobie et al. (1956) noted that attempts to strip eggs from females had been unsuccessful.

Nomenclature

Cyprinus cornutus	— Mitchill 1817: 289 (type locality Wallkill River, N.Y.)
Cyprinus megalops	— Rafinesque 1817b: 121
Leuciscus cornutus	— DeKay 1842: 207
Leuciscus vittatus	— DeKay 1842: 212
Leuciscus frontalis	— Agassiz 1850: 368
Leuciscus gracilis	— Agassiz 1850: 370
Minnilus cornutus Mitch.	— Cox 1893: 40
Notropis megalops	— Eigenmann 1895: 110

Minnilus cornutus (Mitchill) — Cox 1896b: 64
Luxilus cornutus (Mitchill) — Jordan, Evermann, and Clark 1930: 128
Notropis cornutus — Gilbert 1964: 140

Etymology *Notropis* — back; keel; *cornutus* — horned.

Common names Common shiner, eastern shiner, redfin shiner, silver shiner, dace, silverside, rough-head, hornyhead, creek shiner. French common name: ***méné à nageoires rouges.***

BIGMOUTH SHINER

Notropis dorsalis (Agassiz)

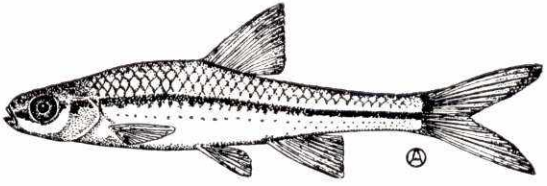
Description Body compressed laterally, length to about 2.5 inches (64 mm), its greatest depth 16.6–20.2% of total length. Head bluntly triangular, large, its length 20.6–25.0% of total length; eye relatively large, its diameter 24.6–30.0% of head length; snout moderate, its length 25.0–31.5% of head length; interorbital moderate, width 29.4–38.0% of head length; mouth large, extending to below anterior margin of pupil of eye; pharyngeal teeth mainly 1,4–4,1 but some variability to 0,4–4,1 or 1,4–4,0, teeth with slight hook. Fins: dorsal 1, its origin over or slightly behind origin of pelvic fin, rays 8(10); caudal forked, lobes pointed; anal origin below free margin of depressed dorsal fin, rays 8(10); pelvics originate under or slightly in advance of dorsal fin origin, rays 8(10); pectorals well developed, rays 14(7) or 15(3). Scales cycloid, deciduous; lateral line complete; peritoneum silvery. Vertebrae 34(3), 35(7), 36(4), or 37(1).

Mr A. N. Fedoruk, Canada Land Inventory project, reported capture of 53 specimens of *Notropis dorsalis* (Agassiz) in June 1969 in the Pembina River, Man. (township 6 Range 1 W), 5 miles upriver from the point where the Pembina crosses into North Dakota. This is the first record for this species in Canada. The above description is based on a study of 10 of these specimens. A second occurrence in southern Manitoba has also been noted, in the Woody River.

The characteristic features to look for are: large mouth, a distinct lateral band, especially on posterior part of trunk and caudal peduncle and a distinct mid-dorsal stripe. It closely resembles *Notropis blennius.*

PUGNOSE MINNOW

Notropis emiliae (Hay)



Description Body slender, elongate, averaging 2 inches (50 mm) total length, robust anteriorly, not strongly compressed laterally, its depth 15.3–21.1% of total length. Head bluntly rounded, small, its length 17.3–20.0% of total length; eye moderate, its diameter 30.0–33.3% of head length; snout rounded, its length somewhat greater than eye diameter, 30–35% of head length; interorbital broad, its width 36.8–44.4% of head length; mouth very small and at an acute angle; pharyngeal teeth slender but serrated and hooked, 0,5–5,0. Fins: dorsal 1, inserted over or slightly behind origin of pelvic fins, rays 9; caudal distinctly forked; anal 1, its origin behind insertion of dorsal fin, rays 8; pelvics originate below or slightly in advance of dorsal fin origin, 8 rays; pectorals short, about 15 rays. Scales cycloid, 37–41 in lateral line; lateral line complete, slightly decurved. Peritoneum silvery, but heavily speckled with chromatophores. Vertebrae 37 or 38.

Nuptial tubercles on breeding males restricted to many small, sharp tubercles around the mouth.

Colour Overall colouration silvery, but with straw-colour or light olive overtones and often appearing somewhat translucent; a distinct midlateral band, becoming less distinct anteriorly on head, through eye and around snout. Slight concentration of melanophores at base of central caudal rays. Scales on back and sides distinctly outlined with pigment.

Distribution A North American minnow restricted primarily to the Gulf states and Mississippi valley, the pugnose ranges from Florida to Texas, north in the Mississippi valley and tributaries, to western Lake Erie, west to southern Wisconsin and southern Minnesota.

In Canada the pugnose is a rare minnow and has been reported from the Detroit River, and from Lake St. Clair and its tributary, the Thames River. Captures on the Canadian side of the Detroit River have not been made since 1941, but 7 specimens were caught in the Thames River in October 1968 and reported to the authors.

Biology Information on the biology of this small minnow is almost as rare as is the species itself in Canadian waters, and we have no information on its reproductive biology.

The pugnose minnow apparently prefers clear, slow-moving waters having an abundance of aquatic vegetation, precisely the type of habitat that is rapidly disappearing from southern Ontario. Trautman (1957) noted that the species was intolerant of turbid or muddy waters (conditions unsuited to successful growth of aquatic plants) and was threatened with extirpation from Ohio waters. It seems most unlikely that the species will be able to survive for long in Ontario waters.

Bangham and Hunter (1939) examined 10 specimens from Lake Erie and found 2 infected with the trematodes *Neascus* sp., and *Lebouria cooperi*, and the larval or immature form of the cestode *Ligula intestinalis*.

Relation to man The pugnose minnow is too rare and restricted in distribution to be of any real importance in Canada.

Nomenclature

Opsopoeodus emiliae — Hay 1881: 507 type locality Artesia, Macon, and Enterprise, Miss.)

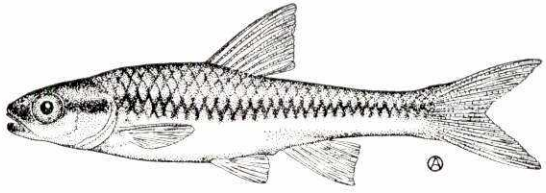
Notropis emiliae (Hay) — Bailey et al. 1970: 22

Etymology *Notropis* —back; keel; *emiliae* — named for Mrs Emily Hay.

Common names Pugnose minnow. French common name: *petit-bec*.

BLACKCHIN SHINER

Notropis heterodon (Cope)

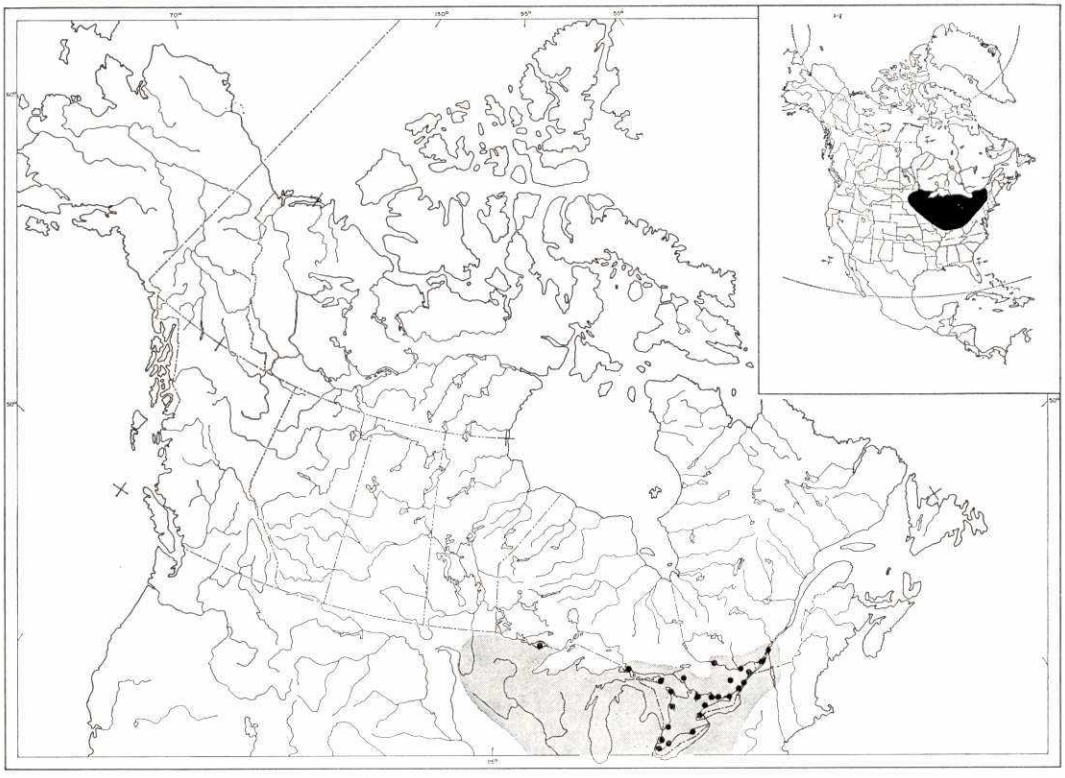


Description A stout-bodied little fish, average length about 2.5 inches (64 mm), only slightly deeper than wide, its greatest depth 15.0–24.5% of total length. Head bluntly triangular, its length 20.0–23.8% of total length; eye relatively large, its diameter 25–40% of head length; snout short, its length 23.8–34.7% of head length; interorbital wide, its width 27.2–40.0% of head length; mouth small, terminal, premaxillary terminating below nostrils; pharyngeal teeth with broad base, pointed, 1,4–4,0; 1,4–4,1; 1,3–4,1. Fins: more or less transtransparent; dorsal 1, its origin more or less directly over pelvic origin, rays usually 8(46), occasionally 7(3); caudal distinctly forked; anal 1, rays usually 7(31), often 8(17); pelvics originate below dorsal fin origin, rays usually 8(37), rarely 7(1); pectorals short, rays usually 13(14) or 14(14), often 12(10). Scales cycloid, clearly outlined with black above lateral band, 34–37 in lateral line; lateral line slightly decurved, complete. Peritoneum silvery. Vertebrae 35 or 36.

Nuptial tubercles on breeding males, very fine, on top of head and upper surface of pectoral fins.

Colour Typically silvery but straw-coloured or yellowish dorsally and white ventrally. The scales on the back are edged with dark pigment. Lateral band dark and distinctive on the body, forming a zigzag pattern, extending onto the head, through the eye, and around the snout and also onto the chin, chin black. Spawning fish are said not to develop bright colours, but field observations in Point Pelee, Ont., area suggested pale yellowish tinge on ventral surface.

Systematic notes *See* section on *Systematic notes* for *Notropis anogenus*, which this species resembles so closely.



Distribution The blackchin shiner occurs only in the Great Lakes basin and tributary watersheds of the north-central portion of North America.

In Canada it ranges from the upper St. Lawrence River (Trois-Rivières), western Quebec, the Ottawa River drainage in the vicinity of Pembroke, west through Lakes Ontario, Erie, St. Clair, and Huron and their tributary streams, north to Sault Ste. Marie (and has been reported from at least six Michigan streams tributary to eastern Lake Superior); recently recorded from Quetico region, Ont.

Clear, clean, weedy waters are essential for survival of the blackchin shiner and it is especially noteworthy that it has been eliminated from the Iowa fauna during the last 25 years and from Ohio waters since around 1950, presumably because of the drastic changes in water quality and loss of habitat.

Biology The life history and ecology of the blackchin have received little attention and definitive studies have not been made or, at least, not published. Certainly there is practically no biological information on Canadian populations.

It has been reported to spawn in May and June in central Illinois. Spawning site and behaviour have not been reported.

Trautman (1957) reported the following growth figures (length) for Ohio specimens: young-of-the-year (October) 0.7–1.4 inches (18–36 mm), around 1 year 1–2 inches (25–51 mm). Adults from Canadian waters average 2.0–2.4 inches (51–61 mm).

The blackchin shiner requires clear weeded waters for survival and seems to prefer quiet pools in creeks and rivers and weedy inshore waters of lakes.

Its food has been reported to consist principally of small crustaceans, such as cladocerans, copepods, and other entomostracans, and small insects. Keast (1965) in a study based on Lake Opinicon, Ont., considered it a specialized feeder, the overwhelming bulk of food ingested from May to August being

Cladocera and flying insects (mainly small Diptera) taken at the surface. Among Cladocera, *Chydorus* and *Bosmina* were the main genera consumed, 400–700 occurring per 10 stomachs in June and July, and some larger *Daphnia* consumed in August.

Bangham (1955) examined one specimen only from South Bay, Manitoulin Island in Lake Huron, and reported one each of two larval trematodes, *Diplostomulum* sp. and *Posthodiplostomum minimum*, from this fish. Bangham and Hunter (1939) recorded the trematode *Neascus* sp. and nematodes *Agamonema* sp. and *Camallanus oxycephalus* in three of the eight specimens examined from the western end of Lake Erie.

Hoffman (1967) listed three species of trematodes, and three species of nematodes, from the blackchin shiner in North America.

Relation to man The blackchin shiner may be an important forage fish whenever it occurs in sufficient numbers but we have no direct evidence. It is probable that it is at least of minor importance in the diet of black crappies in the Rideau lakes region of eastern Ontario since it has been reported by Toner (1943) from a number of lakes in the area.

It is occasionally sold as a bait minnow mixed with other species of *Notropis* (shiners), but is not recognized as a distinct species by bait dealers or fishermen.

Nomenclature

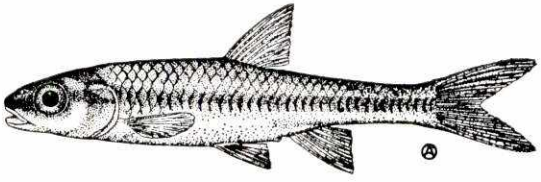
Alburnops heterodon	— Cope 1864: 281 (type locality Grosse Isle, Mich.)
Hybopsis heterodon (Cope)	— Jordan, Evermann, and Clark 1930: 136
Notropis heterodon	— Scott 1967: 67

Etymology *Notropis* — back; keel; *heterodon* — varying; tooth.

Common names Blackchin shiner. French common name: *menton noir*.

BLACKNOSE SHINER

Notropis heterolepis Eigenmann and Eigenmann



Description A stout-bodied little fish, inclined to have a prominent bulging abdomen, average length about 2.5 inches (64 mm), deeper than wide, greatest body depth 13.3–21.3% of total length; head bluntly triangular, its length 19.6–22.9% of total length; eye large, its diameter 25.0–37.5% of head length; snout slightly rounded and pro-

jecting slightly beyond lower jaw, its length 25.0–36.3% of head length; interorbital wide, its width 30.0–42.1% of head length; mouth small, subterminal, premaxillary terminating below nostrils; pharyngeal teeth with slight hook, 0,4–4,0. Fins: transparent; dorsal 1, its origin more or less directly over pelvic origin, rays usually 8(69), occasionally 7(9), rarely 9(1); caudal distinctly forked; anal 1, rays usually 8(53), often 7(26); pelvics originate below dorsal fin origin, rays usually 8(62), rarely 7(2); pectorals short, rays usually 12(30), or 13(29), occasionally 14(4). Scales cycloid, clearly outlined with black above lateral band, 33–40 in lateral line; lateral line slightly decurved, complete. Peritoneum silvery. Vertebrae 34–36.

Nuptial tubercles on breeding males, very fine, on dorsal surface of head only.

Colour Overall colouration typically silvery but often with straw-coloured or pale yellow reflections, and silvery white below. Scales on the back outlined with black, making scale pattern obvious. A dark lateral band (sometimes inconspicuous on living specimens) extends midlaterally around the body and across the snout, but not onto the chin, this lateral band often not visible on body until after death. The anterior portion of the band, from operculum to at least below dorsal fin, characteristically made up of small, dark, crescent-shaped marks, whose convex surfaces are directed anteriorly. Northern populations are sometimes much darker than those from the lower Great Lakes.

Systematic notes The nomenclature for this species is rather confused in some of the early literature but Hubbs (1926) and Dymond (1926) provided explanatory data. The species was described by Eigenmann and Eigenmann (1893a), from a single specimen, 35 mm (1.4 inches) long, taken at "Fort Quappelle," Sask.

The species described by Bensley (1915) from Georgian Bay as "*Notropis cayuga*, var. *muskoka*, Meek" is *Notropis heterolepis*.

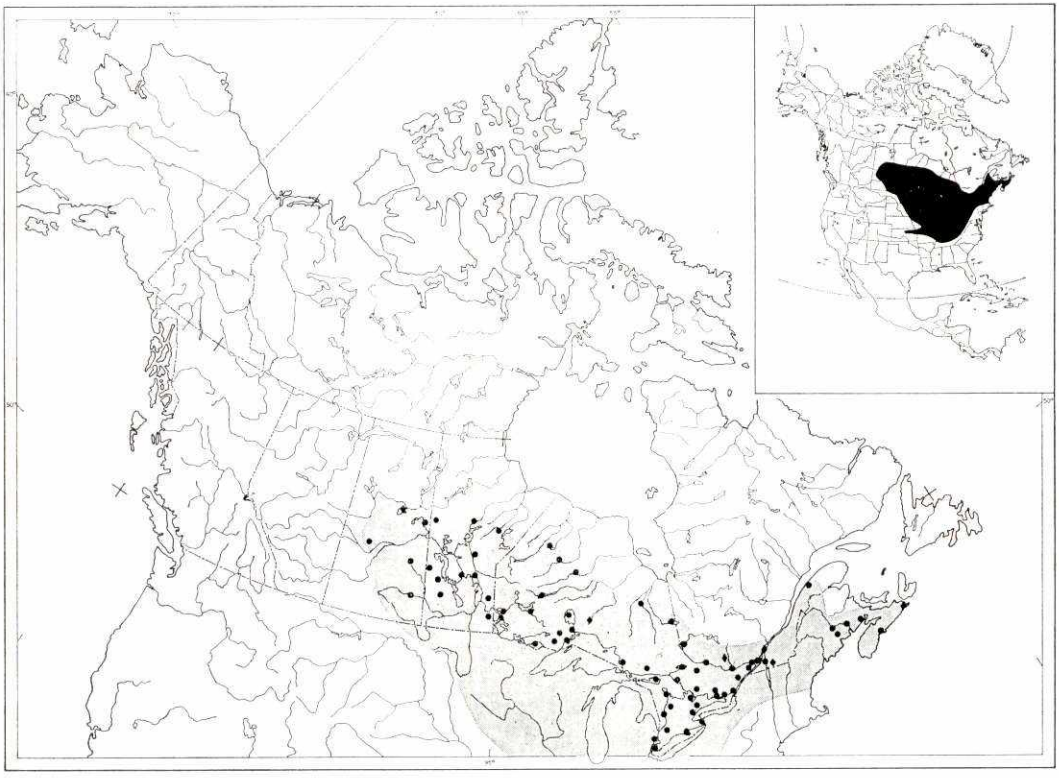
Hubbs and Lagler (1949) described as new a subspecies, *N. h. regalis*, from a small lake on the north side of Isle Royale, Lake Superior. The same authors would designate all Canadian populations as *Notropis heterolepis heterolepis*. But the degree of variability over the entire Canadian range is great and has not received careful study. It seems to us undesirable to make a subspecific designation for such widely separated populations without critical study.

The Cyprinidae regularly have branchiostegal ray counts of 3,3 but considerable variation was displayed by a sample of 10 specimens from Grand Lake, N.S., (ROM 11455), as follows: 3,3(2); 3,4(4); 4,3(3); 4,4(1). This population obviously warrants further study.

Distribution The blacknose shiner is widely distributed from the Hudson Bay drainage in Canada to the New England states west to Iowa. Bailey and Allum (1962) stated that, although the blacknose shiner was once a common minnow in South Dakota, it is now rare and they did not collect the species there. The reduction of clear, vegetated waters, which this minnow prefers, is cited as the cause of its disappearance in this region. Southward it occurs in Missouri and Tennessee, in the Mississippi valley in the Kansas River, but not in the Kansas River basin (Metcalfe 1966).

In Canada the species occurs in the east from Nova Scotia where Livingstone (1953) reported it common in the soft-rock areas of Windsor, Hants County, to Goshon Lake, Guysborough County. In New Brunswick it is found mainly in the waters of the southwestern area of the province, except for a collection from the Petitcodiac River reported by Scott and Crossman (1959). It is distributed through southwestern Quebec; through Ontario in weeded and sandy shallows of lakes, north to the James and Hudson Bay drainage of the north-central area; west in many lakes and streams in Manitoba, as far north as 55°N; in Saskatchewan reported from Waskesui, Greenwater, Amisk, and other lakes (Rawson 1949).

It is absent from Newfoundland, Prince Edward Island, and from the area west of Saskatchewan. Not known from Northwest Territories, Yukon Territories, nor Alaska.



Biology Despite the fact that this is a wide-ranging species that at times occurs in considerable numbers, a detailed description of the biology of the blacknose shiner has apparently never been made. However, various authors have suggested that spawning occurs in spring and summer in parts of the northern United States, over sandy bottoms. Greeley (1929) reported finding females in spawning condition in the New York waters of the Niagara River on July 26, 1928. Dymond (1926) stated, simply, that spawning occurred in July in Lake Nipigon, Ont. Fish (1932) described and figured a young blacknose dace, 20 mm long.

Although details of growth rates are not available, maximum sizes of specimens in our collections range from 3.0 to 3.7 inches (75–95 mm) total length. One collection (ROM 3579) from a small lake in southern Ontario contains a number of specimens measuring 3.4–3.7 inches (85–95 mm) total length.

This small shiner prefers quiet clear, weedy bays and quiet streams, and, in our experience, primarily shallow water with sand or gravel bottom. However, Dymond (1939) found it most common in small lakes and streams with a muddy bottom in the Ottawa region.

Its food has not been reported in detail but it seems likely that Cladocera, insects, and green algae form a substantial part of its diet.

We have no direct evidence of predation but there can be little doubt that it forms a significant part of the diet of predaceous fishes that live in the same habitat. Through much of its Canadian range, especially in the central part, it may occur in numbers, at which times it would be a valuable forage species.

Bangham (1955) examined 25 specimens from South Bay and Lily Lake, Manitoulin Island, Ont., for parasites. The South Bay specimens carried only a single parasite, *Posthodiplostomum minimum*, but the Lily Lake specimens harboured additional species.

Bangham and Hunter (1939) found no parasites in the eight specimens they examined from the western end of Lake Erie.

Hoffman (1967) listed species of protozoans, trematodes, cestodes, one species of nematode, and one Mollusca from the blacknose shiner in North American waters.

Relation to man The blacknose shiner is frequently sold as bait in many parts of southern Ontario.

This small minnow is probably an important forage species in areas where it abounds, as it does (or did) in many parts of Ontario and western Quebec. However, its need for clear weedy waters and intolerance of turbidity will probably limit its distribution in many parts of its Canadian range. Trautman (1957) noted that it has been eliminated from many parts of Ohio where it was abundant before 1935, a trend that has been repeated in Iowa and other states.

Nomenclature

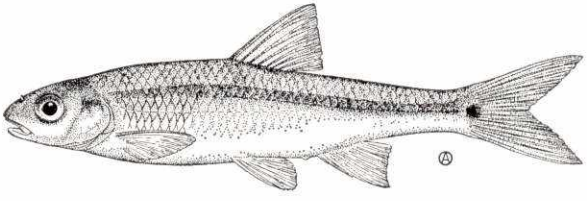
Notropis heterolepis	— Eigenmann and Eigenmann 1893a: 152 (type locality Fort Qu'Appelle, Sask.)
Notropis albeolus	— Eigenmann and Eigenmann 1893a: 152
Notropis jordanii	— Eigenmann and Eigenmann 1893b: 592
Notropis muskoka	— Meek 1899: 308
Notropis cayuga Meek	— Jordan and Evermann 1896–1900: 260
Notropis cayuga var. *muskoka*, Meek	— Bensley 1915: 23
Hybopsis heterolepis (Eigenmann and Eigenmann)	— Jordan, Evermann, and Clark 1930: 134

Etymology *Notropis* — back; keel; *heterolepis* — various; scale.

Common names Blacknose shiner, northern blacknose shiner, black-nosed minnow, blacknose dace, Muskoka minnow. French common name: *museau noir*.

SPOTTAIL SHINER

Notropis hudsonius (Clinton)



Description Body stout, usual length 2.5–3.0 inches (64–76 mm), compressed laterally, greatest depth 15.6–23.2% of total length. Head bluntly triangular, its length 17.4–21.4% of total length; eye relatively large, its diameter 25–40% of head length;

snout rounded and distinctly overhanging the mouth, snout length 25–35% of head length; interorbital wide, its width 33.3–43.7% of head length; mouth moderate, subterminal, premaxillary terminating below anterior margin of eye; pharyngeal teeth flattish, hooked, 2,4–4,2, but highly variable, to 0,4–4,0 and 0,3–3,1. Fins: dorsal 1, its origin directly over pelvic origin, rays almost always 8(62), rarely 9(1); caudal distinctly forked; anal 1, originating at a point in advance of tip of depressed dorsal, rays usually 8(59), rarely 7(4); pelvics small, originating directly below dorsal fin origin, pelvic axillary scale present but inconspicuous, rays 8(37), rarely 7(1); pectorals moderate in size, rays usually 14(16), 15(11), or 13(7), rarely 12(1), 16(1) or 17(2), high counts from southern Ontario. Scales cycloid, large, 38–42 in lateral line; lateral line complete. Peritoneum silvery; intestine short. Vertebrae 37–39, usually 38.

Nuptial tubercles on breeding males, very fine, on upper half of head and a few near the base of anterior pectoral rays.

Colour Overall colouration is silvery with yellow or golden overtones. The back is pale green to olive, the sides silvery, the belly silvery-white. The fins are mainly clear except for the black spot at the base of the caudal fin rays, which is most conspicuous on small fish about 2.5 inches (64 mm), but as they become larger the spot tends to become somewhat obscured by the silvery guanine and by the scales. Large fish of the order of 5 inches (127 mm), often show little evidence of the spot until after death and preservation. The spot is nearly always obvious after preservation even on large specimens.

Systematic notes Hubbs and Lagler (1964) considered *N. hudsonius* to be divisible into geographic races or subspecific groupings as follows: *N. h. saludanus* (Jordan and Brayton) of Virginia to Georgia; *N. h. amorus* (Girard) of the Delaware and Potomac River basins of the northeast; and *N. h. hudsonius* (Clinton) of the Mississippi valley and northward, but excluding the Great Lakes form, thought to be a distinct subspecies since these authors express doubt that the Great Lakes form is identical with the true *hudsonius* of the Hudson River, the type locality. Following an earlier decision of Hubbs and Lagler (1941), Dymond (1947) assigned populations in Lake Superior and northward to the subspecies *N. h. selene* (Jordan).

The limited data available to us (25 cleared and stained specimens) suggest that western populations may have a higher number of vertebrae. The data are admittedly meagre, but suggestive.

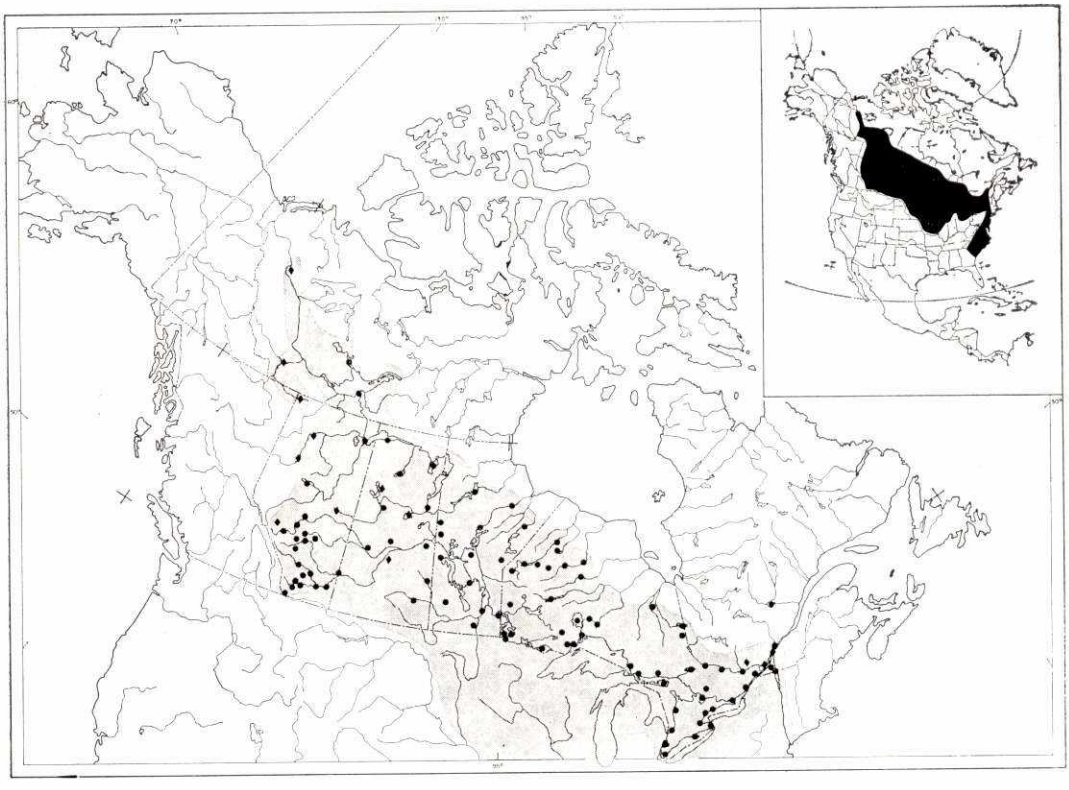
	Vertebrae no.			
	36	37	38	39
Que. (ROM 24002)	1	4	1	–
Ont. (ROM 16246)	–	2	9	–
Sask. (ROM 19056)	–	–	5	2
Total	1	6	15	2

Distribution The spottail shiner occurs in North America from portions of Canada south in the United States to Georgia in the east and Iowa and Missouri in the west. Not in Kansas (*see* Cross 1967).

In Canada the species is found in large bodies of water from about Trois-Rivières, in the St. Lawrence drainage of Quebec, west throughout the Great Lakes, north in Ontario to Big Trout Lake and to about 54°N. It is the most widely distributed species of *Notropis* in the Patricia Portion of Ontario. It is reported as common in Manitoba in almost all larger lakes and rivers (Hinks 1943). Wynne-Edwards (1952) reported its presence in the Saskatchewan–Nelson system and in Hayes River above York Factory. It is widespread and abundant in Saskatchewan, present in Alberta, and in many parts of the Mackenzie River system downstream to Good Hope, but has not been reported from the upper Liard nor upper Peace River systems (McPhail and Lindsey 1970).

It is absent from the waters of the Maritime Provinces, Newfoundland, British Columbia, and Alaska.

Biology The spottail shiner spawns in spring and early summer throughout its wide Canadian range, the precise date depending upon latitude and seasonal weather. Avail-



able evidence suggests that Canadian populations spawn over sandy shoals in June or July. For example, 58 specimens seined over a sand bottom in 3–4 feet of water in eastern Lake Erie, on June 16, 1949, were apparently spawning, for many eggs were found in the algae mass taken with the fish and the females readily extruded eggs with only slight pressure. However, Langlois (1954) reported ripe females taken in Lake Erie on May 15, and Fish (1932) stated spawning occurred in Lake Erie in late June and early July. Hence, it would seem that spawning in Lake Erie is prolonged or else the time of spawning varies greatly from year to year.

A report by Peer (1966) suggested that spawning must have taken place in 1960 in July in Nemeiben Lake, Sask., since all spottails seined before July 10 were in spawning condition and all seined after July 11 were spent. Spawning was considered to have taken place over sandy shoals in this case. Evidence that spottails use the mouths and lower reaches of tributary streams for spawning is scanty except for eastern Lake Superior. Here many hundreds of spottails were taken from June 11 to 20, 1954, at the mouths of such north shore streams as the Stokely, Harmony, and Sable, in gear installed for lamprey control. All fish were judged to be ripe and it was assumed that the aggregations were associated with spawning.

McCann (1959) reported egg sizes and number for Clear Lake, Iowa. Ripe females in May contained (mature, yellow-coloured) eggs as follows: yearlings, 70–90 mm total length, 100–1400 eggs; 2-year-old females, 1300–2600 eggs each. The eggs averaged 0.8 mm in diameter.

Data on rate of development and time to hatching appear to be lacking but Fish (1932) described larval stages and figured 5-mm and 14.25-mm stages, and Mansueti and Hardy (1967) illustrated and described larval stages in the Chesapeake Bay region.

The ages of spottail shiners can be determined by scale examination. Smith and

Kramer (1964), working with populations from Red Lake, Minn., demonstrated the validity of the scale method for age determination and presented data on rate of growth for large samples taken over a number of years. Females grew faster than males at all ages, but some years were shown to be better growing years than others. Calculated total lengths (mm) at time of annulus formation for various age-groups are as follows: age 1 (M = 56.4; F = 58.1); age 2 (M = 85.4; F = 90.1); age 3 (M = 100; F = 106.2); age 4 (M = 103.0; F = 113.1).

Maximum size (from ROM collections) is a specimen from Lake Erie that measures 5.2 inches (132 mm) total length. Spottails over 5 inches (127 mm) in length are unusual, except in Lake Erie.

The spottail is usually regarded as a fish of relatively large lakes and larger rivers and such may well be the case, but collections in the myriad of small Canadian lakes are quite inadequate. Seined collections are usually made in the daytime, whereas the spottail is usually more susceptible to capture by night seining, except in the northwesterly parts of its range. It is often the most abundant minnow in northern lakes. For example, G. H. Lawler (personal communication) provided the following figures of relative abundance for Heming Lake, Man., of cyprinids captured during fishing operations in 1961: 4407 *N. hudsonius*; 32 *N. heterolepis*; 1 *Pimephales promelas.*

We know little of the food of this important forage species in Canadian waters. Dymond (1926) noted that Lake Nipigon spottail shiners seemed to be more plankton feeding than emerald shiners, and that *Daphnia* formed 40% of the diet, although *Bosmina*, *Sida*, and *Leptodora* were also eaten. Aquatic insect larvae, especially Chironomidae and Ephemeroptera, made up almost 40% of its food, on the average. McPhail and Lindsey (1970) reported that spottail shiners from extreme northwestern North America contained insect larvae and masses of filamentous algae. Studies in Minnesota (Smith and Kramer 1964) and Iowa (McCann 1959) indicated that algae, crustaceans (especially cladocerans), aquatic insects, and even eggs and larvae of their own species may, at times, be significant food items. In general, smaller fish ate smaller organisms and small cladocerans were more important to young spottails. Only the larger spottails, especially those over 4.3 inches (110 mm) long, ate their own eggs and young.

The spottail minnow is a forage fish of considerable importance for it is eaten by almost all predaceous fishes (including large spottails) and thus shares, with the emerald shiner, the distinction of being one of the most important forage cyprinids in Canadian lakes. Precise documentation of the extent of predation is scanty although some is provided in the writings of the late Dr D. S. Rawson and others.

Spottail minnows may be infected by a variety of parasitic trematodes, cestodes, nematodes, and protozoans, details of which were provided by Bangham and Hunter (1939) for Lake Erie and Bangham (1955) for Lake Huron. McCann (1959), in a review of spottails in Clear Lake, Iowa, noted that parasitism there was light compared to reports by Bangham.

Bangham and Hunter noted that over half of the 58 Lake Erie specimens examined were infected with *Ligula intestinalis*, which they regarded an exceptionally high percentage, possibly related to the fact that the infected specimens were usually collected near colonies of terns which have been reported as definitive hosts. Lawler (1964) demonstrated infections of 12.5–69.0% of spottails sampled in Heming Lake, Man., and ascribed the differential infections to proximity to fish-eating birds. *See* Hoffman (1967) for his complete list of parasites infecting this minnow in North American waters.

Relation to man The spottail shiner is an important minnow in many parts of its range and is the most frequently used bait minnow in many parts of northern Ontario. In Iowa it is said to be the preferred bait for walleyes. Since it seems to prefer large bodies of water in the southern parts of the Canadian range, it may not be suited to pond culture techniques, but we know of no serious attempts to rear it under artificial conditions.

Nomenclature

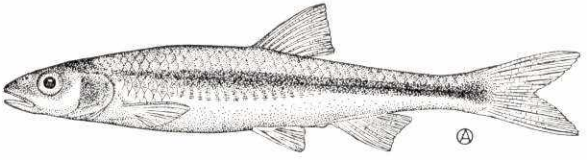
Clupea hudsonia	— Clinton 1824: 49 (type locality Hudson River)
Cyprinus (*Catastomus*) *Hudsonius* (LeSueur)	— Richardson 1836: 112
Luxilus selene	— Jordan 1877a: 60
Minnilus selene	— Jordan and Gilbert 1883a: 188
Notropis scopiferus	— Eigenmann and Eigenmann 1893a: 153
Opsopoeodus borealis	— Harper and Nichols 1919: 266
Hudsonius hudsonius (DeWitt Clinton)	— Jordan, Evermann, and Clark 1930: 132
Notropis hudsonius (Clinton)	— Scott 1967: 62

Etymology *Notropis* — back; keel; *hudsonius* — name from Hudson River.

Common names Spottail shiner, spawneater, shiner, spottail minnow, spottail, spot-tail minnow, sucking carp. French common name: *queue à tache noire.*

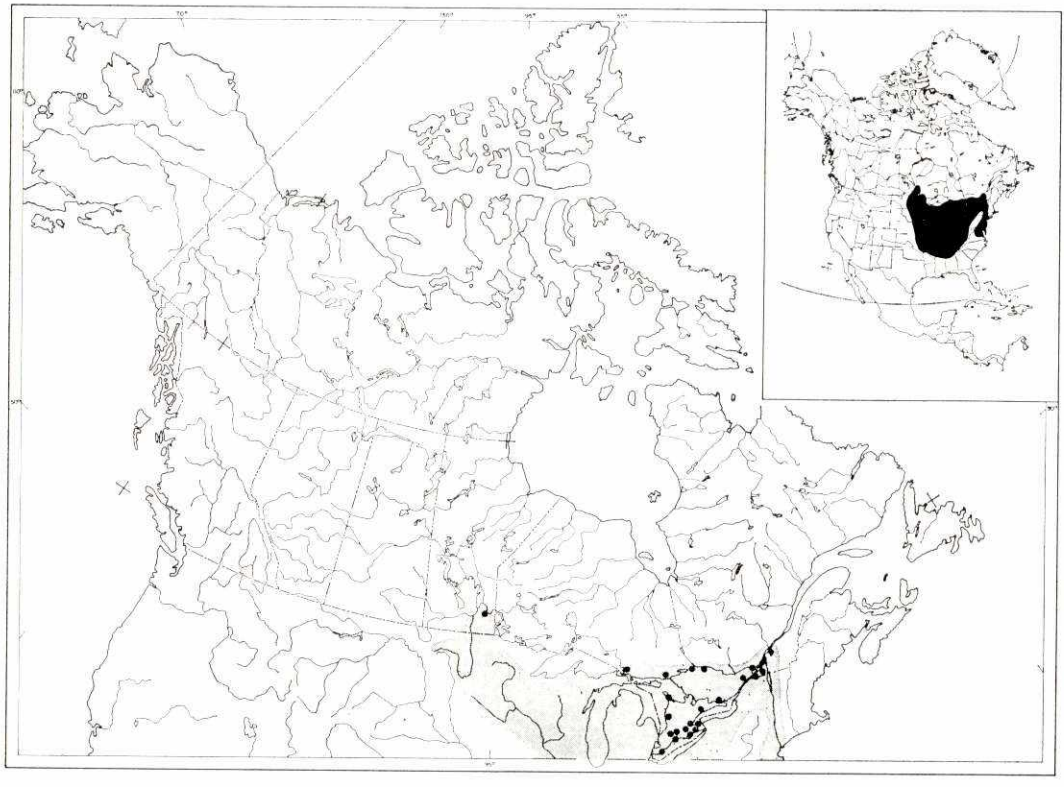
ROSYFACE SHINER

Notropis rubellus (Agassiz)



Description Body slender, elongate, averaging 2–3 inches (51–76 mm) long, moderately compressed, its greatest depth 14.0–18.8% of total length. Head long, triangular, its length 19.1–23.0% of total length; eye relatively large, its diameter 25.0–36.3% of head length; snout noticeably pointed, its length 27.2–36.3% of head length; interorbital wide, its width 27.2–37.0% of head length; mouth large, terminal, premaxillary terminating at a point below nostrils; pharyngeal teeth, slender, slightly hooked, 2,4–4,2; 2,4–4,1; 1,4–3,0; 1,2–1,1. Fins: generally clear; dorsal 1, its origin over or slightly posterior to pelvic fin origin, rays usually 8(52), but in Manitoba 7(5) or 8(5); caudal forked; anal 1, rays usually 10(34), sometimes 9(16) or 11(11); pelvics originate under or barely in advance of dorsal fin origin, rays 8; pectoral rays usually 12(24), sometimes 13(11), rarely 11(4) or 14(1). Scales, cycloid, pigment often concentrated at scale margins giving scales appearance of being dark edged, even below lateral line, 38–45 in lateral line; lateral line complete. Peritoneum silvery. Vertebrae 37–41, usually 39.

Nuptial tubercles on breeding males, fine,



like sandpaper, on head and some predorsal scales and on rays of upper surface of pectoral fins.

Colour The normal colouration is silvery but olivaceous dorsally and silvery white ventrally. Fins transparent. Breeding males have an orange-red colour on the entire head, at least to the nape, and a lighter red on the belly. Colour on breeding females paler than on males. Pigmentation on sides usually bordered below by lateral line.

Distribution The rosyface shiner occurs in eastern and central North America, from Virginia north to New York on the east and Oklahoma and Kansas on the west, and north in the Mississippi drainage to Wisconsin and southern Canada.

In Canada the rosyface occurs from the St. Lawrence River drainage at least to Rivière Nicolet (eastern Lac St. Pierre) westward through the upper St. Lawrence and the lower Ottawa River, through the lower Great Lakes and Lake Huron and extreme eastern Lake Superior and their tributaries, then west only in the Red River in southern Manitoba.

Biology There appear to have been no studies on the biology of Canadian populations of this shiner and any mention of it in the literature is usually limited to records of occurrence. It is more widely distributed in the United States, where some aspects of its biology have been documented.

Pfeiffer (1955) reported on a population in New York State that spawned from June 23 to June 28, in shallow water over gravel at the side of a riffle. The temperature during spawning ranged from 79° to 84° F (26.1°–28.9° C). The release of eggs and sperm occurred over depressions in the gravel and were accompanied by violent vibrations of

the spawning fish. Pfeiffer observed that the schools broke up into spawning groups of 8–12 shiners in which the sexes crowded one another, but the sex composition of the groups could not be determined. The actual spawning act seemed to last for 5 or 6 seconds. The author collected newly hatched fry, 5 mm long, 8 days after spawning was first observed. However, within a few days the fry were difficult to find in the gravel and those that were collected and placed in a jar containing gravel immediately worked their way vertically into the gravel as far as possible.

In a report of spawning in Pennsylvania waters Reed (1957a) noted that spawning occurred first over the nests of *Nocomis* spp. and continued later in shallow riffles. In this case spawning commenced on May 26 and continued until June 25. The later spawning involved smaller groups of fish and a predominance of males although the early spawnings involved sexes in about equal numbers. Reed also noted that the temperature range during spawning in 3 successive years was 68°–72° F (20.0°–22.2° C).

The developmental stages of the rosyface are not fully described but Reed (1958) listed the time sequence between the major developmental stages and said that hatching required 57–59 hours at 70° F (21.1° C). Fish (1932) figured a young rosyface 15 mm long.

In the New York State study, 1-year-old females contained 450 eggs and 3-year-olds contained as many as 1482. Eggs obtained immediately after release into the water average 1.5 mm in diameter, but before contact with water and subsequent swelling, the diameter is 1.2 mm.

Reed (1954) described a case of hermaphroditism in three 2-year-old specimens from Pennsylvania, and two of these contained mature eggs and sperm.

Hybrids involving *N. rubellus* and *N. cornutus* are rather well known in United States waters and Bailey and Gilbert (1960) discussed a case of hybridization between *rubellus* and *volucellus*. However, we are not aware of hybrids involving *rubellus* described from Canadian waters.

Pfeiffer found that age determinations could be made using scales. Both sexes live to age 3, but there is evidence that fewer males than females attain this age. The largest female measured about 3 inches (75 mm) standard length, the largest male 2.8 inches (71 mm).

The rosyface shiner seems generally to prefer the flowing water of streams and rivers to the quiet, still waters of lakes and ponds. It seems to occur most often in the lower portion of a stream, especially over fine gravel or sand, just before its confluence with a larger stream or river. It is quite intolerant of turbidity and it seems to us that it is less common in parts of its range than it was 20–30 years ago, but direct evidence is lacking. It is significant, however, that Trautman (1957) noted that its Ohio range had been greatly reduced. He noted in Ohio it was intolerant of turbid waters and bottoms covered with silt. Marked decreases in abundance were observed in several stream sections which had become increasingly turbid and silted.

In the New York State study, aquatic insect forms dominated in the diet, supplemented by terrestrial insects. Reed (1957b) reported the results of a detailed study of food in Pennsylvania waters and concluded that the rosyface was omnivorous during most of the year, consuming aquatic insects (71.9%), algae, diatoms (18.1%), and inorganic material (10%). Caddisfly larvae were the most important single item, constituting 23.7% of the diet.

Bangham and Hunter (1939) found no parasites in the one specimen of rosyface shiner (which they called *N. rubrifrons*) examined from the western end of Lake Erie.

Hoffman (1967) listed various species of trematodes and one species of nematode (*Spiroxys* sp.) as parasites of this minnow in North American waters.

Relation to man Although direct evidence is lacking, it seems unlikely that the rosyface shiner is of direct importance as a forage or prey species for game fishes. Its sensitivity to turbidity, however, may make it useful in studies of water quality deterioration.

Nomenclature

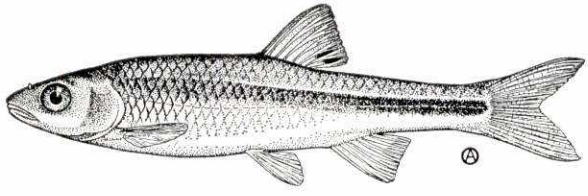
Alburnus rubellus	— Agassiz 1850: 364 (type locality Sault Ste. Marie, Lake Superior)
Alburnus rubrifrons	— Cope 1865: 85
Notropis rubrifrons (Cope)	— Jordan and Evermann 1896–1900: 295
Notropis rubellus (Agassiz)	— Hubbs and Brown 1929: 34
Photogenis rubrifrons Cope	— Hubbs and Brown 1929: 35

Etymology *Notropis* — back; keel; *rubellus* — reddish.

Common names Rosyface shiner, rosy-faced shiner. French common name: *tête rose.*

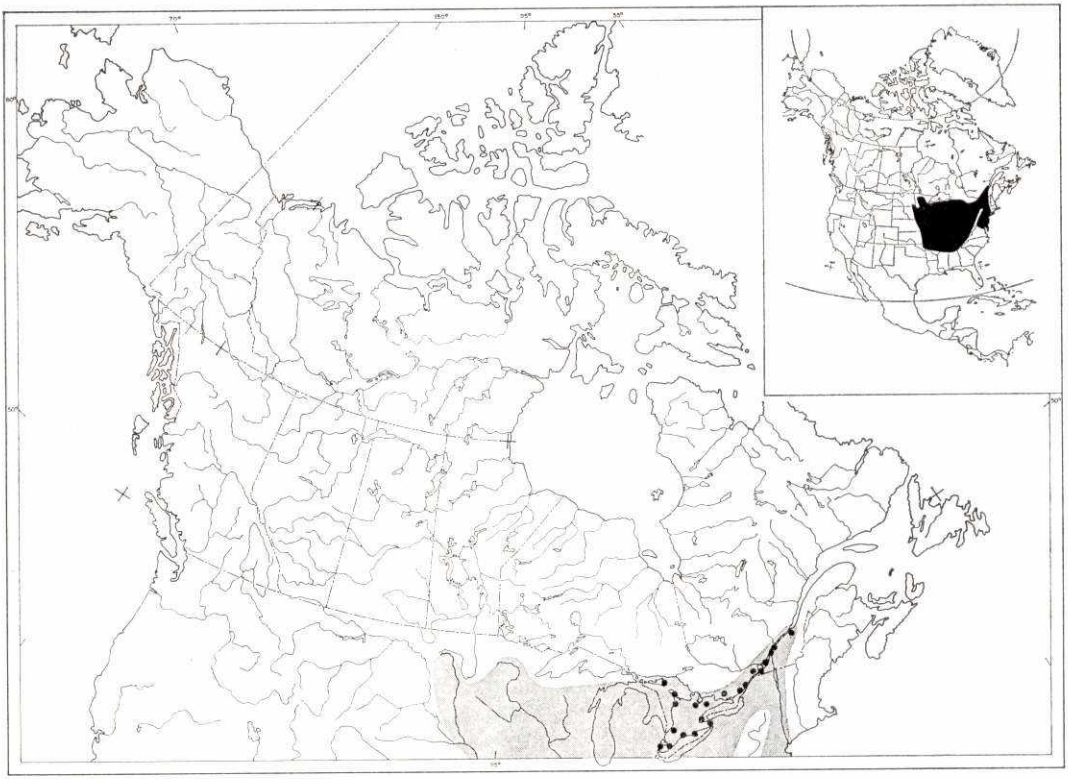
SPOTFIN SHINER

Notropis spilopterus (Cope)



Description Body compressed laterally, large adults (3 inches or 76 mm total length) noticeably deep bodied, greatest depth 16.6–22.8% of body length. Head noticeably pointed, its length 19.0–23.1% of total length; eye diameter 23–33% of head length; snout long and rather sharp, its length 23–40% of head length; interorbital wide, its width 29.1–45.0% of head length; mouth subterminal, slightly overhung by pointed snout, premaxillary terminating below posterior margin of nostril; pharyngeal teeth short, broad, slightly hooked, 1,4–4,1 or 1,4–4,0. Fins: dorsal 1, well developed, high and with distinctive black pigment on membrane between fin rays, particularly on membrane between posterior 3 rays, dorsal rays 8, seldom 7; caudal distinctly forked; anal 1, well developed, but without dark pigment, rays usually 8(22), occasionally 7(2) or 9(2); pelvic rays usually 8(17), occasionally 9(6), rarely 7(1); pectoral rays usually 13 or 14, occasionally 12 or 15. Scales cycloid, large, usually about 39 in lateral line but range is 35–41; lateral line complete. Peritoneum silvery. Vertebrae 37–39.

Nuptial tubercles on breeding males relatively large and pointed, on top of head, and extending posteriorly along nape in a narrow band to origin of dorsal fin, a few also on lower jaw; smaller tubercles also on leading edge of pectoral fin, on anal rays, and on scales, especially posterior margins on flanks above and anterior to the anal fin.



Colour The overall colouration is silvery. Breeding males, especially, have a steel-blue sheen or cast dorsally, less so laterally, becoming silvery white below and with yellowish lower fins. The most characteristic marking is the concentration of black pigment on the membrane between the last three rays of the dorsal fin. Preserved specimens usually exhibit a broad lateral band only on the posterior half of the body.

Distribution The spotfin shiner occurs from Oklahoma and Alabama north to New York State and southern Quebec, west through Great Lakes basin to North Dakota.

In Canada it occurs from the St. Lawrence River in the vicinity of Quebec City west, including Lake Champlain and the lower Ottawa River, to the tributaries of lakes Ontario, Erie, and St. Clair. It appears to be more numerous in rivers than in lakes.

Biology The biology of this species in Canadian waters has not been studied and, hence, the following details are derived from studies in the United States where the species has a much wider range. In New York State, Stone (1941) noted that spawning took place from the latter part of May to mid-August, the peak of the spawning varying with the locality. Place of spawning apparently depends on current strength, depth, and availability of underwater objects, for the eggs are adhesive and are laid on the underside of submerged logs and roots. The same author reported egg counts of 225–1580 using 14 specimens. Stone also noted that the scales had well-marked annuli and could be used for age determination. The oldest spotfins used in his studies were in their fifth year; the largest male 4.2 inches (108 mm) the largest female 3.7 inches (93 mm). The largest specimens examined by us were from Ontario and measured 2.8–3.2 inches (70–80 mm).

Although not a common species anywhere in southern Canada, the spotfin occurs more frequently in large rivers than in lakes, where

we have seined it over clean sand and gravel substrate, often in somewhat turbid waters.

The spotfin shiner is reported to be mainly insectivorous, feeding on terrestrial and aquatic insects.

Although the species doubtless falls prey to larger carnivorous fishes on occasion, we have no information on their utilization as forage fishes.

Bangham and Hunter (1939) examined 58 specimens of the species, which they called *N. whipplii*, and noted 29 lightly infected variously with trematodes, a cestode, nematodes, and a leech, *Piscicola punctata*. Hoffman (1967) listed only one species of trematode, *Posthodiplostomum minimum*, and a cestode, *Proteocephalus* sp., from the spotfin shiner in North American waters.

Relation to man The spotfin is of no real importance as a bait or forage fish because of its limited distribution, but wherever it occurs in sufficient numbers it would undoubtedly be a desirable bait species.

In the United States it has attracted attention as a bait species and Stone (1941) noted that it could be readily propagated in ponds. Lewis and Gunning (1959) noted additional features of southern Illinois populations that enhanced the value of the species as bait.

Nomenclature

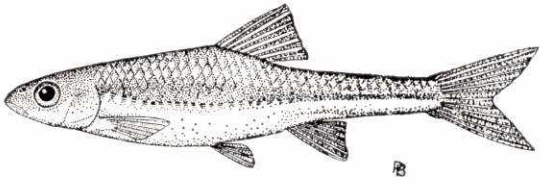
Photogenis spilopterus	— Cope 1869: 378 (type locality St. Joseph River, Michigan)
Hybopsis fretensis	— Cope 1869: 382
Notropis whipplii	— Evermann and Kendall 1902: 212
	— Halkett 1913: 64
Notropis whipplii spilopterus	— Hubbs and Greene 1928: 381
	— Hubbs and Brown 1929: 33
	— Greeley 1930: 80
	— Greeley and Greene 1931: 88
	— Hubbs and Cooper 1936: 61
	— Greeley 1940: 74
Notropis spilopterus	— Radforth 1944: 60
	— Dymond 1947: 21
	— Legendre 1952: xi
	— Gibbs 1957: 187

Etymology *Notropis* — back; keel; *spi'opterus* — *spilos*, meaning spot, and *pter*, meaning wing or fin.

Common names Spotfin shiner, silver-finned minnow, satin-finned minnow. French common name: *méné bleu*.

SAND SHINER

Notropis stramineus (Cope)



Description Body small, averaging 2–3 inches (51–76 mm) long, slender, somewhat compressed, but body not deep, greatest depth usually 13–18% of total length. Head length 18.7–21.7% of total length; eye moderate, diameter 30.0–33.3% of head length; snout length about equal to eye diameter, 30.0–33.3% of head length; interorbital wide, its width 34.6–44.4% of head length; mouth small, terminal or nearly so, upper jaw extending to below posterior nostril; pharyngeal teeth 0,4–4,0. Fins: dorsal 1, rays usually 8; caudal forked; anal 1, rays nearly always 7, rarely 6, never 9; pelvics originating under dorsal fin origin, rays usually 8; pectorals short, broad, rays 12–16, usually 13(13), or 14(7), sometimes 12(3), 15(4), or 16(3). Scales cycloid, large, 34–39 in lateral line; lateral line complete. Peritoneum silvery, lightly speckled. Vertebrae 33–36, usually 35.

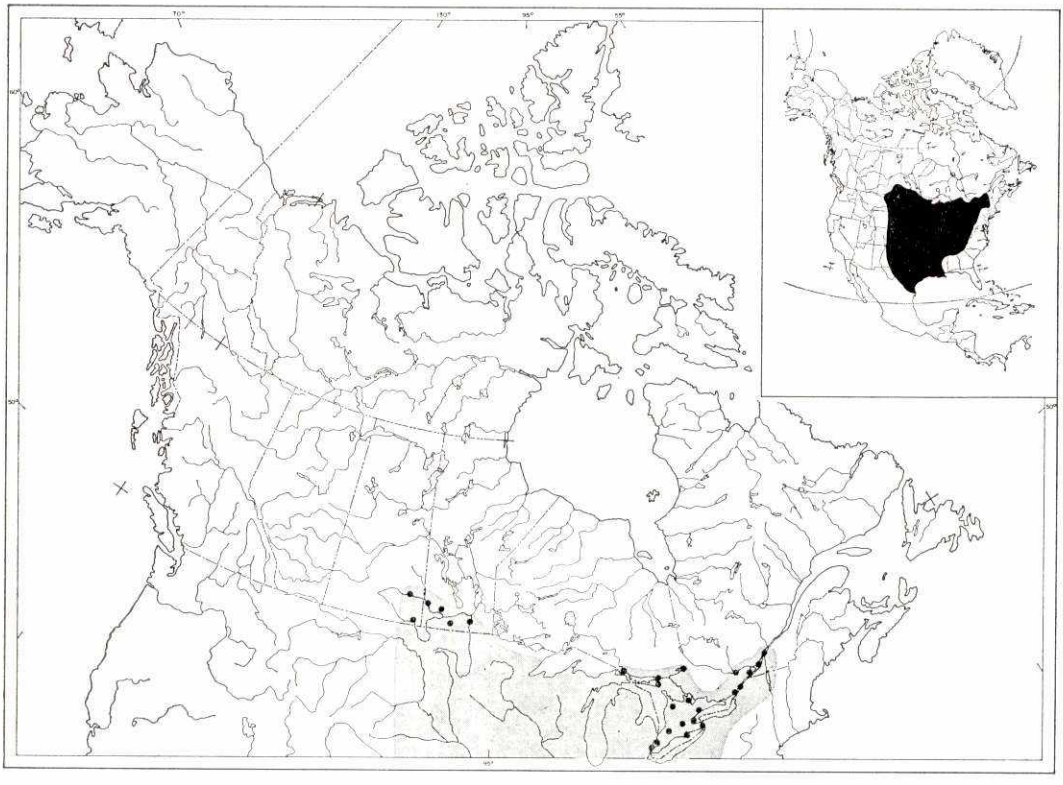
Nuptial tubercles microscopic on heads of breeding males.

Colour Overall colouration silvery with straw-coloured tints. Outlines of scales clearly visible on the back, scales large, not crowded in predorsal region. A thin but distinct mid-dorsal stripe from nape to posterior caudal peduncle, with small concentration of pigment at anterior and posterior base of dorsal fin. Dark lateral band present posteriorly, weak anteriorly and more or less restricted to concentration of melanophores surrounding the lateral line pores. The illustrations of melanophore distribution on head and caudal region presented by Suttkus (1958) are not entirely applicable to Canadian specimens examined by us. Hubbs and Greene (1928) were the first to note that *stramineus* is usually paler northward than its close relative *volucellus*, particularly after preservation, an observation with which we are in complete accord.

Systematic notes The scientific status of the sand shiner has long been confused. The species was known as *Notropis blennius*, then as *Notropis deliciosus*, and finally as *Notropis stramineus*. The early nomenclatural history of the species was thoroughly discussed by Hubbs and Greene (1928) whose informal and critical comments should be of special interest to Canadian students. Trautman (1957) noted that the confusion was such that publications prior to 1928 are of little value. The form reported from Big Creek, Elgin County, Ont., by Hubbs (1926) as *Notropis deliciosus deliciosus*, was shown by Hubbs and Greene (1928) to be *Notropis volucellus*. Again, Dymond (1926) presented systematic and biological information on "*Notropis deliciosus stramineus*" in Lake Nipigon but later re-examination disclosed that the specimens were, in fact, *Notropis volucellus* (Dymond 1944b).

More recently, the status of the species and its subspecies in the northern portion of its United States range was discussed by Bailey and Allum (1962).

The necessity of the change to *Notropis stramineus* was the subject of a thorough



review by Suttkus (1958). Currently, at least two subspecies are recognized, *N. s. stramineus* (Cope), the northeastern sand shiner, and *N. s. missuriensis*, a smaller-scaled type.

Subspecific assignations of Canadian populations seem meaningless in light of the present lack of knowledge.

Distribution The sand shiner occurs through central and southern North America, from the upper St. Lawrence and Lake Champlain region, south in New York and Pennsylvania to the Gulf of Mexico drainage (west of the Mississippi) to northeastern Mexico, and north through the Great Plains to southeastern Saskatchewan.

In Canada it occurs from about Lac St. Pierre of the upper St. Lawrence River, through the Great Lakes drainage of Ontario including extreme eastern Lake Superior. There are no Ontario records west of eastern Lake Superior but it occurs in the Red–Assiniboine River system of southern Manitoba and Saskatchewan.

Biology Few studies have been conducted on the biology of the sand shiner, none on Canadian populations. A recent study by Summerfelt and Minckley (1969) concerns the southern subspecies, *N. s. missuriensis* in Kansas, and hardly seems applicable to Canadian populations. Also, since the species was for many years misidentified, little dependence can be placed on Canadian literature, even that which listed the species under its previous name, *N. deliciosus*. In Iowa spawning occurs in June, July, or August, and the eggs are scattered over clean gravel or sand (Carlander 1969).

Starrett (1951) reported that in Iowa, age 1 females contained about 250 eggs; age 2, 1100 eggs and age 3, 1800 eggs.

Collections in Ontario waters suggest that sand shiners prefer sandy shallows of lakes

and large rivers, often where there is sparse growth of rooted aquatic plants.

Food studies on Iowa populations indicated that sand shiners feed on aquatic and terrestrial insects, and bottom ooze diatoms and, in the absence of data, we assume that food preferences in Canadian populations are similar.

Bangham and Hunter (1939) reported the results of examination of 12 specimens from eastern and western Lake Erie. Trematodes, cestodes, and protozoan parasites were identified but, generally speaking, the degree of infection was low.

Hoffman (1967) listed nine species of trematodes, and one crustacean from sand shiners in North American waters.

Relation to man This small and relatively hardy minnow is not uncommon in suitable habitats but it is seldom recognized and, even in collections, is often misidentified. It must serve as a rather important forage species but, because it is difficult to identify, is seldom recognized in stomach contents.

Gould and Irwin (1965), in reference to southern populations, noted that sand shiners were good bioassay animals because they were easy to transport, withstood low oxygen conditions, and would take dry food readily.

Nomenclature

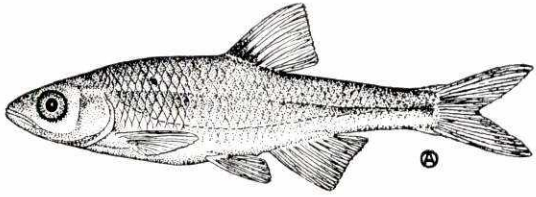
Hybognathus stramineus	— Cope 1864: 283 (type locality Detroit River, Grosse Isle, Mich.)
Notropis phenacobius	— Forbes 1885: 137
Notropis reticulatus	— Eigenmann and Eigenmann 1893a: 152
Notropis deliciosus stramineus (Cope)	— Hubbs and Lagler 1941: 59
Notropis deliciosus (Girard)	— Radforth 1944: 73
	— Dymond 1947: 21
Notropis stramineus (Cope)	— Suttkus 1958: 313

Etymology *Notropis* — back, keel; *stramineus* — made of straw.

Common names Sand shiner, shore minnow, straw-coloured minnow. French common name: *méné paille.*

REDFIN SHINER

Notropis umbratilis (Girard)



Description Body small, less than 2.5 inches (64 mm) total length, compressed laterally, its greatest depth 18.1–24.5% of total length; head appears short, its length 19.4–22.0% of total length; eye diameter 25.0–34.7% of head length; snout blunt, its length 27.2–36.3% of head length; interorbital broad, its width 28.5–40.0% of head length; mouth relatively large, terminal, premaxillary terminating below posterior margin of nostril; pharyngeal teeth slender, not obviously hooked, 2,4–4,2. Fins: transparent; dorsal 1, its origin slightly posterior to origin of pelvics, the anterior base conspicuously suffused with black pigment, rays 8(34), rarely 7(1); caudal distinctly forked; anal 1, rays usually 11(20), occasionally 10(6) or 12(5); pelvics originate slightly in advance of dorsal origin, rays usually 8(22), rarely 7(1) or 9(1); pectorals reaching almost to pelvic fin origin, rays 12(13) or 13(11). Scales cycloid, small, 39–46 in the lateral line; lateral line somewhat decurved, complete. Peritoneum silvery with speckles. Vertebrae 35 or 36.

Nuptial tubercles on breeding males, very fine, on head and muzzle, extending onto nape in a narrow band to dorsal fin origin, also in 2 rows on each side of mandible, not apparent on lower fins or flanks above anal fin. (*See* figures in Trautman 1957.)

Colour A silvery minnow with clear fins; anterior base of dorsal fin suffused with dark pigment, not forming a spot, but whole base dark; sides speckled with pigment; during spawning males become darker overall, steel-blue on sides, although caudal and anal fins take on a distinct reddish hue and paired fins may also have a slight reddish cast.

Systematic notes Canadian populations lie within the range of the subspecies *N. u. cyanocephalus* (Copeland).

Distribution The redfin shiner occurs rather widely in the southern portion of the Great Lakes watershed and south in the Mississippi River system, from New York and Pennsylvania west to southern Minnesota, south to Louisiana and Texas.

In Canada it is known to occur in only a few streams of southern Ontario: Black Creek near Marburg, Norfolk County, a tributary of Lake Erie; Thames River, Essex County; Sydenham River, Middlesex County; Ausauble River, Lambton County; and the Saugeen River, Bruce County.

Biology There are only a few localities in Ontario where the redfin shiner thrives, but such populations have either not been studied or, if studied, not reported except for reports of occurrence. Dates of spawning in Ontario are not known but observations of Norfolk County populations suggest that spawning takes place in July and August. Eleven adult females taken in Black Creek on August 15, 1946, contained large eggs and were presumably spawning; males taken at the same time displayed vivid spawning colours. Trautman (1957) recorded spawn-

ing over sand and gravel bottoms in slow-moving sections of streams and our limited observations suggest similar behaviour.

Hunter and Hasler (1965) described reproductive behaviour of the species in pools or ponds of the University of Wisconsin Arboretum. Redfin shiners used the nests of the green sunfish for spawning sites and the authors suggested that this may be regular procedure when such nests are available and being used by the sunfish. They are not used if the sunfish are not spawning, suggesting that the minnows are attracted by sexual fluids of the sunfish. Water temperature differences in the Canadian environment may prevent such close ecological associations.

When not spawning, redfin shiners are reported to prefer the clear, quiet waters of weedy pools, where submerged and emergent vegetation abound.

Bangham and Hunter (1939) found no parasites in the 13 specimens examined from the eastern end of Lake Erie.

Relation to man The small size, attractive colours, and tolerance of quiet, weedy waters combine to make the redfin a potential aquarium species, and its reproductive behaviour suggests that much could be learned from aquarium-based studies. We have no evidence of Canadian economic significance for it is too small and uncommon to be a useful bait or forage species at the present time. In some parts of the United States, such as Iowa, the redfin is used extensively for bait.

Nomenclature

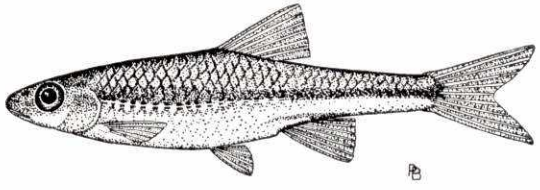
Alburnus umbratilis	— Girard 1857a: 193 (type locality Arkansas)
Lythrurus umbratilis (Girard)	— Jordan, Evermann, and Clark 1930: 125
Notropis umbratilis	— Scott 1967: 65

Etymology *Notropis* — back; keel; *umbratilis* — from *umbro*, meaning to shade.

Common names Redfin shiner. French common name: ***méné d'ombre***.

MIMIC SHINER

Notropis volucellus (Cope)



Description Body small, average size 2–3 inches (51–76 mm) long, slender, somewhat compressed but body not deep, greatest depth usually 13.5–16.3% of total length. Head length 18.8–21.8% of total length; eye moderate, diameter 28.5–38.0% of head

length; snout length somewhat less than eye diameter, 27.2–34.7% of head length; interorbital wide, its width 27.2–36.3% of head length; mouth small, terminal or nearly so, upper jaw extending to below posterior nostril; pharyngeal teeth 0,4–4,0. Fins: dorsal 1, rays usually 8; caudal forked; anal 1, rays nearly always 8, rarely 9, pelvics originate below dorsal fin origin, rays usually 9(29) seldom 8(9), rarely 10(2); pectoral fin rays usually 12(7), 13(7), 14(10), or 15(15), rarely 16(1). Scales cycloid, large, 36–39, usually 37 or 38; lateral line complete. Peritoneum silvery, lightly speckled. Vertebrae 34–37, usually 36.

Nuptial tubercles on breeding males, microscopic, on top of head, densely clustered on snout, sparse on preopercle and lower surface of head.

Colour Overall colouration silvery (less straw coloured than *N. stramineus*). Outlines of scales clearly visible on back, scales large, not crowded in predorsal region. No distinct dorsal stripe. Dark lateral band evident posteriorly, becoming vague and ill-defined from below dorsal fin, anteriorly; lateral band expanded in tail region more or less, as illustrated by Suttkus (1958). Black pigment about anus and at base of anal fin. Canadian specimens are noticeably darker than *N. stramineus*, especially after preservation in formalin solution (*see N. stramineus*).

Systematic notes *Notropis volucellus* and *N. stramineus* present more difficulties in identification to Canadian students than any other group of fishes except the coregonines (*Coregonus* spp.). *See N. stramineus* for confusion with that species, and *see also* Hubbs and Greene (1928) for a discussion of its similarity to *N. stramineus* (= *deliciosus*).

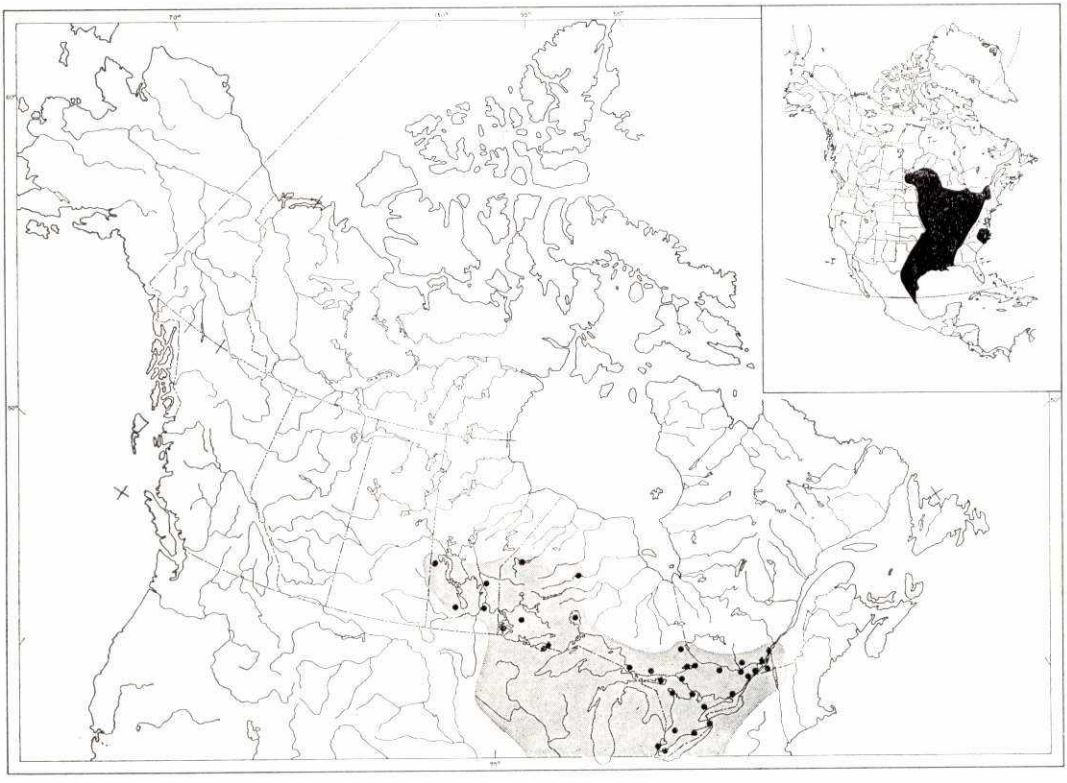
Subspecies have been described (Hubbs and Greene 1928; Trautman 1931), and the typical subspecies *N. v. volucellus*, the northern mimic shiner, was said by Hubbs and Lagler (1958) to be the form occurring in Canada. However, the taxonomic relationships of the mimic shiner throughout its range have not been studied and, hence, the assignation of subspecific designations to the even lesser-known Canadian populations seems unwarranted at this time. The form occurring in Big (or Talbot) Creek, Elgin County, Ont., was considered by Hubbs and Greene (1928) to be an aberrant form, which they once assigned to the subspecies *N. v. buchanani* Meek, but which later (Hubbs and Lagler 1958) has been regarded as an aberrant form of *N. volucellus*.

Distribution The mimic shiner ranges from the upper St. Lawrence River on the northeast, southwest to northern Alabama and the Gulf coast states to Texas; in the Mississippi valley north through Missouri and Iowa and all the Great Lakes states to Manitoba.

In Canada it occurs from tributaries of Lac St. Pierre (Nicolet, Saint-Francois, and Yamaska rivers) west through the Great Lakes and tributaries, north in Ontario to Attawapiskat and Sandy lakes, west through Rainy River and Lake of the Woods to Manitoba, where its northern limit was noted by Keleher (1956) to be Fishing Lake on the Manitoba–Ontario boundary at about 52° N. In Ontario and Manitoba the mimic shiner reaches its northern limit between the 60° F (15.6° C) and 65° F (18.3° C) July isotherms.

Biology The problems of identification have been partly responsible for the absence of studies on the biology of the mimic shiner. Dymond (1926) presented the only available detailed account of morphometric and meristic data (under the name *N. deliciosus stramineus*) in a comprehensive study of Lake Nipigon fishes, but provided little information on its biology. Dymond's introductory sentence in the Lake Nipigon account, "This is one of the most insignificant of the minnows, both in size and appearance," perhaps also helps to explain why it has been ignored.

In the only study of the life history known to us, Black (1945) worked with the mimic shiner in Shriner Lake, Ind. He was unable to determine when or where spawning



occurred but speculated that it possibly took place at night and perhaps the eggs were broadcast over aquatic vegetation at depths of 15–20 feet. In the year of study all females examined were ripe by June 20, most were partly spent by July 9, and nearly all were spent by July 24. Study of 103 gravid females (preserved) yielded an average egg number of 367 per female. Black considered that the fish attained 2 years of age (by size groups).

Various authors note that the mimic shiner seems to prefer quiet or still water. Black also remarked on the peculiar movements of the species; for example, that the schools move offshore before dark, then break up, and individuals could not be captured in shore seining after dark, and repeated efforts by trawling in deeper water yielded only four specimens.

Black examined the stomach contents of over 500 shiners and concluded that the most important foods in Shrine Lake, Ind., were entomostracans (especially *Daphnia*), insects (particularly Chironomidae), and green and blue-green algae.

In turn, the mimic shiner was eaten by a variety of predators, fishes and birds, but particularly largemouth and smallmouth bass.

The parasites harboured by mimic shiners in Lake Erie and Lake Huron (and Manitoulin lakes) have been reported by Bangham and Hunter (1939) and Bangham (1955) respectively. Black (1945) also reported *Ligula* and a sporozoan parasite of the genus *Myxobolus*. From these studies, and the comments of the authors, one would conclude that the mimic shiner seems to carry a relatively small parasite fauna, involving mainly trematodes, cestodes, and nematodes.

Hoffman (1967) listed six trematodes, one nematode, and a crustacean in specimens from North America waters.

Relation to man Based on the number and size of the collections in museums, and

the statements of a few observant collectors, the mimic shiner is (or was) common in parts of the upper St. Lawrence River system (Toner 1937; Cuerrier et al. 1946), and in some regions of southern Ontario. It undoubtedly forms a part of the diet of predators, such as smallmouth bass. There are no direct observations, but when abundant, its contribution would be significant. Its value as a bait minnow in our area is unknown since the species is seldom recognized either by bait dealers or investigating biologists.

Nomenclature

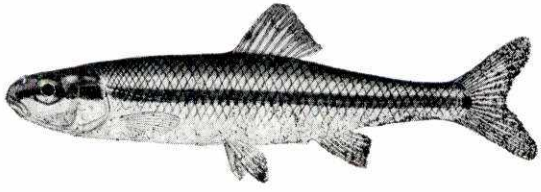
Hybognathus volucellus	— Cope 1864: 283 (type locality Detroit River, Grosse Isle, Mich.)
Notropis deliciosus stramineus	— Dymond 1926: 50
Hybopsis volucella (Cope)	— Jordan, Evermann, and Clark 1930: 133
Notropis volucellus (Cope)	— Scott 1967: 70

Etymology *Notropis* — back; keel; *volucellus* — a diminutive, from *volucer*, winged or swift.

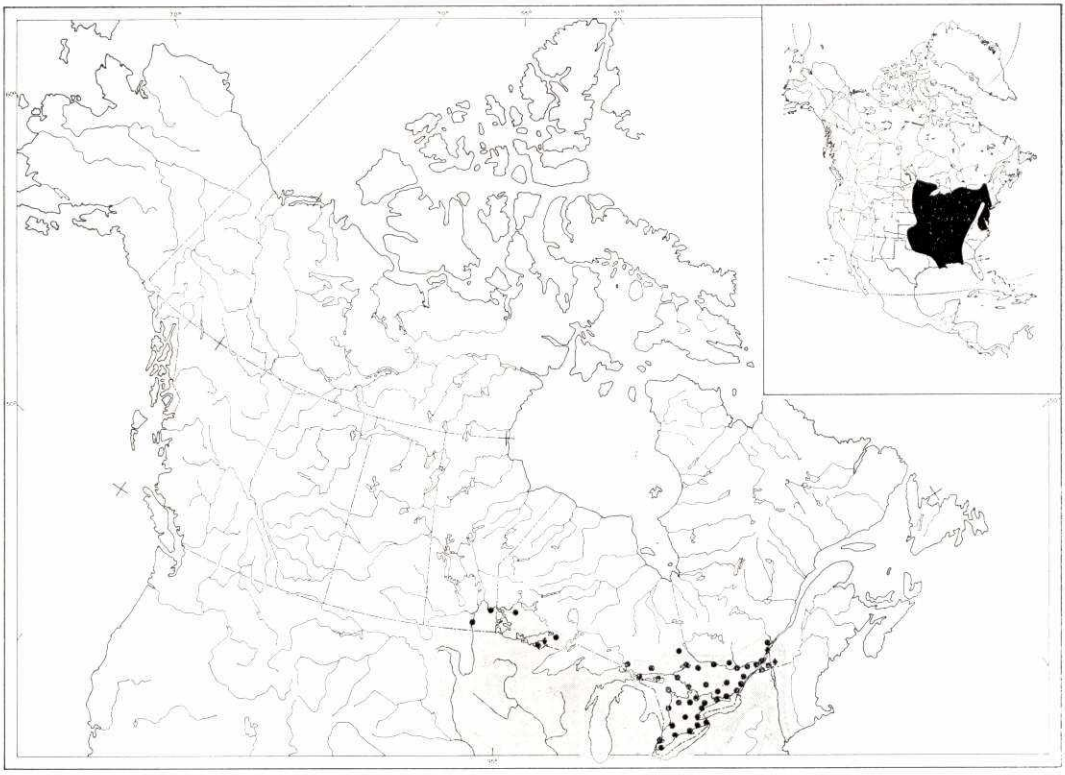
Common names Mimic shiner. French common name: *méné pâle.*

BLUNTNOSE MINNOW

Pimephales notatus (Rafinesque)



Description Body elongate, tubular, average length 2.5 inches (64 mm), not strongly compressed laterally, and body not deep, its greatest depth 14.5–20.4% of total length. Head broad, bluntly triangular, and small, its length 18.1–21.4% of total length; eye moderate, its diameter 25.0–37.5% of head length; snout rounded, blunt (hence name), slightly overhanging upper lip, its length 25.0–36.3% of head length; interorbital broad, its width 35.2–50.0% of head length; mouth, inferior, overhung by rounded projecting snout, gape not reaching front of eye; a thickened papillalike protuberance at each corner of mouth of large breeding males; pharyngeal teeth 0,4–4,0. Fins: all fins transparent in young, olive in adults; dorsal 1, its origin slightly behind pelvic fin origin, rays 8(44); caudal rather shallowly forked and rounded; anal 1, relatively small, its origin



below tip of depressed dorsal, rays 7(43), rarely 8(1); pelvics originate slightly in advance of dorsal fin origin, rays 8(33); pectorals small, rays usually 15(16), or 16(14), rarely 14(1), or 17(1). Scales cycloid, small, and crowded predorsally; lateral line complete, lateral line scales 42–50. Peritoneum uniformly black; intestine elongated. Vertebrae 37 or 38.

Nuptial tubercles large, sharp, and in 3 rows across the snout of males, not extending above the nostrils; many small tubercles may also occur on dorsal surface of anterior pectoral rays.

Colour Back olive-green, to brown, silvery on sides and silvery white below. Fins with yellowish or olive tint. The scales have a dark edge, which imparts a crosshatched appearance to young fish. A conspicuous black spot at base of caudal fin. A dark lateral band extends from caudal spot to eye. Both caudal spot and lateral band most evident on preserved specimens, which often have a rusty tinge above anterior portion of lateral band immediately behind head.

Breeding males are very dark, almost black; even the fins, particularly dorsal fin, suffused with dark chromatophores.

Distribution The bluntnose minnow occupies a broad range through central North America including the Mississippi and Great Lakes drainage systems. It occurs in lakes, ponds, rivers, or creeks from southern Quebec and Lake Champlain south in the Hudson valley to the coast and to Virginia; southwest to the Gulf states and north through the Mississippi drainage system to the Great Lakes, and southeastern Manitoba.

In Canada, it occurs in southwestern Quebec, west through the Great Lakes (but only in extreme eastern Lake Superior drainage), and tributary waters, including the Ottawa River and its tributaries, north to Timagami, and west to Lake of the Woods. A rare species

in Manitoba, it was reported from only three localities by Keleher and Kooyman (1957): at Winnipeg, St. Andrews Locks on the Red River, and at Echo Lake (50°13′N, 95°22′W).

Biology The spawning habits are well known, perhaps because it builds a nest in shallow water and fights off all intruders, or because it is relatively common in waters adjacent to populated areas. The bluntnose minnow deposits its eggs on the under surface of flat stones, boards, logs, broken tile, bricks, or any other object that offers a suitable lower surface, but it prefers a flat stone or other object resting directly on bottom in 6 inches to 3 feet of water. In spring, the male selects a suitable stone and commences to hollow out a nest beneath it. Using his snout, armed with large nuptial tubercles, he pushes pebbles and other objects out of the way, and removes silt and light material by successive heavy sweeps of his tail. After a shallow depression has been created, the male carefully cleans off the under surface of the overlying stone with his back and mouth. The males do not seek out females and will drive them off if they approach the nest before it is completed. When all is ready to his satisfaction, the male will allow the female to enter. The adhesive eggs are deposited on the cleared underside of the overhanging stone, log, or whatever surface was chosen by the male.

The eggs are large, and measure 1.0–1.5 mm in diameter. One female deposits 200–500 eggs per season. Hubbs and Cooper (1936) observed that individual females would remain in a nest for 10–30 minutes and deposit 25–100 eggs. Successive females would be allowed to enter and deposit their eggs in the nest, which was under constant guard by the male. Hubbs and Cooper reported that the average nest covered 21 square inches and contained 2447 eggs, or 128 eggs per square inch. Most spawning takes place at night (Westman 1938) but some spawning may occur in the daytime (Hubbs and Cooper 1936).

Spawning commences in late May or June when water temperatures are at least 68° F (20° C) and may continue until August in some areas. Fish culturists know that in artificial ponds females may spawn at least twice in a season. Spawning was considered to be prolonged in southeastern Ontario by Toner (1943), who found males with well-developed tubercles from May to August. Observations of nests clearly indicate that not all spawning takes place at one time, for the nests normally contain freshly laid eggs and eggs in an advanced state of development. Westman examined ovaries of 10 females in New York State in April and found the number of eggs varied from 1743 to 2223. The eggs in each female were always in several different stages of development.

Males may build nests literally side by side when a large spawning object is available. Hubbs and Cooper reported that long boards would have one nest for each linear foot.

Westman noted that if the male was removed from the nest, the eggs would die within 12 hours. The male's presence is essential to ensure a continuous flow of water over the eggs and to keep them free of silt.

The eggs hatch in 7–14 days depending upon temperature, the young being about 5 mm long.

The eggs and young have been described in considerable detail by Fish (1932), who provided drawings of developing eggs and young; drawings and descriptions are given for young at lengths of 5 mm (newly hatched), 6 mm (7 days old), and 12 mm.

Westman observed that young bluntnose minnows achieved a standard length of 12 mm 2 weeks after hatching and a length of 37 mm by December. He provided additional evidence indicating that only a small percentage attained a standard length of 55 mm during their first growing season. Females may attain sexual maturity in their second year (i.e., at age 1) but males seem not to mature until the third year (age 2). Length of life is not known but both males and females have been taken in their fourth summer (age 3). Males grow larger than females and may attain a total length of 4 inches (102 mm), females 3 inches (76 mm).

The bluntnose minnow seems to prefer the sand- and gravel- (or occasionally mud-) bottomed shallows of clear lakes and ponds

but lives also in a variety of rocky or gravelly streams and creeks. It appears to avoid heavily weeded areas.

The inferior mouth is an adaptation to bottom feeding. Examination of stomach contents revealed that the food consisted almost entirely of organic detritus (bottom ooze) from the bottom (20–50% by volume), chironomid larvae (5–30%), and Cladocera (10–75%), according to Keast and Webb (1966) whose studies were conducted in Lake Opinicon, Ont. Samples from Kearney Lake, Algonquin Park, contained mostly chironomid larvae and algae.

The bluntnose minnow is preyed upon by a wide variety of predators, including its own species, for young nonspawning males will quickly devour the eggs in an unprotected nest. The young are ideal forage for yellow perch, and the young of the sunfishes, rock bass, and other centrarchids that occupy the same habitat. Specific food studies involving the bluntnose are lacking but it is an ideal forage fish for any larger, predaceous species, as it utilizes a food resource not exploited by game fishes.

Bangham and Hunter (1939) examined 13 specimens of the bluntnose minnow from Lake Erie and reported 5 minnows parasitized. Parasites identified were trematodes *Neascus* sp. in the 2 parasitized fish of the 3 taken from the east end of the lake. Trematodes *Lebouria cooperi* and *Neascus vancleavei*, the cestode *Ligula intestinalis*, and Protozoa and Myxosporidia were recorded from west end specimens.

Bangham (1955) found all 17 hosts examined from Lake Huron and Manitoulin Island infected. The trematode *Posthodiplostomum minimum* occurred in 14 of the specimens examined. Other parasites included trematodes, protozoans, and the nematode *Rhabdochona cascadilla*.

Hoffman (1967) listed many species of Protozoa, Trematoda, Cestoda, Nematoda, molluscan glochidia, and the crustacean *Lernaea cyprinacea* from this species in North American waters.

Relation to man The bluntnose minnow is an important forage minnow for game fishes. Although it is used for live bait in Canada, it is not a popular bait species because it does not withstand crowding in a minnow pail as well as other species. It is commonly used as a bait fish in the United States.

The bluntnose can be artificially propagated with considerable success. Cooper (1936a) and Dobie et al. (1956) reported yields of up to 104,800 fish (250 pounds) per acre in Michigan, and 473,350 individuals per acre in Ohio. Artificial nesting sites are provided in ponds by floating boards on the surface or driving shingles into the bank a few inches below water level. Artificially reared bluntnose minnows were widely distributed throughout Ohio where the bluntnose has been widely introduced to ensure an adequate supply of forage minnows as food for game fishes.

Nomenclature

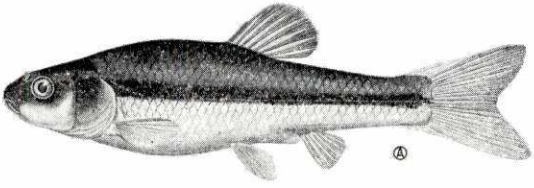
Minnilus notatus	— Rafinesque 1820c: 47 (type locality Ohio River)
Hyborhynchus notatus Rafinesque	— Hubbs 1926: 48
Pimephales notatus Rafinesque	— Hubbs and Lagler 1964: 86

Etymology *Pimephales* — fat, head; *notatus* — noted or spotted.

Common names Bluntnose minnow, blunt-nosed minnow. **French common name:** *ventre-pourri*.

FATHEAD MINNOW

Pimephales promelas Rafinesque

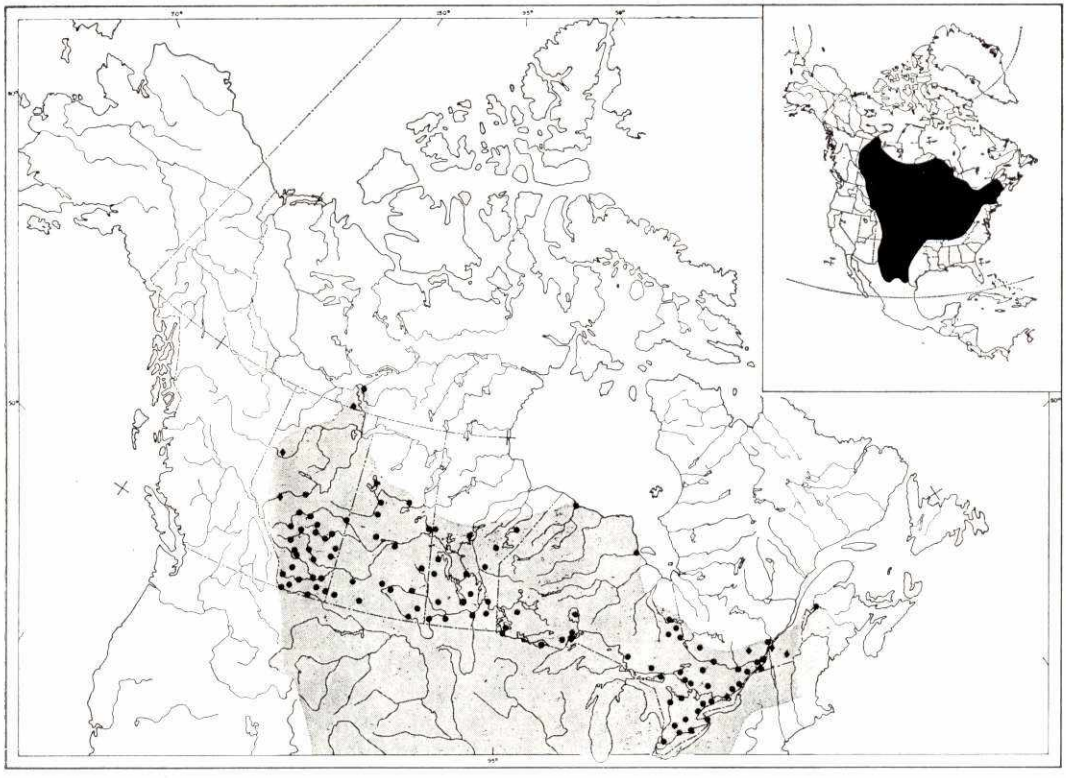


Description Body short, average length about 2 inches (51 mm), thick set, compressed laterally and deep bodied, often with a pronounced belly, body depth 20.0–27.5% of total length. Head rather sharply triangular, its length 20.3–25.0% of total length; eye moderate, not noticeably large, its diameter 18.7–30.0% of head length; snout slightly overhanging upper lip, snout length 24–40% of head length; interorbital broad, its width 33.3–53.8% of head length; mouth small, nearly terminal, snout slightly protruding beyond upper lip, gape not extending to front of eye; pharyngeal teeth 0,4–4,0, slightly hooked. Fins: dorsal 1, its origin over pelvic fin origin, rays always 8(89), first ray short and not tightly bound to second ray, males may have a black spot or blotch on lower third of first 2 or 3 rays; caudal shallowly forked; anal 1, its origin below depressed dorsal fin, rays always 7(89); pelvics small, originating below dorsal origin, usually extending to anal fin origin in males, but not in females, rays always 8(89); pectorals relatively short, rays usually 15(21), or 16(18), sometimes 17(8), rarely 14(1), or 18(1). Scales cycloid, moderate in size; lateral line incomplete, usually terminating below dorsal fin origin or before, scales in lateral series 41–54; some populations, notably those in the Thunder Bay region of Ontario, may have lateral line complete except for 3 or 4 pored scales. Peritoneum uniformly black; intestine long but variable, usually 2.0–2.5 times body length. Vertebrae usually 37(18), sometimes 36(11), seldom 35(3), or 38(3).

Nuptial tubercles on males only, large, well-developed ones on snout that rarely extend beyond nostrils, in three main rows, also a few on lower jaw; sometimes scattered minute tubercles on top of head; in addition to nuptial tubercles, there is an elongate fleshy or spongy pad extending in a narrow band from nape to dorsal fin origin, wide anteriorly, the pad narrows to engulf first dorsal ray.

Colour Overall colouration usually dark. Dark olive-green or brown above, with silvery or brassy reflections on sides and silvery white below, but in parts of western Canada they may be quite light in colour. Young and nonbreeding adults lighter in colour but exhibiting a distinct lateral band which extends from caudal peduncle to head. The band may be absent on breeding males or, if present, it becomes very diffuse anteriorly. The band is usually most apparent on preserved specimens. Dymond (1926) described the saddle-like pattern often associated with the fathead in which a light area develops just behind the head and another beneath the dorsal fin, the areas between producing a saddle effect. McPhail and Lindsey (1970) noted that they had not observed this, nor indeed have we, but it is described by Dymond (1926), Trautman (1957), Cross (1967), and others.

In eastern Canada, at least, breeding males are very dark, including even the fins, particularly the dorsal fin. The tubercles on the head are light in colour and the rugose, spongy pad on the back is slate-blue or gray.



Systematic notes The fathead minnow varies greatly in many characters throughout its wide geographic range and some populations have been designated as subspecifically distinct; e.g., *Pimephales promelas promelas*, the northern fathead minnow; *P. p. harveyensis,* Harvey Lake fathead minnow; and *P. p. confertus*, southern fathead minnow (Hubbs and Lagler 1949, 1958). The pattern of variation, however, caused some workers to doubt the validity (Taylor 1954). A statistical analysis of geographic variation was published by Vandermeer (1966), whose work suggested that two of the three described subspecies intergrade clinally. He, like Taylor, recommended that subspecies not be recognized. Vandermeer found that eye diameter showed a north–south trend, the northern fish having smaller eyes; another character studied was completeness of lateral line, which showed a northeast–southwest cline, with northern fish having the least complete lateral line. However, since some Canadian populations exhibit a nearly complete lateral line, the subject obviously warrants further study.

Distribution The fathead minnow ranges through most of central North America, from Louisiana and Chihuahua, Mexico, north to the Great Slave Lake drainage; and from New Brunswick on the east to Alberta on the west.

In Canada, it occurs from the Saint John River drainage near Edmundston, N.B., west through southern Quebec; all of Ontario; north in Manitoba to Lake Athapapuskow and God's Lake; north in Saskatchewan to parts of the Churchill River drainage; through all of Alberta north into the Northwest Territories to the Hole Lakes, Little Buffalo River, which flows north into Great Slave Lake. There are no records for British Columbia.

Biology The spawning behaviour and activities of the fathead minnow in spring are

rather well known because of the early interest in raising this fish in ponds for feeding pond-reared black bass. The breeding habits are generally very similar to those of the bluntnose minnow, *P. notatus*. Observations on populations in Quebec lakes were reported by Wynne-Edwards (1932) and Richardson (1937). Spawning activities commence when water temperatures reach 60° F (15.6° C), although 64° F (17.8° C) was considered minimum spawning temperature by Dobie et al. (1956). Spawning is prolonged and may continue into August in many parts of the range. Dymond (1926) reported ripe females and males from the vicinity of Lake Nipigon, Ont., June 17, 1924; Toner (1943) found a male guarding eggs attached to the underside of a rock embedded in a bank of Jones Creek, St. Lawrence River drainage, June 12, 1936; Richardson (1937) observed spawning activities in Quebec, June 19, 1933.

The male selects for a spawning site the underside of a log or branch, large rock, board, or, more rarely, a lily pad, in shallow water, 2–3 feet deep (Wynne-Edwards 1932). A female is sought out and herded into position below the nesting site, the male usually positions himself on the female's left side. After much circling below the nesting site, the female is nudged and lifted by the male's back until she lies on her side immediately below the undersurface of log or branch. The adhesive eggs are deposited, fertilized by the male, and the female driven off. The female has an ovipositor (Flickinger 1969), which is doubtless an adaptation to this unusual method of egg deposition. After deposition of the eggs, the male is most aggressive and will drive off all other intruding small fishes, aided, of course, by the large tubercles on the snout. Males may seek out a number of females in a like manner, so that each nest contains eggs from more than one female and these in various stages of development, and, of course, each female deposits eggs in more than one nest.

In addition to guarding the nest, Wynne-Edwards reported that the eggs were stroked or rolled by the male, using the thick rugose pad on his back, but subsequent authors (Markus 1934; Hubbs and Cooper 1936) cast doubt on this function of the male.

Wynne-Edwards reported the eggs to be 1.3 mm in diameter (Quebec) and Markus 1.15 mm (Iowa). The time to hatching depends on temperature but on the average requires 4.5–6 days; at 77° F (25° C) 5 days are required. Newly hatched young are about 5 mm long, and white in colour. Fish (1932) described and illustrated a young fathead at the 11.6 mm stage. The pattern of scale formation was described by Andrews (1970) who noted that in Colorado no scales were found on fish smaller than 14 mm and average length for first scale formation was 16.3 mm.

Growth is rapid in warm, food-rich waters, so rapid that Markus considered that fish hatched in May in Iowa reached adult size and were spawning by late July, but, as Hubbs and Cooper noted, such rapid growth is unlikely in more northerly waters. In Canada, adult sizes of 2.0–2.8 inches (50–70 mm) total length are probably not attained until at least age 2. Maximum total lengths from museum collections, in millimeters (Quebec 88, Ontario 94, Manitoba 83), suggest greater ages than reported elsewhere, but rates of growth studies have apparently not been calculated for Canadian populations.

In all populations the males grow more rapidly and to a larger size than females. This is characteristic of species of minnows, such as the bluntnose minnow, in which the males guard the nest, whereas the female is usually larger where no nest-guarding occurs.

Most reports indicate that the fathead is quite short lived, rarely living beyond age 2. Markus (1934) reported 80% mortality of the adult fish after spawning, and it appears that this postspawning mortality is a characteristic of the species, although it has not been reported for Canadian populations. In a critical age and growth study in Iowa, Carlson (1967) reported one fish of age 3, and noted that annulus formation coincided with peak spawning, which took place in July. Whether these circumstances apply to Canadian populations is not known but it seems probable that more fathead would reach age 3 in our cooler waters.

The preferred habitats and species associated with the fathead minnow seem to vary greatly throughout the Canadian range. In general, it prefers the still waters of ponds to the flowing waters of streams. In the St. Lawrence drainage, it often occurs in muddy ditches and warm brooks. In north-central Ontario it occurs most frequently in clear but stained, acid waters of beaver ponds and small lakes, usually in association with fivespine sticklebacks, pearl dace, and finescale dace (Dymond 1926; Dymond and Scott 1941). In the Prairie Provinces it occurs in reservoirs, muddy brooks, and alkaline lakes, sometimes in considerable numbers. In a review of the saline lakes in Saskatchewan, Rawson and Moore (1944) noted that the fathead minnow was one of the more abundant species in such lakes and could tolerate salinities in excess of 10,000 ppm. McPhail and Lindsey (1970) reported it in muddy streams and mud-bottomed lakes in the northwest.

Food of the fathead seems not to have received critical attention; most authors refer to the studies of Coyle (1930) who found algae to be one of its main foods in Ohio. Elsewhere in the United States the items found in stomachs include organic detritus, bottom mud, aquatic insect larvae, and zooplankton. The elongate intestine is characteristic of cyprinids that have a high vegetative content in their diet.

The fathead minnow is an ideal forage fish since it is widely distributed, small, highly prolific, and has a prolonged spawning period, assuring the availability of recently hatched or small fatheads to predators throughout the warm summer months. To list all predators of this minnow would require listing all fish-eating birds and fishes associated with it.

Bangham and Venard (1946) examined 60 specimens of fathead minnows from lakes in Algonquin Park, Ont., and found 46 parasitized. Forty-three from Chickaree Lake were infected with the trematode *Posthodiplostomum minimum*. They noted that northern dace and redbelly dace caught in the same location were only lightly infected with this trematode.

Bangham and Hunter (1939) examined 11 specimens from Lake Erie, Ont. Four fish were infected, the parasites identified being trematodes, *Neascus* sp., Protozoa, and Myxosporidia.

Ligula intestinalis was found in 88% of a sample of 290 fish examined in Nebraska by McCarraher and Thomas (1968). The number of parasites per infected minnow ranged from 1 to 22. The lake in question, Rodgers Lake, was highly alkaline with a *p*H of 9.2, which is perhaps significant.

Hoffman (1967) listed species of Protozoa (2), Trematoda (10), Cestoda (5), Nematoda (2), and Crustacea (1), from this fish in North American waters.

Relation to man The fathead minnow has attracted much attention as a forage fish suitable for pond culture in the United States; often as food for pond-reared smallmouth bass and other game fish. Considerable information on pond cultural practices and yields are available in Dobie et al. (1956) who reported yields up to 328 pounds (200,000 fish) per acre. Pond culture has not been practiced seriously in Canada as yet, although when it is, the fathead will no doubt offer promise.

It is not generally regarded as an important bait species in Canada because of its small size, but in certain areas where it is abundant, such as in the Kenora region of Ontario, it may be a valuable bait fish.

Its primary importance in our waters at present is as a forage fish, converting algae, organic detritus from bottom deposits, and planktonic organisms into food for other fishes. Its value in this role is inestimable.

Nomenclature

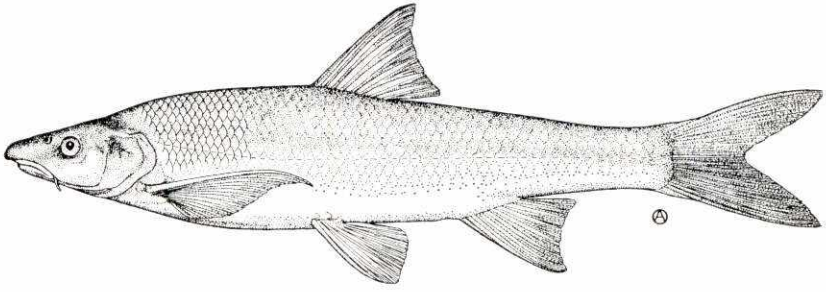
Pimephales promelas — Rafinesque 1820c: 53 (type locality near Lexington, Ky.)
Pimephales milesi Cope — Jordan and Evermann 1896–1900: 217

Etymology *Pimephales* — fat; head; *prømelas* — before; black.

Common names Fathead minnow, northern fathead minnow, blackhead minnow. French common name: *tête-de-boule*.

FLATHEAD CHUB

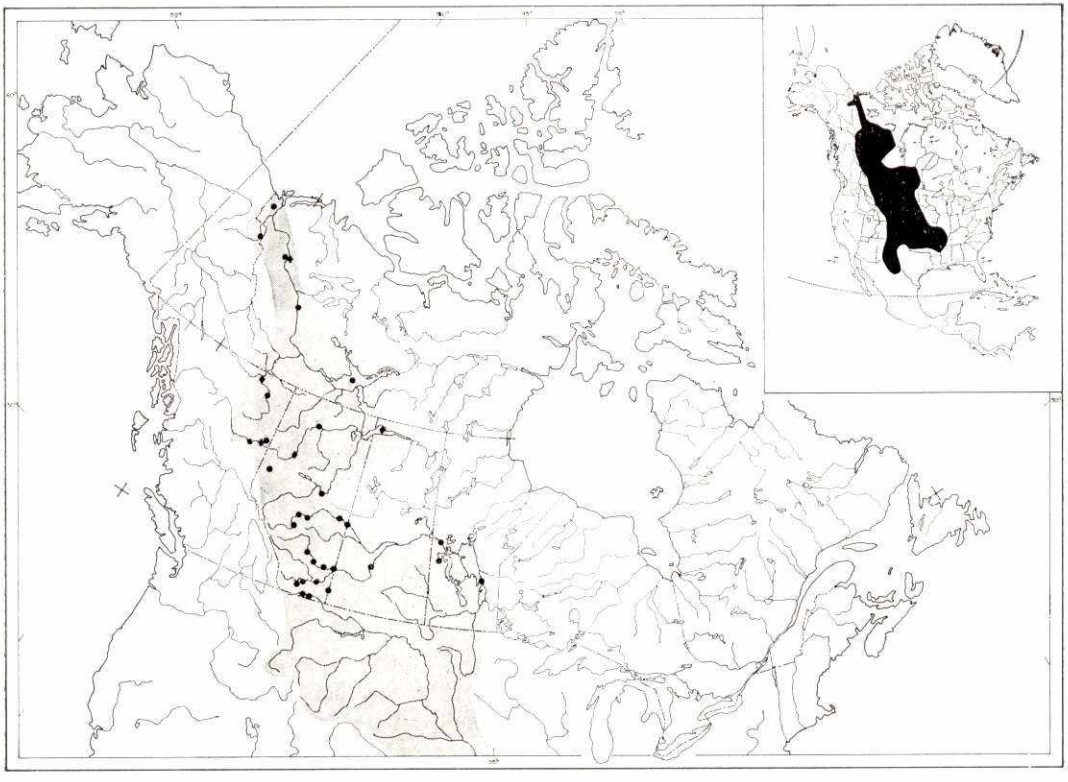
Platygobio gracilis (Richardson)



Description Body elongate, about 5–7 inches (127–178 mm) average total length, not strongly compressed laterally, caudal peduncle deep, about one-half body depth, body depth 14.5–20.0% of total length. Head small, wedge-shaped, dorsal surface distinctly flattened, length 16.8–18.9% of total length; eye relatively small, its diameter 13.6–23.8% of head length; snout long, protruding beyond upper jaw, nostril flaps conspicuous, length 35.8–41.3% of head length; interorbital region distinctly flattened, wide, width 38.0–52.4% of head length; mouth large, subterminal, overhung by snout, extending posteriorly to about midpoint of eye; well-developed terminal barbels at end of maxilliaries; pharyngeal teeth 2,4–4,2. Fins clear: dorsal 1, its origin usually slightly in advance of origin of pelvic fins, base short but fin high, pointed, trailing edge falcate, rays 8, rarely 7; caudal distinctly forked, lobes pointed, lower lobe darker than upper lobe; anal 1, its origin at a point below tip of depressed dorsal, trailing edge distinctly falcate, rays usually 8, rarely 7 (McPhail and Lindsey 1970, said 8 or 9); pelvics originate usually under dorsal fin origin, pelvic axillary process evident, rays usually 8, rarely 7 or 9; pectorals long and acutely pointed, extending at times almost to pelvic origins especially in males but variable, rays 16–19, usually 17 or 18. Scales cycloid, large, persistent; lateral line complete, slightly decurved, scales 50–58 (McPhail and Lindsey said 42–59). Peritoneum silvery; intestine short. Vertebrae 40–47, usually 43–47 in Canadian waters.

Nuptial tubercles minute, on top of head and sparsely on scales of back, also on dorsal surface of first pectoral and pelvic rays and on lateral faces of first dorsal fin ray.

Colour Brownish or dusky above, silvery on sides and light below; pigmentation ceases abruptly midlaterally, coincidentally



with lateral line posteriorly, but anteriorly the lateral line curves downward below the line of pigmentation.

Fins clear except lower lobe of caudal fin, which is darker than upper lobe.

Systematic notes We have chosen to use the generic name *Platygobio* instead of *Hybopsis* for the same reasons expressed by McPhail and Lindsey (1970). It seems unnecessary to repeat them here.

The flathead chub exhibits considerable morphological variation throughout its North American range. This geographic variation was studied in detail by Olund and Cross (1961) who concluded that observed differences were best expressed by the recognition of subspecies, *Platygobio gracilis gracilis*, the northern flathead chub, which occurs in Canada and parts of the United States; and *P. g. gulonella*, the southern flathead chub, which occupies the western and southern part of the range. The populations in Frenchman River, in the Cypress Hills region of southwestern Saskatchewan, were considered by these authors to be intergrades between the two subspecies. *Platygobio g. gracilis* attains a larger size, has a slender, streamlined body, a wedge-shaped, flattened head, falcate fins, and a larger number of scales, pectoral fin rays, and vertebrae. Bailey and Allum (1962) interpreted the data differently, and considered the differences exhibited throughout the range as manifestations of environmental differences rather than genetic ones. The problem obviously requires further study.

Distribution The flathead chub occurs in west central North America, from 35° to 68°N latitude; from the Mississippi River and tributaries at about the South Canadian River in Oklahoma to the Rio Grande in New Mexico, north to Lake Winnipeg, and the Saskatchewan and Mackenzie River systems.

In Canada, it occurs in Manitoba, where it is occasionally caught in commercial fishermen's nets in Lake Winnipeg. It is said to be common around rapids in the Assiniboine

River, and Keleher and Kooyman (1957) reported it from Kelsey Lake, 53°37′N, 101°00′W. In Saskatchewan, it occurs in the Cypress Hills area, the South and North Saskatchewan rivers, and Lake Athabasca. In Alberta, it occurs throughout the province, from the Milk River to North and South Saskatchewan rivers and the Red Deer and Peace River systems. In British Columbia, it is present in the northeastern part, in the Peace River and at Lynx Creek east of Hudson Hope, and in the Fort Nelson and Muskwa rivers (Carl et al. 1967). In the Northwest Territories it occurs from Great Slave Lake through the Mackenzie River to the delta.

Biology Details of the spawning habits of the flathead chub are unknown but available information indicates that spawning takes place in summer. Olund and Cross (1961) favoured mid or late summer: they reported collections of males and females in spawning condition, taken in the Milk River, in August 1955; prespawning females caught in the Saskatchewan River in Saskatchewan, on June 7, 1957; and a single prespawning female from the Red Deer River in June, 1952. McPhail and Lindsey (1970) reported the capture of females with large ovaries of almost free eggs, and one spent female caught in the Mackenzie River at 64°N, on June 27. They considered that spawning had ceased before August 4 in the Peace River at Fort Vermilion since the females caught on that date were spent. Olund and Cross suggested that spawning occurred when water levels receded to the seasonal low, i.e., summer in Canada.

No growth studies have been published, especially for Canadian populations, but McPhail and Lindsey (1970) suggested that this chub lives for several years, since several size groups may be present in a single collection. The largest specimen known to them was one 12.5 inches (317 mm) total length from the Peel River at 66°N. A female chub in the Royal Ontario Museum collection measured 11.4 inches (290 mm) and is also from the Peel River, 15 miles from Aklavik, 68°N. Olund and Cross suggested that sexual maturity was attained at about 3.3 inches (85 mm) standard length.

The flathead chub occurs in the turbid, flowing waters in main channels of large rivers throughout its range, sometimes moving into smaller streams in the spawning season (Olund and Cross 1961). It is well designed for life in such an environment, as its elongate body, pointed snout, and elongate fins attest. It is seldom found in the clear, still waters of ponds or lakes.

The flathead chub is predaceous and feeds on a wide variety of organisms, probably both by sight and also by using the gustatory or taste-buds associated with the barbels. Insects, adults especially, form a major part of the diet, according to data compiled by Olund and Cross, who included information from Saskatchewan and Alberta. Water boatmen (Corixidae) made up 35% of the stomach contents of the Saskatchewan sample, and such terrestrial insects as ants (21%), beetles (30%), and dipterous flies (9%) were important in Alberta.

McPhail and Lindsey (1970) also noticed the importance of terrestrial and aquatic insects but observed, in addition, that small fishes and even young rodents have been found in the stomachs.

Severe infections of the tapeworm (*Proteocephalus*) in young flathead chubs were reported by Hubbs (1927). The heavy degree of parasitism apparently produced abnormalities that resulted from the retention of juvenile characters, and ultimately caused the death of the chubs before reaching maturity. Hoffman (1967) listed only the larval form of the trematode *Bolbophorus confusus* from this species in North American waters.

Relation to man The flathead chub is not of great economic importance in Canada, but it does afford some sport when angled with a small baited hook or artificial fly. It is also occasionally used as a food fish. Carl et al. (1967) noted that the Indians at Fort Nelson, B.C., made a sort of stew from these fish, which they caught by baited hook. In Iowa, it is a preferred bait fish for blue catfish because of its size and hardiness.

Nomenclature

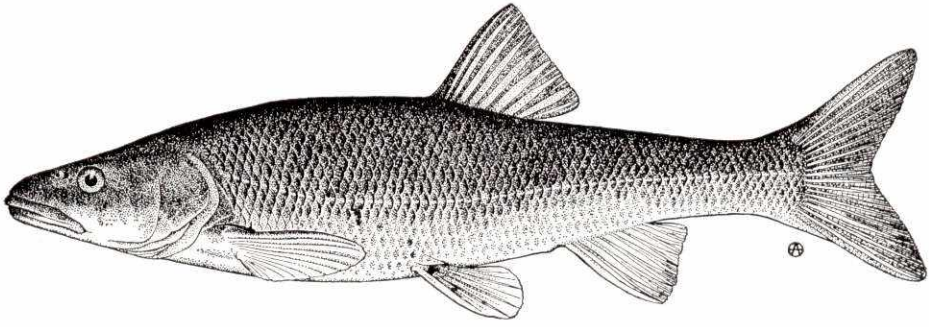
Cyprinus (*Leuciscus*) *gracilis*	— Richardson 1836: 120 (type locality Saskatchewan River at Carleton House)
Platygobio gracilis (Richardson)	— Jordan and Evermann 1896–1900: 326
Pogonichthys communis Girard	— Jordan and Evermann 1896–1900: 326
Coregonus angusticeps Cuvier and Valenciennes	— Jordan, Evermann, and Clark 1930: 136
Hybopsis gracilis	— Bailey 1956: 356

Etymology *Platygobio* — flat; gudgeon; *gracilis* — slender.

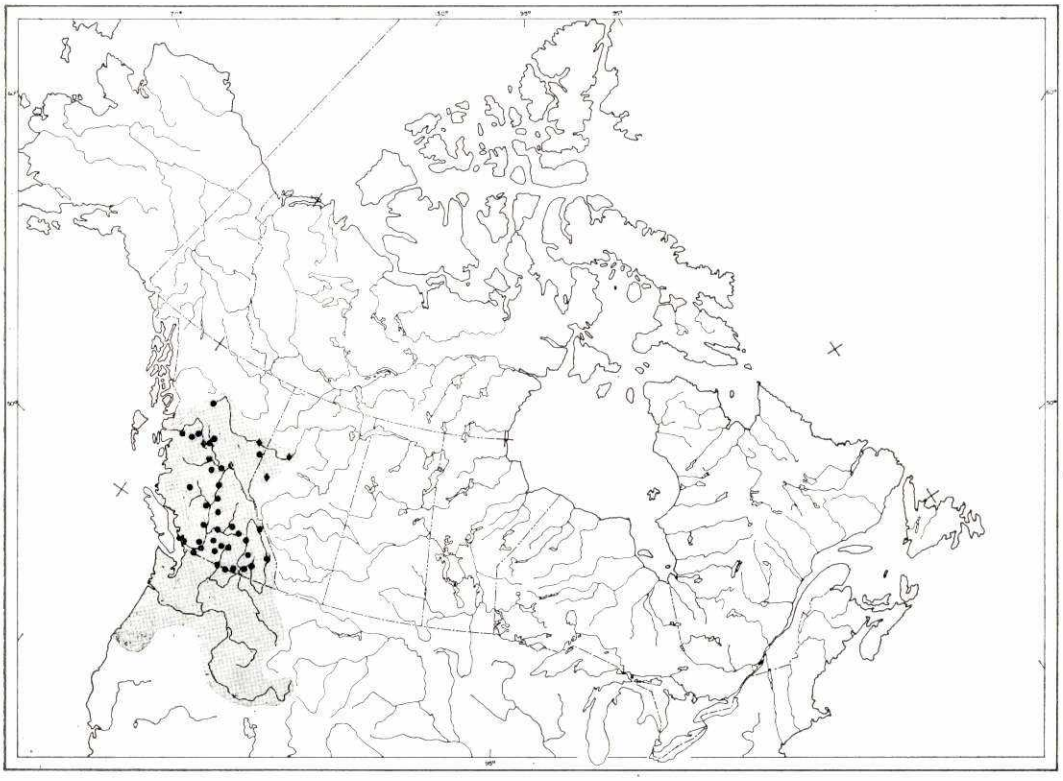
Common names Flathead chub, Saskatchewan dace. French common name: *méné à tête plate.*

NORTHERN SQUAWFISH

Ptychocheilus oregonensis (Richardson)



Description Body elongate, size large (maturing at 12 inches (305 mm) total length), somewhat compressed laterally, not deep bodied, greatest depth 14.7–18.5% of total length, belly gently rounded in mature individuals. Head moderately long, its length 22.3–23.3% of total length; eye small in adults, 16.2–19.1% of head length; but larger in young 3 inches (76 mm) long, when 23.7–26.7% of head length; snout long, 31.6–34.6% of head length of adults; interorbital width 26.9–32.2% of head length; mouth terminal, large, extending back to below anterior margin of eye; pharyngeal teeth tips hooked, usually 2,5–4,2 (Dymond 1936, stated outer row sometimes 3 instead of 2, inner sometimes 4–4). Fins: all fins clear; dorsal 1, its origin over, or slightly behind, origin of pelvic fins, dorsal rays 9, sometimes 10; caudal distinctly forked, lobes pointed; anal 1, its origin below free edge of dorsal fin, rays 8, seldom 9 (McPhail and Lindsey 1970, gave 8–10); pelvics small, origin under or slightly in advance of dorsal fin origin, rays 9;



pelvic axillary process usually a ridge; pectorals relatively short, rays 15 or 16; McPhail and Lindsey (1970) gave 15–18 (usually 16) for northern populations. Scales cycloid, small, 65–77 in lateral line; lateral line complete. Peritoneum speckled; intestine short. (*See* Weisel 1962, for a thorough description of digestive tract.) Vertebrae 44(2), 45(7), or 46(7); McPhail and Lindsey (1970) reported 40–43 but must exclude 4 Weberian vertebrae.

Nuptial tubercles fine, on head and back, and on the pectoral and pelvic fins and sometimes on caudal fin.

Colour Dark green or green-brown above, lighter on sides and silvery white or cream ventrally. The males are colourful at spawning time when the lower fins become yellow or yellow-orange. Young fish, when preserved, exhibit a black spot at the base of the caudal fin and a rather weak, narrow, lateral band that commences before the dorsal origin and terminates almost at the caudal spot.

Systematic notes *Ptychocheilus oregonensis* is a stable species in itself but there are three additional members of the genus *Ptychocheilus*, which occur in other west coast watersheds — *P. grandis*, the Sacramento squawfish; *P. lucius*, Colorado squawfish; and *P. umpquae*, the Umpqua squawfish.

Distribution The northern squawfish occurs on the Pacific slope of western North America, in the Malheur Lake system of Oregon, in the Columbia River system and north in the Pacific slope drainages to the Nass River of British Columbia. It occurs east of the Continental Divide only in the Peace River system.

In Canada, it occurs in British Columbia, through the entire Fraser, Columbia, and Skeena River systems, through the Klinaklini and Dean River systems and in Meziadin

Lake and the settlement of Aiyansh of the Nass River system. It has traversed the Continental Divide in the Peace River system and occurs in Summit and McLeod lakes, east in the Peace River to the Peace River townsite in Alberta.

Biology Squawfish spawn from late May to July (Carl et al. 1967). Spawning takes place in gravelly shallows, sometimes along a lake shore, sometimes in lakes near a tributary stream, and sometimes a short distance upstream. Observations by Jeppson and Platts (1959) and Patten and Rodman (1969) suggested lake-dwelling forms spawned in streams only when suitable gravelly shallows in lakes were not available. The spawning fish tend to gather in large numbers, but no nest is built. A female may be accompanied by a few to many males, the small eggs and sperm are released close to the bottom, and the eggs, which are adhesive and demersal, and 1 mm in diameter, settle in the gravel. Some authors (Carl et al. 1967) described the eggs as greenish, others (Patten and Rodman 1969) observed them to be pale orange. Each female is said to carry large numbers of eggs and probably does not release all of its eggs at one time.

According to Carl et al. (1967), the eggs hatch in about 1 week. Sexual maturity is attained in about 6 years when the squawfish are about 12 inches (305 mm) long. The following fork lengths (mm) at successive ages are calculated figures from British Columbia populations at Okanagan Lake and Woods Lake (Clemens 1939):

Age	Okanagan L.	Woods L.
1	46	48
2	89	99
3	130	147
4	160	198
5	201	226
6	239	274
7	–	302
8	–	345
9	–	366
10	–	386
11	–	411

A maximum weight of 29 pounds (13 kg) (no length available), and a length of 25 inches (360 mm), were reported by McPhail and Lindsey (1970) who also suggested life expectancy of 15–20 years.

The northern squawfish is typically a lake species, preferring still waters to swift streams. The young inhabit inshore waters in summer months, moving offshore into deeper waters in fall; the larger fish tend to remain offshore.

The food habits of the squawfish have received considerable attention. Ricker (1941) examined over 300 stomachs and concluded that while in inshore waters in spring and summer, these fish consume shiners (*Richardsonius balteatus*), sticklebacks, terrestrial insects, and some plankton. Aquatic insect larvae and crustaceans may also be eaten at this time. During fall and winter, squawfish move offshore into deeper water where fish become the major food item.

Young squawfish, 1–4 inches (25–102 mm), feed heavily on insects but as they grow larger, fish become increasingly important, and very large squawfish feed almost exclusively on other fishes and, sometimes, crayfishes.

Male squawfish were observed eating eggs on their own spawning ground by Patten and Rodman (1969), who also noted that squawfish eggs were eaten by prickly sculpins and newts.

Bangham and Adams (1954) examined 408 specimens of northern squawfish from 32 locations in British Columbia and found 373 parasitized. They reported many different species of parasites and noted that there were often very heavy infections of encysted eye flukes, *Diplostomulum* sp., and the strigeid fluke *Posthodiplostomum minimum* (*see* Bangham and Adams (1954), for further details).

Hoffman (1967) listed trematodes (5), cestodes (3), nematodes (5), acanthocephalans (1), leeches (1), crustaceans (2), and molluscs (1) as parasitic on squawfish.

Relation to man Any North American fish species that is predatory and grows to a size in excess of 5 pounds, will be of interest to man, either directly as a sport or game fish, or indirectly as a competitor with man for

more desirable species. The squawfish qualifies, in a minor way, as a sport fish, for it feeds at the surface in the evening and will take a fly. Its relatively large size ensures at least a short-lived tussle, but it quickly succumbs to the angler.

It is in the role of a competitor, that it is better known since, being large and predatory, it consumes other fishes, and when salmon (*Oncorhynchus spp.*), especially sockeye salmon, are included in its diet, the squawfish is in conflict with the most effective and selfish predator of all. In addition and perhaps equally important, it often competes with salmon and trout for the same food supply.

Proof of man's interest in the squawfish becomes readily apparent from the titles of some scientific papers, such as *Ecology and control of Columbia squawfish*; *A chemical selectively lethal to squawfish*; *The control of squawfish by use of dynamite, spot treatment, and reduction of lake levels.*

Squawfish do eat the young of salmon and trout, commencing when they are only 4 inches (102 mm) long, in the case of sockeye. Ricker (1941), considered the predation to be most serious from September to April. For further information, *see* papers by Foerster and Ricker (1942), Jeppson (1957), Jeppson and Platts (1959), and Ricker (1938a, 1941).

The squawfish is not unanimously regarded as a good food fish, although the flesh is edible. Rostlund (1952) suggested that Indian peoples were not enthusiastic about its food qualities although Jordan and Evermann (1908) wrote that it ". . . is highly esteemed by the Indians, hence its most popular name."

Nomenclature

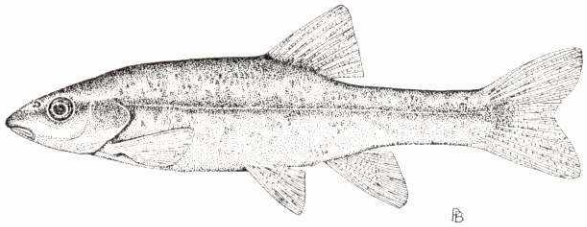
Cyprinus (*Leuciscus*) *Oregonensis* (Richardson)	— Richardson 1836: 305 (type locality Columbia River)
Leuciscus oregonensis (used by Günther 1868)	— Evermann and Goldsborough 1907a: 95
Ptychocheilus oregonensis Richardson	— Halkett 1913: 62
Ptychocheilus oregonensis (Richardson)	— Dymond 1936: L68
Ptychocheilus oregonense (Richardson)	— Lindsey 1956: 768

Etymology *Ptychocheilus* — fold; lip, the skin of the mouth behind the jaws being folded; *oregonensis* — of Oregon.

Common names Northern squawfish, Columbia squawfish, Columbia River dace. French common name: *sauvagesse du nord.*

BLACKNOSE DACE

Rhinichthys atratulus (Hermann)



Description Body stout, elongate, average length about 2.5 inches (64 mm), spindle-shaped, not strongly compressed laterally, body depth 15.1–22.9% of total length. Head triangular, broad, its length 19.6–23.2% of total length; eye relatively small, its diameter 16.6–28.5% of head length; snout long, upper lip overhanging mouth, snout length 32.0–41.6% of head length; interorbital broad, 33.3–46.1% of head length; mouth slightly inferior, nonprotractile, gape terminating below nostril, a small barbel visible at each corner of the mouth; pharyngeal teeth 2,4–4,2. Fins: dorsal 1, its origin slightly posterior to pelvic fin origin, rays usually 8(54), occasionally 7(3); caudal shallowly forked, lobes rounded; anal 1, its origin approximately below insertion of dorsal fin, rays usually 7(55), rarely 6(1), or 8(1); pelvics relatively small, origin slightly in advance of dorsal fin origin, rays 8(38); pectorals relatively small, rounded, rays 13–15 east of Ontario, 14–16 in Ontario and Manitoba. Scales cycloid, small, 56–68 in lateral line, radii in all fields; they commence to form at 15 mm and nearly cover body by 20 mm (Noble 1965); lateral line straight or nearly so, complete. Peritoneum uniform brown; swim bladder well developed in adults. Vertebrae 37–40, usually 38 or 39.

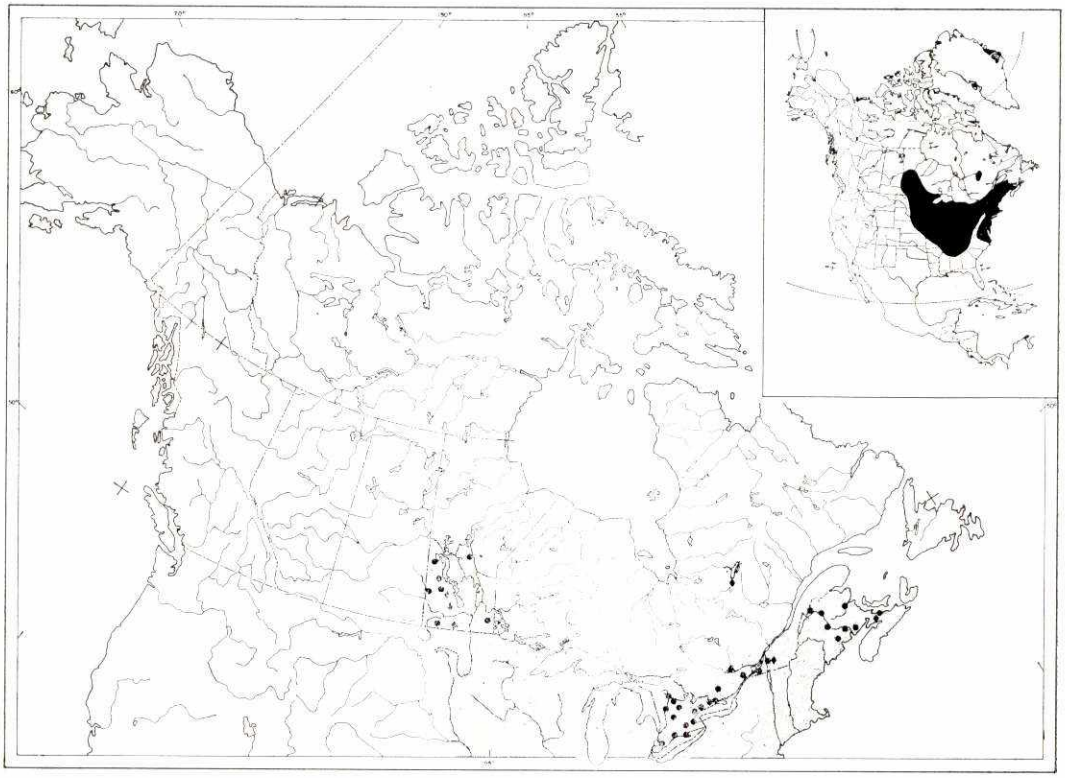
Nuptial tubercles developed on breeding males, on head, over entire body surface, and on fins; tubercles on pelvic fins better developed than on other fins.

Colour Overall colouration is dark with speckles or mottling on sides. The back is olive-green to dark brown, and the sides are sprinkled with specialized, darkened scales becoming lighter on lower sides and silvery white below.

Breeding males have a rust-red colouration on the sides and, some orange or red colouration on the pectoral fins, the intensity depending on the subspecies; *R. a. meleagris* perhaps more brilliantly coloured, but *see* section on *Systematic notes*.

Systematic notes *Rhinichthys atratulus* (Hermann) is generally considered to be represented throughout its range by at least four subspecies. Two of these are southern in distribution and do not enter our area but the remaining two have Canadian distributions as follows: *R. a. atratulus* (Hermann), eastern blacknose dace, ranges from eastern Lake Ontario, east through southern Quebec, into New Brunswick and Nova Scotia; *Rhinichthys a. meleagris* Agassiz, western blacknose dace, west from eastern Lake Ontario through the Great Lakes and Lake of the Woods to Manitoba.

Rhinichthys a. atratulus is considered to have a more slender caudal peduncle, dark speckling more prominent than lateral band, and spawning males with orange-red pectoral fins and a cinnamon-brown to orange lateral band, whereas *R. a. meleagris* has a deeper



caudal peduncle, lateral band more prominent than speckling and brick-red lateral band, but less red on pectoral fins of spawning males. There is a suggestion of a subspecific difference in the number of pectoral rays also (*see* section on *Description*).

Distribution The blacknose dace occurs from the Atlantic coast west through the Great Lakes region to North and South Dakota. Southward it is found on both sides of the Appalachian Mountains to Georgia, Alabama, and Mississippi (Moore 1968).

In Canada, the species inhabits cool, clear streams from Nova Scotia to Manitoba. McKenzie (1959) remarked that it may be taken, occasionally, in brackish water in Miramichi River tributaries before the head of tide. In Nova Scotia it was reported by Livingstone (1953) from only two localities in Cumberland County — River Philip, and a branch of the Shinimicas River that flows into Northumberland Strait. Cook (1961) extended the range to five new localities — Atkinson Brook (first Nova Scotia record from the Bay of Fundy drainage basin), a stream near Dewar Lake, the junction of Highway 4 and the road to Salt Springs, in the Pugwash River at Hansford (all from Cumberland County), and the French River at Oliver in Colchester County. It is reported to occur in every major watershed in New Brunswick (Scott and Crossman 1959); widespread in Quebec in the St. Lawrence River drainage; and ranging east to Gaspé; through southern Ontario to Lake of the Woods (not recorded north of Sault Ste. Marie); and in Manitoba, where it reaches its northernmost and westernmost limits of range in Canada, it has been recorded from Pembina, Whitemud, and Assiniboine River systems, and in tributary streams of lakes Dauphin, Winnipegosis, and Swan. These localities are in western Manitoba and Keleher and Kooyman (1957) noted that it had not been collected east of La Rivière (98°43′W long) except in the southern part of the province.

Biology Blacknose dace spawn in spring, when water temperatures reach about 70° F (21.1° C), usually in May or June. Spawning takes place over gravel bottoms in the fast water of shallow riffles, where the water is a few inches to a foot deep. Raney (1940c) first drew attention to the differences in the spawning habits of two races of blacknose dace, *R. a. atratulus* and *R. a. meleagris*, from studies in New York State waters. Additional differences in spawning behaviour apply to the southern subspecies as well. No nest is built, although a territory may be established, particularly by male *meleagris* (which, logically, has the better-developed tubercles) but may be abandoned once spawning begins in earnest, although a large male will tend to remain in his territory and by successive spawning will wear a depression near the centre. Clearing away of silt may be performed by *attratulus* but silt clearing by *meleagris* may be effected, perhaps incidentally, as Raney noted, by the lower fins during ceaseless guarding of territory. At the height of spawning, one to several males will accompany and harass every female appearing on the spawning ground. The spawning male and female orient side by side, the tubercles on the male probably helping him to retain contact with the female; the eggs and sperm are extruded during violent vibrations, which may last up to 2 seconds. The female has a well-developed anal papilla that serves as an ovipositor and some eggs may be forced into the sand or gravel during the spawning act. Raney observed that there was a rush by other dace to eat the eggs, which are vigorously defended by the male.

Traver (1929) noted that the eggs are 0.8 mm in diameter, transparent, and amber in colour. Newly hatched fry are about 5 mm long. Time to hatching has apparently not been recorded. Fish (1932) figured and described a 17.25-mm specimen from a Lake Erie tributary.

The age of blacknose dace can be determined from scales and were used by Noble (1965) for an Iowa population of *R. a. meleagris*. No growth studies have been made for Canadian populations but Trautman (1957) reported lengths of 25–61 mm for 1-year-old Ohio dace. Hubbs and Cooper (1936) considered that Michigan populations matured at age 2. It is probable that the species is short lived, reaching an age of 3, or at most, 4 years.

The blacknose dace prefers small, clear, swiftly flowing streams with gravelly substrate. Trautman (1957) demonstrated the importance of gradient by noting that the areas originally occupied in Ohio were those having a maximum relief of over 100 feet.

The food of the blacknose dace consists primarily of aquatic insect larvae, according to studies conducted in Iowa by Noble (1965), who noted that chironomids were the most important food but that diatoms and desmids were eaten during November and March. Noble did not detect any change in diet with increase in size or age.

Blacknose dace prey on their own eggs during spawning (Raney 1940c). The young and adults serve as food for large brook trout. Since this dace is often the most common fish species in the streams in the Maritime Provinces, it is preyed upon by many fish-eating birds, such as the American merganser (White 1957).

Houde (1964) reported the larval strigeid trematode *Crassiphiala bulboglossa*, which causes black-spot, in the blacknose dace from Mill River, Williamsburg, Mass., the first report of this trematode as a causative agent for black-spot in the blacknose dace.

Wagner (1969) collected blacknose dace, from a highly localized site in a limestone creek in central Pennsylvania, with the leeches *Illinobdella alba* and *I. moorei* attached to the fins.

Bangham and Hunter (1939) examined 54 specimens of blacknose dace in Lake Erie and reported 27 from the east end of the lake parasitized with trematodes, *Neascus vancleavei* and *N. rhinichthysi*.

Hoffman (1967) noted this species infested with several protozoans, trematodes, nematodes, and the larval form of a cestode, *Proteocephalus* sp.

Relation to man The blacknose dace is used to a limited extent as a bait minnow in Ontario and Quebec. It is one of the more

common minnows in the fast-flowing streams in the southern portion of eastern Canada; many of these are trout streams and in such situations it may serve as an important food of large brook trout. However, it is strictly a stream species and is not important in lakes.

It is considered to be a relatively hardy species in the United States, where it is popular as a bait fish for bass and catfish in Iowa and other states, such as Ohio and Minnesota. Dobie et al. (1956) noted that artificial fertilization is practical.

Nomenclature

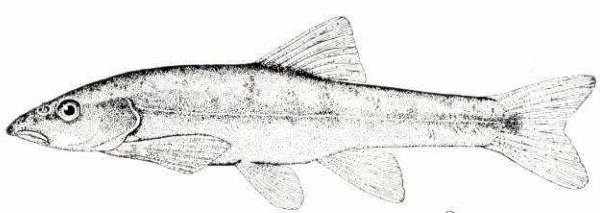
Cyprinus atratulus. Nobis.	— Hermann 1804: 320 (type locality America septentrionali)
Cyprinus atronasus	— Mitchill 1815a: 460
Leuciscus atronasus	— Perley 1852: 194
Rhinichthys atronasus (Mitchill)	— Evermann and Goldsborough 1907a: 97
Rhinichthys atratulus (Hermann)	— Hubbs 1936: 124

Etymology *Rhinichthys* — snout; fish — the snout being prominent; *atratulus* — probably from *atratus*, meaning clothed in black as for mourning.

Common names Blacknose dace, black-nose dace, eastern blacknose dace, dace, striped or redfin dace, brook minnow, potbelly, pottlebelly. French common name: ***naseux noir***.

LONGNOSE DACE

Rhinichthys cataractae (Valenciennes)



Description Body stout, averaging about 3 inches (76 mm) total length, nearly round in cross section, especially anteriorly between head and dorsal fin, body depth 14.8–19.4% of total length. Head triangular, broad, usually a slight but distinct hump at nape, head length 19.4–25.0% of total length; eye relatively small, its diameter 16.6–24.1% of head length; snout long, extending beyond, and overhanging mouth, bulbous, its length 38.4–50.0% of head length; interorbital broad, its width 26.0–42.4% of head

length; mouth inferior, nonprotractile, overhung by snout, upper lip fleshy, gape terminating in front of eye, a small barbel at each corner of mouth, hidden in skin fold, conspicuous on large adults; pharyngeal teeth usually 2,4–4,2, occasionally 1,4–4,1 or 1,4–4,0, but always 4 in main row. Fins: dorsal 1, its origin posterior to pelvic fin origin, rays 8(58); caudal shallowly forked, lobes rounded; anal 1, origin approximately below insertion of dorsal fin, rays 7(58); pelvics small, origin in advance of dorsal origin, pelvic axillary process present, rays usually 8(44), rarely 7(2) (McPhail and Lindsey 1970, said sometimes 9); pectorals short, rounded and somewhat paddle-like, rays 13(5), sometimes 12(1) in Quebec, 13(25), or 14(15), occasionally 15(7) in Ontario, Manitoba, and Saskatchewan. Scales cycloid, small, 61–72 in lateral line (58–76 in northwestern Canada, McPhail and Lindsey 1970), radii on all fields; lateral line straight or nearly so, complete. Peritoneum silvery, speckled with brown. Swim bladder not usually well developed in adults (Gee and Northcote 1963), extending only to about origin of pelvic fins. Vertebrae 37–41 (McPhail and Lindsey 1970, gave range of 40–42). But *see* vertebral variation with latitude in the table below.

Colour Colour of the back varies from olive-green to brown, shading to cream or silvery white on the belly; dark dorsal colour often ceasing abruptly below midpoint of sides. In lakes, the back is generally greyish. Sometimes there is a faint mottling formed by scattered, darkened scales, which are usually confined to midlateral pigmented area. Often a dark stripe ahead of the eye. Dark lateral line from gill cover to caudal base on fish from some areas, or only on posterior half on others, or may be absent, except on young which have a distinct lateral stripe from snout to tail.

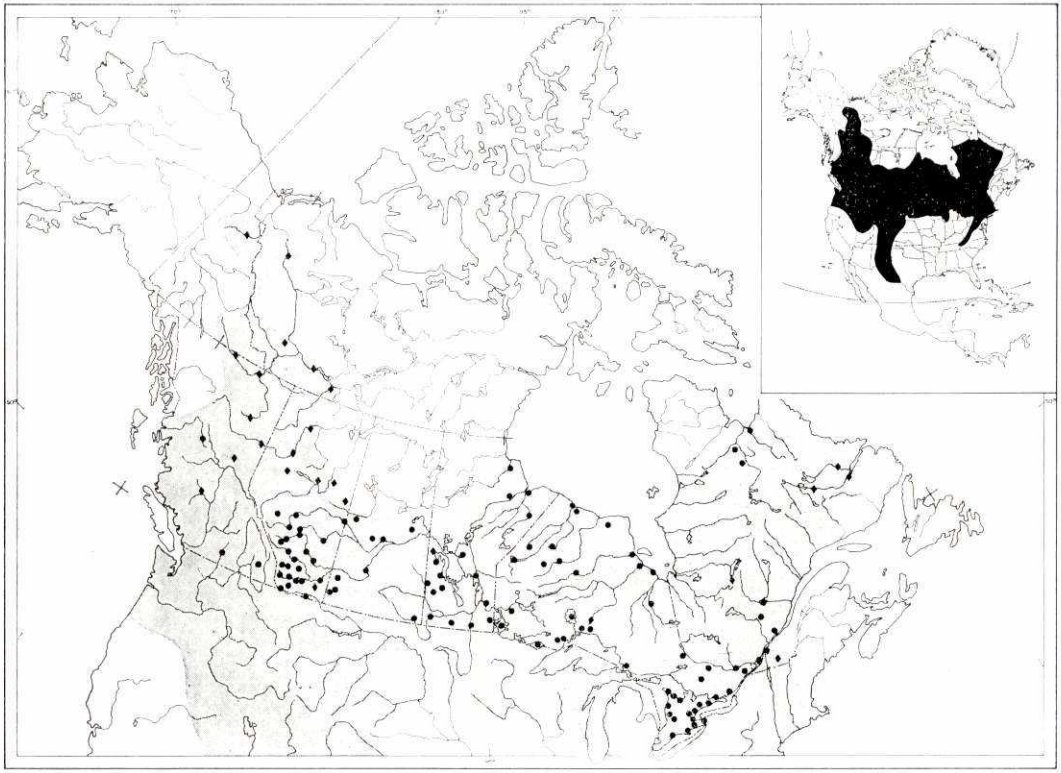
Breeding males in southern Ontario waters display an orange-red colouration on the corners of the mouth, spreading lightly onto cheeks, also in the posterior axils of the pectoral fins, a trace on the pelvics, and sometimes along the anterior base of anal fin. Keleher (1952a) noted that 10 specimens from Lake Winnipeg exhibited bright orange tinge on pectoral fins and premaxillaries.

Systematic notes The reduced size of the swim bladder in adult longnose dace has been known for many years, but it appears that there is much variation in the degree of its development from population to population. The failure of most adults to develop normal swim bladders was discussed by Bailey and Allum (1962), Gee and Northcote (1963), and McPhail and Lindsey (1970) (*see* these references for further information).

As noted by Radforth (1944), an understanding of the zoogeography of the longnose dace must await a systematic study of the species throughout its range. Such a study has still not been made. Note relatively low vertebral counts for Alberta specimens ROM 25921, given in *Description*.

Distribution The longnose dace is widely distributed from coast to coast in north-central North America. In the east, it occurs south along the mountains to Virginia; in the Mississippi drainage south to Iowa; and in the western basin south to northern Mexico; recently reported from northeastern

°N		ROM cat. no.	Vertebrae 37	38	39	40	41	42
43	Ont., Dufferin Cr.	24072		3	6			
45	Que., Rigaud R.	24021		4	4			
46	Ont., Stokely Cr.	16237			4	6		
51	Man.,Steeprock R.	18443			5	4	1	
57	Que., Whale R.	22533			2	1		
60+	McPhail and Lindsey (1970)					×	×	×
49	Alta., Bow R.	25921	1	3	4	2		



Nevada (Moore 1968). It occurs in the inshore waters in all the Great Lakes.

In Canada the species is found in swiftly flowing streams and also in lakes, from Labrador; the upper St. Lawrence River and Ungava drainages (Koksoak and Whale rivers) of Quebec; throughout the Great Lakes area, north to Hudson Bay in Ontario; common and widely distributed in Manitoba, Saskatchewan, Alberta; throughout most of British Columbia, from the Fraser and Columbia River systems north to the Peace and Liard rivers, and on the Pacific slope north to the Skeena River system. It occurs through the Mackenzie River system of Alberta, the Northwest and Yukon territories, to the Arctic Circle. Previous reports of its occurrence in New Brunswick were shown to be unverified by Scott and Crossman (1959). Neither does it occur in Nova Scotia nor Prince Edward Island.

The extremely wide range of the longnose dace creates a number of interesting zoogeographic problems. Radforth (1944) suggested an eastern postglacial refugium as well as a Mississippi one. McPhail and Lindsey (1970) suggested the Pacific region as a possible third refuge to survive glaciation. Its peculiar distribution in eastern Canada was discussed by Power (1965), who noted its apparent absence east of the Saguenay River in Quebec, yet its presence in the Ungava drainage of far northern Quebec suggests that if its absence from the interior is real, then the Ungava and Labrador populations must have survived from the period of the climatic optimum of some 4000–6000 years ago.

Biology Little has been written about the spawning habits of the longnose dace, which seems strange considering it is one of our most wide-ranging minnows. Spawning is usually considered to begin in May, June, or early July. (McPhail and Lindsey 1970 noted that it may continue into late August in Kananaskis Lake, Alta.) Carl et al. (1967)

noted that ripe males and females were taken at a temperature of 53° F (11.7° C) in the Nicola River drainage, British Columbia, June 7, 1956, and Dymond et al. (1929) reported ripe males and females taken at the mouth of the Credit River, Lake Ontario, July 16, 1927. Dymond (1926) gave June and July as the times of spawning in Lake Nipigon.

Spawning probably occurs in riffles over a gravelly bottom, but, on occasion, spawning must occur near or over the nest of the river chub, *Nocomis micropogon*, since hybrids have been reported. Indeed, this hybrid enjoyed the distinction of specific identity, *Rhinichthys bowseri* Goldsborough and Clark. (*See* Raney 1940b, for a complete account.) Hybridization with *Richardsonius balteatus* has also been reported (Carl et al. 1967), and with *Couesius plumbeus* (Hubbs and Lagler 1949). McPhail and Lindsey (1970) suggested that, although no nest is built, a territory is established and one parent guards the nest. They noted that in Manitoba, females laid 200–1200 transparent, adhesive eggs that hatched in 7–10 days at 60° F (15.6° C). The yolk sac is absorbed about 7 days after hatching and the young then rise to the surface and inflate the posterior lobe of the swim bladder. Fish (1932) described the photophore pattern of the larvae and figured a 13.7-mm specimen. The young are pelagic, unlike the adults, and inhabit quiet waters near shore. McPhail and Lindsey noted that the pelagic stage lasts about 4 months before the typical bottom-dwelling existence of the adults commences.

Apparently the longnose dace grows rather slowly. In Minnesota, they have been reported to grow to total lengths of 1.9 inches (48 mm) by age 1, 2.4 inches (61 mm) by age 2, 2.9 inches (74 mm) by age 3, 3.4 inches (86 mm) by age 4, and 3.9 inches (99 mm) by age 5 (Kuehn 1957). Scales were used for age determination. Hubbs and Lagler (1949) reported 7-inch (178-mm) specimens from Isle Royale, Lake Superior, Ont.

The longnose dace is characteristic of clean, swiftly flowing, gravel or bouldery streams, at times inhabiting very turbulent waters. They also occur in inshore waters of lakes over boulder or gravel bottoms. In warm lakes they may move offshore into deep water during the heat of summer as noted by Trautman (1957) for the Ohio waters of Lake Erie, but such offshore movements cannot be ascribed without modification to the Ontario shore east of Long Point, for, during investigations in 1946–1949, we seined longnose dace from sand–gravel–boulder beaches through June, July, and August.

The longnose dace is a benthic or bottom-living species and, hence, its food habits are directly related to bottom-living organisms. Dymond (1926) noted that chironomid larvae were the main food items in Lake Nipigon and one longnose dace had eaten eggs of another fish, presumably the trout-perch. Carl et al. (1967) gave midge larvae as the main food in British Columbia, supplemented by other aquatic insect larvae. Reed (1959) examined stomachs of 796 adults from Pennsylvania waters and reported that nearly 90% of the food consisted of adult or immature stages of blackflies (Simulidae), midges (Chironomidae), and mayflies (Ephemeroptera). The most comprehensive published food study of this species is that of Gerald (1966) for the Yellowstone River in Montana. He studied the diet for all sizes to 100 mm, from early July to September. He concluded that availability and abundance of the food organisms were the primary factors governing diet; simulid larvae, being in the fast-flowing water, were eaten mainly by the larger dace since the swift current would be a deterrent to small dace.

Bangham and Hunter (1939) examined 51 specimens of longnose dace from Lake Erie and found 17 infected variously with the trematodes *Neascus rhinichthysi* and *Leboura cooperi* and the nematode *Camallanus oxycephalus*.

Bangham and Adams (1954), working with the species from the Columbia and Peace River drainages, found that 27 of 44 longnose dace were parasitized, but stated that the species frequently had few parasites.

Bangham (1955) reported the encysted larval form of the trematode *Posthodiplostomum minimum* in the five fish examined from

Pleasant Creek, near South Bay, Manitoulin Island, Ont.

Hoffman (1967) listed various forms of trematodes, nematodes, the protozoan *Cryptobia* sp., molluscan glochidia, and the crustacean *Lernaea cyprinacea* from longnose dace in unspecified North American waters.

Relation to man Despite its wide range and availability, the longnose dace is not, to our knowledge, a commonly used bait species in Canada, possibly because of its drab colouration and its intolerance of the still water of minnow pails. However, it is widely used as a bait fish in various parts of the United States. Simon (1946) remarked that it was of great value as a forage fish in Wyoming, and Iowa authorities stated that it was widely used in that state as bait for bass and catfish. Dobie et al. (1956) reported that it has been propagated at least once in Minnesota in long, narrow ponds having a weak flow of water.

Nomenclature

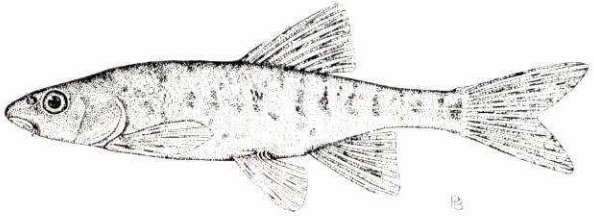
Gobio cataractae	— Cuvier and Valenciennes 1842: 315 (type locality Niagara Falls)
Rhinichthys marmoratus	— Agassiz 1850: 354
Argyreus nasutus	— Cope 1869: 369
Rhinichthys cataractae	— Jordan and Evermann 1896–1900: 306

Etymology *Rhinichthys* — snout; fish — the snout being prominent; *cataractae* — of the Cataract, the original type being from Niagara Falls.

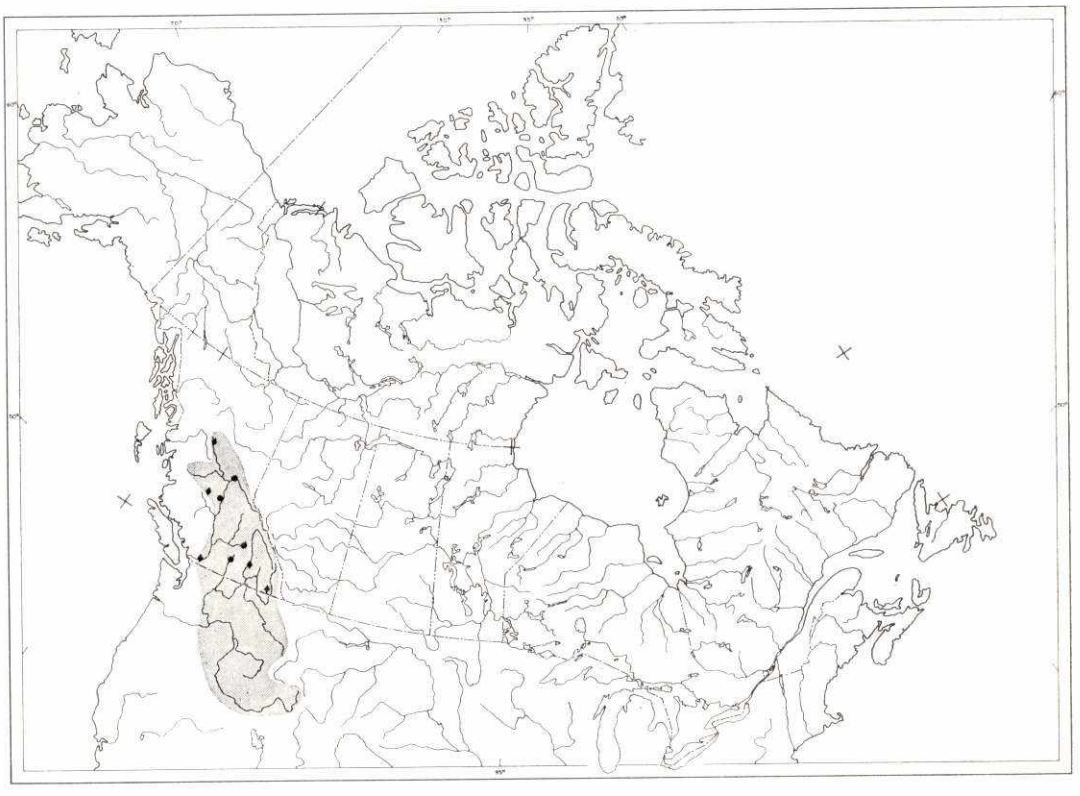
Common names Longnose dace, long-nose dace, long-nosed dace. French common name: *naseux de rapides*.

LEOPARD DACE

Rhinichthys falcatus (Eigenmann and Eigenmann)



Description Body elongate, total length averaging about 3 inches (76 mm), body distinctly heaviest before dorsal fin, somewhat compressed laterally, its depth 14.8–18.2% of total length; caudal peduncle very slender, distinctly compressed laterally. Head triangular, its length 19.1–21.7% of total length; eye diameter 20.0–27.7% of head



length; snout bluntly rounded, its length 31.3–36.8% of head length, slightly overhanging mouth; interorbital moderate, its width 26.6–30.0% of head length; mouth small, nearly horizontal, with a rather conspicuous barbel at each corner of the mouth; pharyngeal teeth usually 2,4–4,2. Fins: dorsal 1, trailing margin of fin slightly concave (i.e., fin sickle-shaped), origin of dorsal scarcely behind origins of pelvic fins, rays 9; caudal deeply forked, attached to a slender caudal peduncle; anal 1, its origin slightly in advance of dorsal fin insertion, rays 7; pelvics uniquely equipped with fleshy stays joining base of fin rays to surface of body, rays 8; pectorals rather small, more or less rounded, rays usually 14, range 13–15. Scales cycloid, radii absent on basal field, 52–57 in lateral line; lateral line complete, almost straight. The swim bladder is rather well developed (*see* Gee and Northcote 1963, for details). Vertebrae 38–40.

Fine tubercles developed on top of head, over back and sides, and on the upper surface of the pectoral fins (one male, ROM 18575, taken in the Nechako River, clearly shows fine tubercles on rays of pectoral fins, although none were observed by Gee and Northcote 1963).

Colour A light-coloured dace, creamy on the sides, somewhat darker on the back, especially on head where darker colouration extends to below the eye; and silvery white below; sides marked with many large (covering 4–8 scales) irregularly shaped spots. Yellowish tinge on fins. On breeding males, the lips and base of pelvic fins are orange-red according to Carl et al. (1967). Gee and Northcote (1963) observed this high colouration in all seasons.

Distribution The leopard dace occurs in the Fraser River system, and in the Columbia River basin east of the Cascade Mountains.

In Canada, it is known only from British Columbia. It occurs in Okanagan Lake, Lower Arrow Lake, Pend Oreille River, and possibly Similkameen River (Columbia system), and from various lakes and rivers in the Fraser River system. For details *see* Carl et al. (1967).

Biology The spawning habits of the leopard dace appear to be unknown but, by examining gonads, Gee and Northcote (1963) concluded that spawning occurred early in July.

These authors also used the length–frequency method to distinguish age-groups and calculated the following age–fork length relation: age 0 in August, 9–18 mm; age 1 in June, 18–36 mm; age 2 in June, 44–61 mm; age 3 in June, 60–80 mm; age 4+, 80–120 mm. They also concluded that females were heavier and slightly longer than males.

When leopard dace occur in the same river systems as the longnose dace, the two species have quite different current-flow preferences: *falcatus* prefers slow-moving currents, probably less than 0.5 metres/second, and the longnose prefers more rapid water.

Young-of-the-year feed almost entirely on dipterous larvae whereas yearling dace feed primarily on aquatic insect larvae (Ephemeroptera and Diptera predominate), especially during June and July. By September, these yearlings will switch to a diet of terrestrial insects. Adult dace age 2 and older, also eat aquatic insect larvae (Ephemeroptera and Diptera), some terrestrial insects, and also earthworms (*Lumbricus*) displaced from the soil by high water. *See* Gee and Northcote for a discussion of the differences in food and habitat of leopard and longnose dace.

The parasites of the leopard dace have apparently not been studied.

Relation to man It is not possible to evaluate the importance, if any, to man since we have so little information, but we know of no commercial importance associated with the leopard dace.

Nomenclature

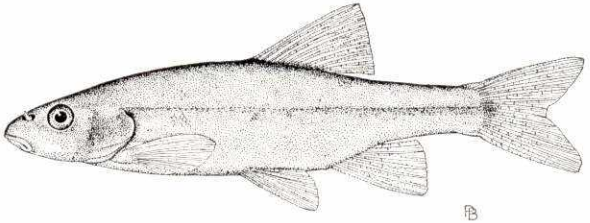
Agosia falcata	— Eigenmann and Eigenmann 1893a: 153 (type locality Boise River, Caldwell, Idaho)
Agosia shuswap	— Eigenmann and Eigenmann 1893a: 154
Apocope falcata (Eigenmann and Eigenmann)	— Jordan, Evermann, and Clark 1930: 141
Rhinichthys falcatus (Eigenmann and Eigenmann)	— Carl and Clemens 1948: 80

Etymology *Rhinichthys* — snout; fish — the snout being prominent; *falcatus* — sickle-shaped.

Common names Leopard dace, silvery grey minnow. French common name: *naseux léopard.*

SPECKLED DACE

Rhinichthys osculus (Girard)



Description Body elongate, 2–3 inches (51–76 mm) total length, greatest depth in front of dorsal fin, rather heavy bodied anteriorly, but distinctly compressed laterally behind dorsal fin, greatest body depth 15.8–20.0% of total length. Head bluntly triangular, a small but distinct hump behind the head, head length 21.1–24.1% of total length; eye moderate, its diameter 20.5–24.7% of head length; snout long and distinctly overhanging mouth; interorbital relatively narrow, its width 22.3–32.4% of head length; mouth inferior, sucker-like, lower jaw with fleshy lip, overhung by snout, extending back to about midnostril, 1 maxillary barbel at each corner of mouth in United States specimens but not on Canadian specimens, upper lip protractile, free from snout; pharyngeal tooth count variable throughout range, in Canada 1,4–4,1 to 2,4–4,2. Fins: dorsal 1, its origin distinctly behind pelvic fin origin, posterior margin straight, rays 8 or 9; caudal forked, lobes rounded; anal 1, its origin about under posterior base of dorsal fin, rays 6 or 7; pelvic fins relatively small, rounded, rays 8 or 9; pectorals small, rounded, rays 13 or 14. Scales cycloid, about 55–75 in lateral series; Carl et al. (1967) said 55–58 in British Columbia; lateral line complete, or terminating before base of caudal fin. Peritoneum uniformly dark brown or with darker patches. Vertebrae 37 or 38.

Colour Overall colouration grey or grey-brown with scattered and vague darker flecks, usually above midline of sides; lower sides and belly somewhat yellowish or creamy white. A faint lateral band beginning weakly under dorsal fin and extending onto caudal peduncle, terminating with a diffuse spot on caudal fin base; this spot and the lateral band are more conspicuous on young fish. Sigler and Miller (1963) reported that an orange-red colouration appeared about mouth, upper part of gill opening, anal base, and lower caudal lobe of spawning males in Utah, but such colours have not been reported for Canadian populations.

Distribution The range of the speckled dace is restricted to western North America, where it occurs in Pacific watersheds from the Columbia River south to the Colorado River system, and coastal streams and interior waters of southern California. It occurs also in the Chehalis River and in the Deschutes and adjacent rivers in Washington State (McPhail 1967). It is reported to be abundant in Wyoming, New Mexico, and the lower Colorado River (Miller 1952).

In Canada the species has been reported from only three localities along the Kettle River of the Columbia system in extreme south-central British Columbia at 49°N lat, 118°W long.

Biology Throughout its United States range, the speckled dace inhabits greatly diverse habitats and exhibits great differences in the morphological and meristic characters

usually used to distinguish species. It seems likely that the form known as *Rhinichthys osculus* may include more than one species. For example, La Rivers (1962) treated four named subspecies for Nevada. Since we do not have detailed information on the biology of the British Columbia population, it would be misleading to suggest that the characteristics of speckled dace in Nevada or Utah could be applied. Carl et al. (1967) noted that in the Similkameen River, B.C., *R. falcatus* exhibited characters approaching those of *R. osculus*, and further that nothing seemed to be known of the life history, presumably of the northern populations, of speckled dace.

A variety of parasites, including protozoans, trematodes, nematodes, crustaceans, and molluscan glochidia were listed by Hoffman (1967) for the speckled dace, presumably from various populations in the United States.

Relation to man The speckled dace is of some importance as a forage species and is also widely used as a bait fish, in various parts of the western United States, although Miller (1952) questioned its suitability for bait because of its small size. According to Simon (1946) it is an important bait species in Wyoming.

It is not regarded as an important species in Canadian waters because of its limited occurrence.

Nomenclature

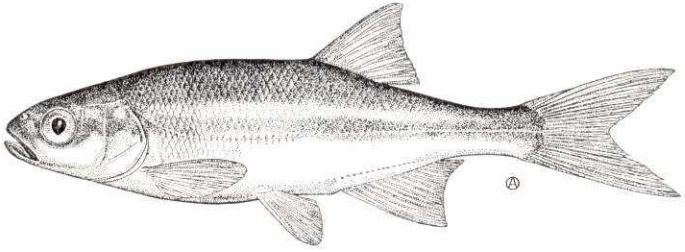
Argyreus osculus	— Girard 1857a: 186 (type locality tributary of Rio San Pedro, Ariz.)
Agosia oscula (Girard)	— Jordan and Evermann 1896–1900: 309
Apocope oscula (Girard)	— Jordan, Evermann, and Clark 1930: 141
Rhinichthys nubilus (Girard)	— Miller 1952: 30
Rhinichthys osculus (Girard)	— Carl, Clemens, and Lindsey 1967: 123

Etymology *Rhinichthys* — snout; fish — the snout being prominent; *osculus* — small-mouthed.

Common names Speckled dace. French common name: *naseux moucheté.*

REDSIDE SHINER

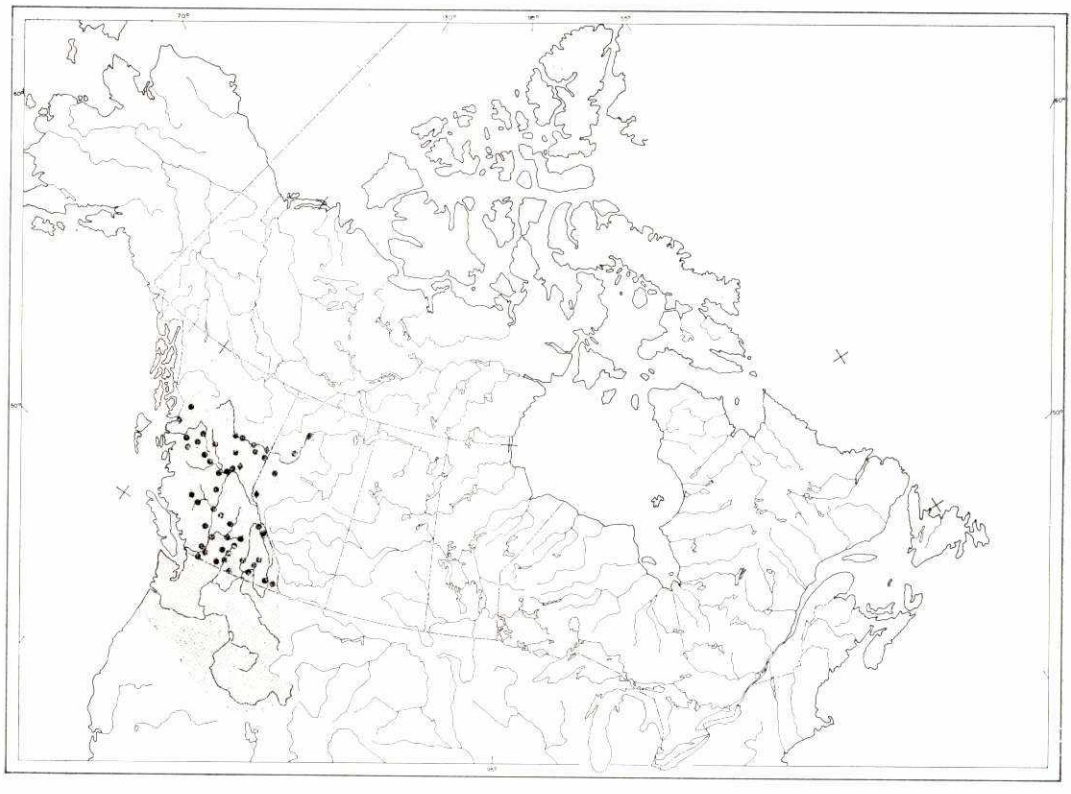
Richardsonius balteatus (Richardson)



Description Body variable but moderately deep, greatest depth, between paired fins, 20.8–24.7% of total length, moderately compressed laterally; caudal peduncle twice as long as deep; adults usually 3–5 inches (76–127 mm) in length. Head long, 18.0–20.5% of total length, wide, interorbital width 34.2–40.6% of head length; eyes large, diameter 25.5–33.3% of head length, forward of centre of head; snout moderately long, 28.5–34.2% of head length, about equal to eye diameter, bluntly pointed; mouth moderately large, maxillary extending almost to anterior edge of orbit, terminal and only slightly oblique; pharyngeal teeth in several combinations but usually 2,5–5,2, 2,5–4,2, without grinding surfaces, anterior tooth on left often shorter than others, remote from them and dagger-shaped. Gill rakers are short and stubby, 6–9 on first arch. Fins: dorsal 1, moderately large, at midpoint of body, origin well in advance of origin of anal fin, but behind insertion of pelvic fins, base length less than height, edge little curved, rays 8–12, usually 10; caudal long, deeply forked, tips pointed; anal 1, with long base but height about equal to base length, edge markedly falcate, number of rays high but extremely variable, usually 15, 13–18 in specimens examined, but 10–24 in Canada according to the literature, anal ray number often different between sexes in the same population; abdomen near anal fin somewhat keeled; pelvics abdominal, low, small, tips rounded, 8 or 9 rays; pectorals larger than pelvics, above ventral surface, tips with rounded points, 13–16 rays. Both pelvic fins and pectoral fins longer in males than in females. Scales cycloid, small, 52–67 in lateral series; lateral line complete, beyond pectoral fins straight and at midbody. Peritoneum pale, silvery, lightly speckled with black; intestine long and coiled. Vertebrae 38–43.

Nuptial tubercles on males only, on head and upper surface of paired fins.

Colour Dorsal surface of body and head steely blue, olive, or dark brown to black. On the flanks, below the countershading of the dorsal surface, is a narrow unpigmented band from operculum to dorsal fin. Below this, in the middle of the sides, is a dark band extending from snout to caudal peduncle, broadest below dorsal fin and often inconspicuous from head to tip of pectoral fins. Body below lateral band bright silver and ventral surface silver or white. Fins clear, amber to dusky. Eye with black pupil, a narrow, gold ring and white beyond, with pigmented patches carrying the lateral band through the eye. Both sexes more highly coloured at spawning time. The female is then a golden colour above and below the lateral band and on the head. The male is more strikingly coloured with a band of yellow between the dorsal countershading and the more intensified, dark lateral band. Below the lateral band is a broad stripe of orange to



crimson from the operculum to the anal fin, the lower part of the body is yellow, as is most of the head below the eye. The lower fins are a bright yellow, especially in males.

Systematic notes The great variation in anal fins in different localities over the range of this species and the possible correlation to subspecific entities, and such parameters as sex, latitude, altitude, and temperature have intrigued workers since Eigenmann in 1895 (Lindsey 1953; Weisel 1961). The variation in anal rays led to the designation of several species or subspecies including *balteatus*, *gilli*, *montanus*, *lateralis*, *thermophilus*, *hydrophlox*, and *siuslawi*. It is generally conceded now that only two main forms exist in the west, *R. balteatus* (10–24 anal rays) and *R. egregius*, the Lahontan redside (8 or 9 anal rays) (McPhail and Lindsey 1970).

Redside shiners are known to hybridize with northern squawfish, longnose dace, and peamouth chub.

Distribution This species is restricted to North America and occurs mainly west of the Rocky Mountains. It extends from the Peace River in northwestern Alberta throughout much of British Columbia from the Nass River south, coastal streams of Washington and Oregon, the Columbia River basin, the Malheur basin in Oregon and in the Bonneville River basin of Washington, Oregon, Idaho, Montana, Nevada, and Utah. Introduced into the Colorado River.

In Canada, it occurs in the Wapiti River system (Peace River) of Alberta south almost to Vermilion, west through British Columbia including the upper reaches of the Nass, Skeena, Klinaklini and Homathko rivers and the entire Fraser, and Columbia River systems; absent from Vancouver Island and other coastal islands.

Biology Contrary to the case for so many species, much is known of the biology of this cyprinid in Canada, largely as a result of interest in its morphological variability and ecological impact on trout. For detailed accounts, *see* Lindsey and Northcote (1963), Johannes and Larkin (1961), Crossman (1959a, b), Crossman and Larkin (1959), and Lindsey (1953). The following is largely from Lindsey and Northcote.

Spawning takes place in groups of 30–40 fish, in streams or in lakes, over a 7- to 10-week period from May to late July or early August. Adults move into spawning streams in the afternoon and evening as soon as stream water temperature exceeds 50° F (10° C). There is apparently a strong homing tendancy. Males arrive earlier than females. In streams, spawning takes place in riffles where water is as shallow as 4 inches (102 mm), during day and night. During spawning a female and one or two males thrash violently side by side for about 2 seconds. No nest is built. Egg number for females ranges from 829 to 3602. The eggs, which are released in lots of 10–20 at each spawning act at irregular intervals, are demersal and adhesive and adhere to the bottom gravel or vegetation. Eggs are 1.9–2.2 mm in diameter and have a pale yellow yolk. Hatching takes place from 3 days at 69.8° F (21° C) to 15 days at 53.6° F (12° C). At hatching, fry are 5.3 mm total length and lie dormant on the bottom, feeding on the yolk for a week. In areas where stream spawning takes place, the fry are carried downstream at night by the stream current, about 10 days after hatching. They are in a very immature state when they reach the lake so they must be displaced very soon after hatching. By 10 days, when they begin feeding, they are 8.7 mm long. Age determination by scales is apparently difficult and uncertain. Size frequencies have been used but these yield only approximate results as growth rates differ greatly from year to year and from one location to another. An approximation of age–fork length relation at midsummer for Sixteen Mile Lake, B.C., is shown in the following table.

Age	FL	
	(inches)	*(mm)*
0	0.2–0.4	5–10
1	1.0–2.1	25–55
2	2.1–2.7	55–70
4+	4.3+	110+

An individual from Shumway Lake, B.C., 6.7 inches (170 mm) in total length, was judged to be 6 or 7 years of age. Females grow faster and live longer, so most of the very large and old individuals are females. Maximum age varies from place to place but probably does not exceed 7 years. Maximum size is 7 inches (180 mm) but most individuals are 3–5 inches (76–127 mm) in length. They appear to attain larger sizes in British Columbia than in areas to the south.

Sexual maturity is apparently first attained in the third year. In any summer the same mature individuals, particularly males, may return to the spawning grounds more than once, may spawn several times in one season and the production of eggs and sperm may be more or less continuous (Weisel and Newman 1951). As high as 46% of the spawners of any single year live to spawn again the following year, and some may survive to spawn even a third time.

This minnow occurs, often in schools numbering in the thousands, in large lakes, moderately fast streams, and small ponds, with widely varying temperature and trophic conditions. In lakes there is a vertical and horizontal stratification of sizes, the smallest are highest and closest to shore. In the daytime in summer, shiners are found only inshore, over shoals (2–12 feet deep) that have heavy growths of food-producing, rooted vegetation. They are rarely seen more than 25 feet beyond these shoals except at night when they move out in the top layer of the deeper water, often to the centre of the lake. Other than spawning migration, there appears to be little directed movement, except for a seasonal one, on and off the shoals in response to water temperatures. Upper lethal temperature for this species has been calculated as 77° F (25° C) when the fish were acclimated at 48°–52° F (8.9°–11.1° C).

Redside shiner fry feed on diatoms, copepods, ostracods, and other small planktonic and demersal crustaceans. Larger shiners are

mainly insectivorous, and they consume terrestrial insects such as beetles and ants that fall to the surface of the water but consume mainly adult and immature forms of most aquatic insects; algae; molluscs; fish eggs; and small fishes including other redside shiners, other minnows, and trout. Egg predation by redside shiners may be one of the most limiting factors on the survival of their own eggs. They are active foragers, working right into the vegetation for food, and often crop off food organisms at sizes too small for other more economically important species (such as trout) to utilize.

This species is preyed on by a variety of fishes including rainbow trout, cutthroat trout, probably Dolly Varden, and squawfish; by many fish-eating waterfowl such as mergansers and loons; and by mink if not other mammals. Redside shiners are serious competitors for food and space with species of trout.

Incidence of parasitism is often very high in the dense schools of this species, both in variety and number. Older fish are often bloated by the presence of one or more large cestodes, *Ligula intestinalis*. Parasites appear often to be both a direct and an indirect cause of death. Redside shiners bearing large *Ligula* move more slowly or tumble down through the water and more easily fall prey to trout. Bangham and Adams (1954) examined 1532 specimens of redside shiners from the Columbia, Fraser, Skeena, and Peace River drainages, and found 1493 heavily infected. Many varieties of trematodes, cestodes, crustaceans, nematodes, acanthocephalans, etc., were identified. Hoffman (1967) listed the following for the species throughout its range: Trematoda (11), Cestoda (5), Nematoda (6), Acanthocephala (1), Mollusca (1), Crustacea (1).

Relation to man The interest in this species, which has led to a great deal of study and which, in effect, constitutes a statement of its relation to man, was succinctly expressed by Lindsey and Northcote (1963) as follows: "It has received attention from some biologists because of its spectacular but puzzling morphological variation, and from others because of its well-documented impact on sport fisheries for rainbow trout. It has so far defied most attempts of the former to rear it, and of the latter to eradicate it."

In lakes where it has accidentally entered a habitat previously exploited by trout alone it has had serious effects on the growth rate and production of the trout. The redside shiner in lakes like Paul Lake near Kamloops, B.C., can develop populations as high as 5000–100,000 per acre and then constitute a minor predator on, a serious competitor of, and a substantial food for rainbow trout. The effect on the trout population has led to costly and disruptive attempts at chemical eradication, which destroy the existing trout also. This leads to the requirement for extensive fish cultural support to renew the fishery. The Paul Lake example of the drastic consequences of such an introduction was dealt with in detail by Larkin and Smith (1954), and by the authors listed at the beginning of this species account.

Nomenclature

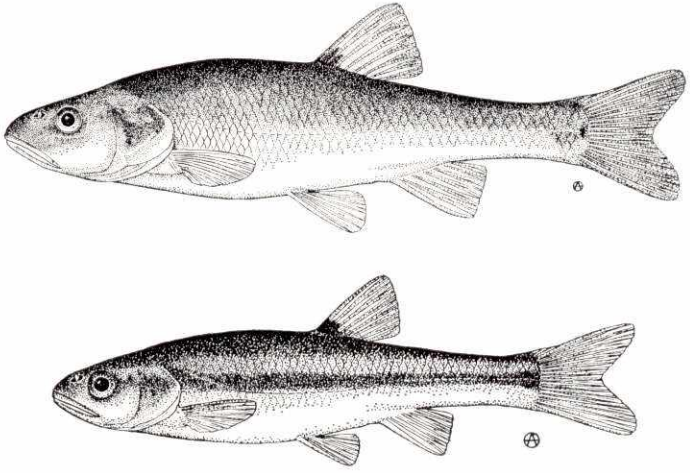
Cyprinus (Abramis) balteatus (Rich.) — Richardson 1836: 301 (type locality Columbia River)
Richardsonius balteatus — Girard 1857a: 202
Richardsonius lateralis — Girard 1857a: 202
Abramis lateralis — Günther 1868: 309
Abramis balteatus — Günther 1868: 309
Leuciscus balteatus (Richardson) — Eigenmann 1895: 112
Leuciscus balteatus lateralis (Girard) — Eigenmann 1895: 113

Etymology *Richardsonius* — after Sir John Richardson, surgeon–naturalist with the Franklin expeditions, who first described it; *balteatus* — girdled.

Common names Redside shiner, red-sided bream, Columbia River minnow, Richardson's minnow, silver-sided minnow, shiner, silver shiner. French common name: *méné rose.*

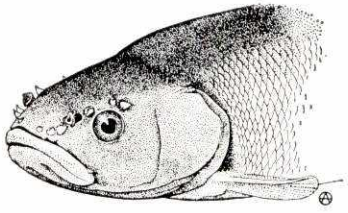
CREEK CHUB

Semotilus atromaculatus (Mitchill)



Description Body thickset, robust, average length to about 4 inches (102 mm), not noticeably compressed laterally except caudal peduncle, greatest body depth at about tip of depressed pectoral fin 17.0–26.1% of total length. Head broad, heavy, its length 21.4–25.3% of total length; eye relatively small, its diameter 15.1–26.6% of head length; snout moderate to large, 29.1–36.6% of head length, upper lip projecting slightly beyond lower or equal; interorbital broad, its width 35.2–44.5% of head length; mouth large, gape wide, upper jaw reaching to a point below pupil, upper and lower lips thick, lower not included but upper lip projecting slightly or equal; premaxillaries protractile, a flaplike barbel located in groove between maxillary and premaxillary, in advance of posterior end of maxillary, seldom absent; pharyngeal teeth usually 2,5–4,2 but variable, 2,4–4,2, 2,4–5,2, strong, hooked. Fins: dorsal 1, its origin slightly behind pelvic fin origin, small, rays almost always 8(93), rarely 9(2), a distinct and obvious black spot at base of first 3 rays; caudal slightly forked, lobes rounded; anal 1, small, unpigmented, its origin slightly overlapped by free margin of depressed dorsal fin, rays 8(92), rarely 7(1), or 9(1); pelvics small, origin slightly in advance of dorsal origin, rays 8(30); pectorals small, rounded, rays usually 17(13), 16(10), or 15(4), seldom 13(1), 14(1), or 18(1). Scales cycloid, persistent; lateral line usually complete, sometimes interrupted, scales 53–61. Peritoneum silvery with light speckling; intestine short, a single loop.

Vertebrae usually 42(28) or 43(14), but sometimes 40(9) or 44(4), seldom 39(1) or 40(1). There appears to be a tendency for counts to be slightly higher in western populations.



Nuptial tubercles large, sharp, and well developed on head and dorsal surface of pectoral fins of males. On head, 6–10 or 12 on each side, extending backward from upper lip, in a single line on each side of head, in line with nostril, and arching over orbit, small but well-developed tubercles on opercle, extending onto opercular membrane, tubercles on first 6–8 rays of pectoral fin, in single row.

Colour Back olive to olive-green, silvery on the sides and silvery white below. The sides often show violet or purple iridescence. There is a conspicuous and characteristic black spot at the anterior base of the dorsal fin.

Breeding males usually have a rosy cast but may also exhibit tints of orange, yellow, blue, and purple on the body, especially on sides of head and body, and sometimes on fins. The young (*see* lower illustration p. 507) are silvery in appearance, are not noticeably compressed laterally, and have a narrower lateral band than fallfish (*S. corporalis*), which commences behind the eye and terminates in a small discrete spot on caudal fin base (Hubbs and Cooper 1936).

Systematic notes Two subspecies have been described for the creek chub. The typical subspecies, *S. a. atromaculatus* (Mitchill), is considered to occupy all of the range except in the extreme southeastern United States, where the species is represented by *S. a. thoreauianus* Jordan. Bailey et al. (1954) considered that the difference in scale size, which was the major distinguishing feature, was clinal in nature and that subspecific distinctions were unwarranted.

Natural hybrids in the following combinations have been reported: *Clinostomus elongatus* × *S. atromaculatus* (Greene 1935), *Notropis cornutus* × *S. atromaculatus* (Raney 1940a; Greeley 1938).

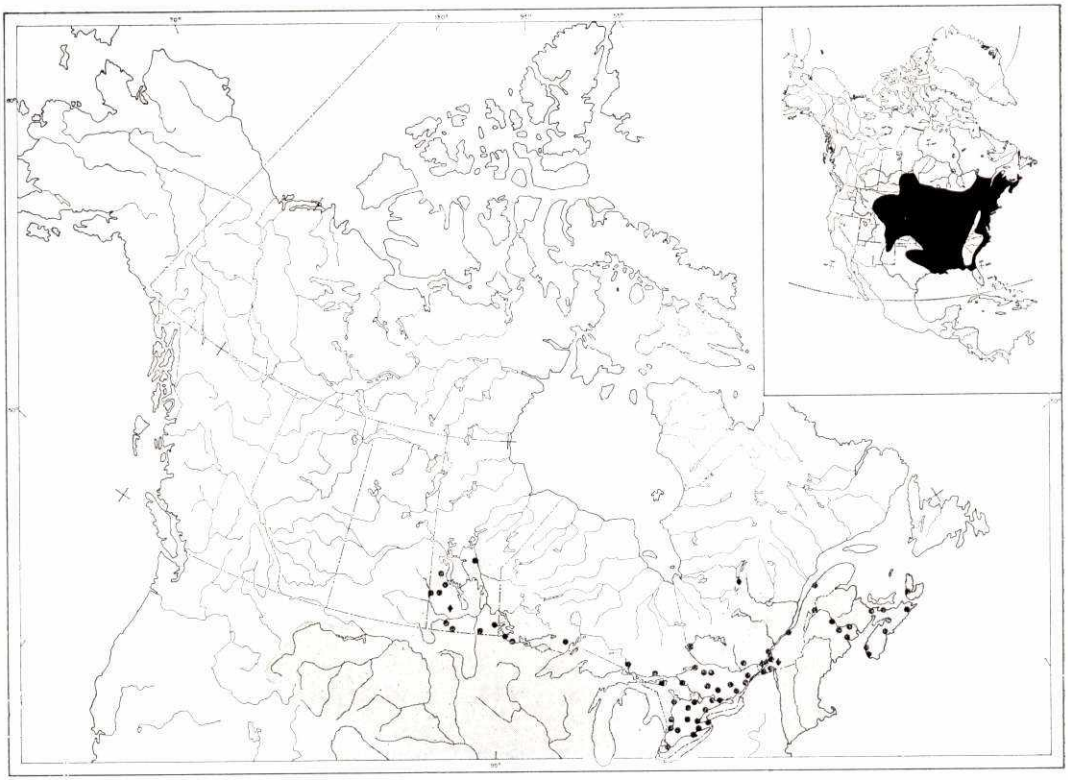
Distribution The creek chub is found in small clear brooks from the Gaspé Peninsula to Montana, south on both sides of the Appalachian Mountains to Georgia and the Gulf states, southwesterly to northeastern Texas, and New Mexico. Not to Alberta nor to Newfoundland as reported by Carlander (1969).

In Canada it is widely distributed in many lakes and streams throughout the eastern and central portions. Common in Nova Scotia, except on the plateau of northern Cape Breton, wide ranging in New Brunswick in all major river systems north to and including the Miramichi and probably including the Restigouche River system; in Quebec from Gaspé west in the St. Lawrence drainage system and in the Saguenay River system including Lake St. John, and the James Bay drainage of Rupert River, Lake Wakonichi, where it was common in 1944. It occurs throughout Ontario in suitable habitats, north to the Algoma District, and in the Rainy River District, but not in region north of Lake Superior.

It reaches its western limit in Canada in the Assiniboine River in Manitoba. Collected in western tributaries in lakes Manitoba, Dauphin, Swan, and Winnipegosis, and tributaries of the Red and Assiniboine rivers, but not east of Dominion City.

Biology The creek chub is probably the most common stream minnow in eastern North America and one that has been widely used for bait, hence, its life history has received considerable attention.

Spawning occurs in the spring, usually beginning at temperatures of 55° F (12.8° C) and above. Spawning sites are most often selected in rather small, gravelly streams in smooth water just above or below a riffle. The male creates a pit or depression in the stream



bottom by vigorously swimming against the bottom, and by picking up stones in his mouth and carrying them a short distance upstream. By excavating downstream and depositing upstream, he digs a trench that is constantly being filled in. Spawning occurs in the pit, the eggs dropping quickly to the bottom and then being covered with stones carried from the downstream end of the pit. The trench or pit is usually 10–12 inches wide and may be many feet long. The male spawns with several females, meanwhile continuing to expand the trench downstream and cover it and the eggs upstream, and, of course, guarding the nest against invading males at all times. When spawning is completed the eggs are thus buried under the stones and gravel and the completed nest appears as a long gravel ridge.

Each nest is usually the work of one male but in large streams with good gravel substrate, there may be several nests side by side.

In Canada spawning occurs during May and June and into July but surprisingly few observations have been published. Richardson (1935) considered spawning to have been mainly completed by mid-June in the eastern townships of Quebec.

The spawning act was fully described in a classical paper by Reighard (1910). The female approached the pit of the nest, the male remained near the bottom. Eventually, the female approached the male who reacted, in Reighard's words, as follows: "Usually when she has come near enough, the male gets his head and his expanded pectoral fin of one side beneath her, and then with a movement often too rapid to be followed by the eye, he tosses her into an upright position and at the same time encircles her body with his own." This brief embrace requires only about a tenth of a second, and is made possible by the tubercles on the pectoral fin, opercle, and body of the male. During the embrace, about 50 eggs or fewer are emitted by the female, are fertilized, and sink into

the nest or the upper slope. After the spawning act, the female floats for a moment, belly up, as if dead, and then swims off. Each female spawns a number of times, in the same or a different nest, continuing to spawn over a period of many days until all ripe eggs are extruded.

The early life-history stages were described by Fish (1932), who also provided a figure of the 14-mm stage.

Growth is rapid, young chub attaining a length of 2.0–3.5 inches (51–89 mm) the first year, and 4–7 inches (102–178 mm) at the end of the fourth year. Females usually mature in the third year, males in the fourth in Michigan. Males continue to grow and attain a maximum length of about 12 inches (305 mm), a weight of about 12 ounces (340 g), and an age of about 7 years, whereas females are smaller, 7–8 inches (178–203 mm) and reach a maximum length of 11 inches (279 mm) in Michigan; in Ohio, females reach a maximum length of 9.5 inches (241 mm). The largest specimen from Canadian waters known to us is a male 9.8 inches (248 mm) in total length from a stream near Holt, Ont., although longer ones are to be expected.

In a study of 76 creek chub from Quebec waters, Leonard (1927) concluded that none were older than 3 years but his age determinations seem questionable. Considerable data on lengths and weights were provided.

The creek chub seems to prefer small, clear, streams and brooks, although it does inhabit the shore waters of small lakes. It is one of the most common minnows in the populated regions of Ontario and those to the east.

Its omnivorous food habits are doubtless partly responsible for the considerable success the species enjoys. It has been classified as a sight feeder by Evans (1952), which is in keeping with the clear-water habitat preferred. Young chub eat planktonic organisms, consuming larger organisms as they grow. Aquatic and terrestrial insects larvae and adults (such as beetles, mayflies, caddisflies, and chironomids) form a major part of the diet and large males will also eat crayfishes and small fishes. A food study of Quebec creek chub by Leonard (1927) indicated the importance of insects in the diet but showed also that cladocerans, algae, and higher plant tissues were significant.

A large number of species of parasites infecting creek chub are listed in the literature, much too extensive to repeat here. Hoffman (1967), for example, listed over 30 species. Regional studies by Bangham and associates should be consulted also: Bangham and Hunter (1939) for Lake Erie, Bangham and Venard (1946) for Algonquin Park, Ont., and Bangham (1955) for Lake Huron region.

A new species of monogenetic trematode, *Octomacrum semotili*, from the gills of creek chub in Algonquin Park lakes, was described by Dechtiar (1966b).

Relation to man The creek chub is one of our most important bait minnows because it is hardy, grows to a large size, and can be readily caught in most streams within its region of distribution. Although almost all chub sold in Canada are "wild" fish, they can be reared artificially. Dobie et al. (1956) described in considerable detail how they can be spawned and reared in a hatchery type operation.

The creek chub used to be one of the first fishes caught by small boys and still provides considerable enjoyment to youthful anglers, for it will eagerly take a baited hook. Although somewhat small and bony, the flesh has a fine flavour.

Chub are consumed by a variety of natural predators such as loons, kingfishers and mergansers (White 1953, 1957). They probably do not compete seriously with brook trout because they occupy the warmer sections of streams but their diet is competitive with the brown trout to some extent, although the trout tend to occupy larger water courses than those preferred by the creek chub.

Nomenclature

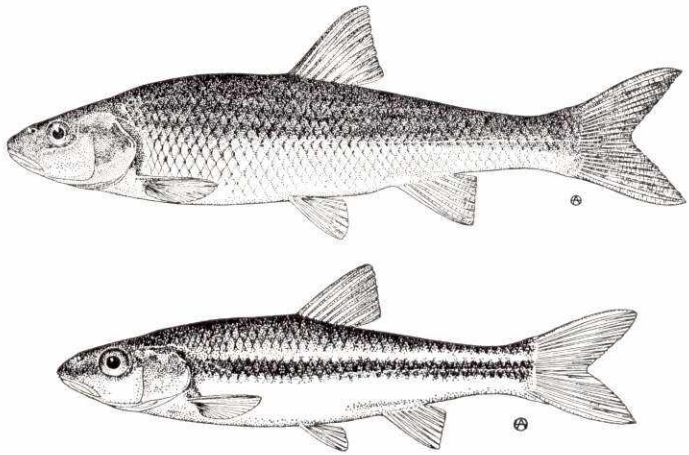
Cyprinus atromaculatus	— Mitchill 1818a: 324 (type locality Wallkill River, N.Y.)
Semotilus dorsalis	— Rafinesque 1820c: 49
Leuciscus cephalus	— Perley 1852: 194
Leuciscus atromaculatus DeKay	— Fortin 1866: 72
Semotilus atromaculatus	— Bicknell and Dresslar 1886: 16
Semotilus corporalis Mitchill	— Cox 1896b: 65

Etymology *Semotilus* — banner (i.e., dorsal fin); the second part of the word was used elsewhere by Rafinesque to mean 'spotted'; *atromaculatus* — *ater* —black, *macula* — spot.

Common names Creek chub, horned dace, chub, common chub, northern creek chub, tommycod, brook chub, silvery chub, mud chub, blackspot chub. French common name: *mulet à cornes.*

FALLFISH

Semotilus corporalis (Mitchill)



Description Body somewhat compressed laterally, elongate, average length about 4 inches (102 mm) but grows to over 12 inches (305 mm), greatest body depth 17.0–21.1% of total length. Head bluntly pointed, its length 20.1–23.7% of total length; eye somewhat larger than for *atromaculatus*, its diameter 17.3–29.4% of head length; snout moderate to large, its length 28.5–40.5% of head length, slightly projecting

beyond upper lip; interorbital broad, but less so than *atromaculatus*, its width 32.0–41.1% of head length; mouth slightly subterminal, overhung by snout, and lower lip included in upper lip, upper jaw reaching barely to the anterior margin of orbit, premaxillaries protractile, a slender flaplike barbel in groove between maxillary and premaxillary in advance of posterior end of maxillary, usually not well developed and often absent on one or both sides, but usually apparent on large adults; pharyngeal teeth usually 2,5–4,2 but variable and may be 2,4–5,2, 2,4–4,2. Fins: dorsal 1, its origin directly over pelvic origin, or more nearly so than either on *margarita* or *atromaculatus*, dorsal larger, rays always 8(53); caudal distinctly forked, lobes pointed; anal 1, large, slightly falcate, its origin not quite overlapped by depressed dorsal fin, rays usually 8(48), seldom 7(6) or 9(1); pelvics well developed, origin about under dorsal fin origin, rays usually 8(36), seldom 9(3); pectorals moderate, pointed, rays 16(12), 17(11), or 18(16) but regional differences exist, and counts appear to be higher in Maritimes. Scales cycloid, large, and characteristically pigmented (*see* following sketch) with crescent-shaped pigmented areas on anterior field; lateral line complete, scales 43–50. Peritoneum silvery, scattered speckles; intestine short, single main loop. Vertebrae usually 43(20), sometimes 42(9) or 44(1).

Nuptial tubercles small, but not minute; on spawning males, on snout extending posteriorly in two lateral patches to surround nostrils and continue toward orbit, a single row of small tubercles on dorsal arc of orbit, a patch of fine tubercles on lower posterior edge of opercles and on adjacent branchiostegal rays, decreasing in extent medially. Fine tubercles also on opercular flap and on adjoining lateral aspect of trunk, on skin but not on scales; on first 7–9 rays of pectoral fin a single row of fine tubercles, extending along length of ray, including its branches; no tubercles evident on dorsal or pelvic fins.

Colour Back olive-brown to black, sides silvery and underparts silvery white. Scales on adult fallfish present a characteristic pattern consisting of a series of dark, crescent-shaped or triangular black bars at the base of each scale along the sides. Large adults, quite silvery in overall appearance, are

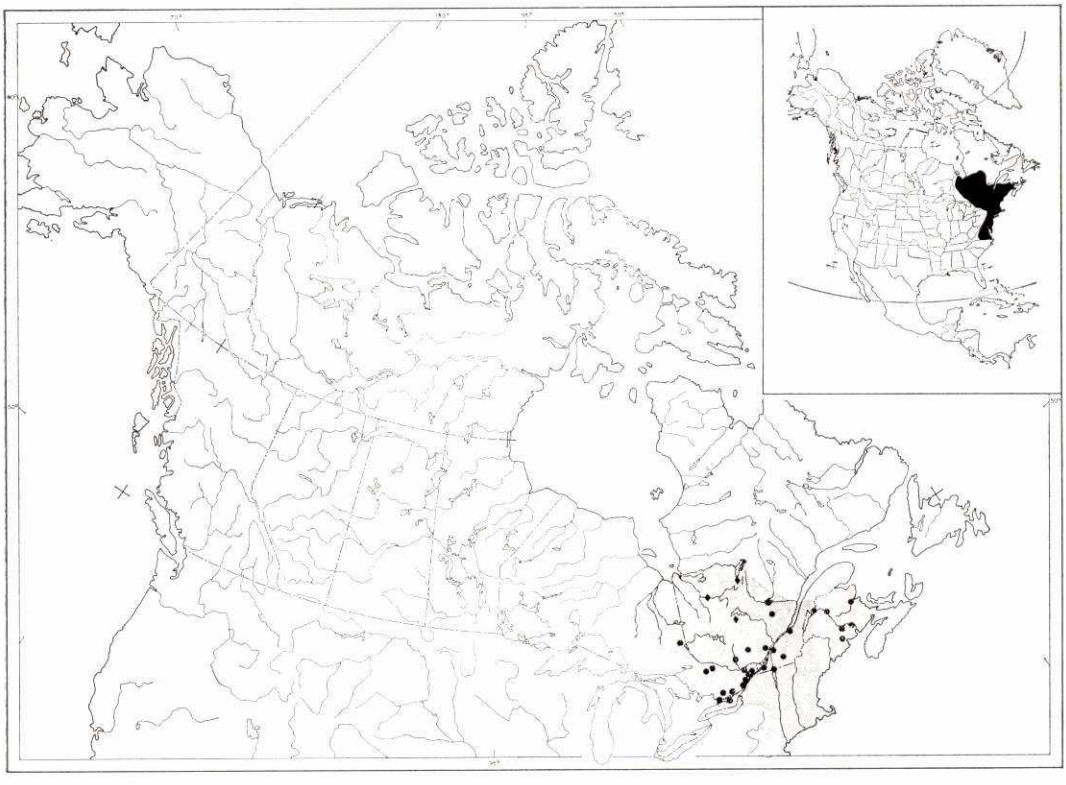
usually called silver chub by trout fishermen who catch them unintentionally. Young fish, 4 inches (102 mm) or less in length are also silvery, appear moderately laterally compressed, and have a pronounced wide lateral band that is evident on the head behind the eye, extending the length of the body and usually terminating in a rather large black spot on the posterior caudal peduncle. *See* lower illustration p. 511.

Distribution The fallfish occurs in clear streams and lakes south from New Brunswick, Quebec, and Ontario, east of the Appalachians, to Virginia.

In Canada, the species is common in some parts of New Brunswick as far north as the Miramichi River system but there are no records of it in the Petitcodiac, Nepisiguit, or Restigouche River systems (Scott and Crossman 1959). It is common in the waters of the St. Lawrence River drainage in Quebec, north to the James Bay watershed of Quebec and Ontario; in Lake Wakonichi of the Rupert River system of Lake Mistassini; in Ontario through the Ottawa valley and north to the Petawawa River drainage in Algonquin Park, and west along the north shore of Lake Ontario to at least the Trent River.

The record of a fallfish from Cedar Creek, Thunder Bay District, Lake Superior drainage, published by Allin (1951), was based on a misidentification. The specimen in question is a creek chub, *Semotilus atromaculatus*.

Biology The fallfish spawns in the spring over a pile of stones in the gravel bottom of a flowing stream. This mound of



stones is a nest, which is built by the male, carrying the stones in his mouth.

As is so often the case, there are few published Canadian observations on the biology of this species. In the eastern townships in Quebec, Richardson (1935) reported that nest building commenced in a stream tributary to Brome Lake on May 19 while the water temperature was only 53.6° F (12° C). Spawning commenced on May 20, at a temperature of 61.9° F (16.6° C). The nonadhesive eggs were deposited into elongate mounds of gravel, averaging about 2 feet (61 cm) long, and were covered with gravel after spawning. Richardson noted that a completed nest was somewhat conical in shape, averaging 4 feet (121.9 cm) in diameter and 2 feet (61 cm) high. The size of the nest was dependent on the sizes of the constructing male, which in that case ranged from about 6.1 to 7.4 inches (155–188 mm) long. Raney (1949), who worked mainly in New York State, considered the nests to be elongate, and to be characterized by a keel-like crest, which could be either in line with the current or crosswise to it. Raney examined several nests that were 6 feet (183 cm) in diameter and reached a height of 3 feet (91.5 cm), probably built by males measuring 15–18 inches (381–457 mm) in length. Nests of comparable size were built in eastern Ontario streams by fish of comparable sizes. Toner (1943) examined several nests believed built by this species in Spectacle Lake Creek, Leeds County, Ont. He caught several large fallfish nearby but could find no eggs in the nests.

Fallfish nests are sometimes used by spawning common shiners, *Notropis cornutus*, occasionally resulting in *N. cornutus* × *S. corporalis* hybrids (Greeley 1938).

Few figures on egg number are available but Richardson reported an average of 2300 eggs per female from fish of about 6.7 inches (170 mm) long. Data on time to hatching are sparse, but the same author noted that

the head and tail were free in the majority of eggs 2 days after spawning. He also noted that larvae 12 mm long were present in a nest on June 6 and left the nest 2 days later. Young attained a length of 35 mm by the end of the first summer. Mansueti and Hardy (1967) illustrated and described a juvenile (about 93 mm total length) from the Chesapeake Bay region. There are few data available on maximum size attained, but the largest specimen on hand measured 16.6 inches (420 mm) long and weighed about 1.75 pounds (794 g). It was caught in Fire River, a tributary of the Missinabi River, Ont. Actual lengths and weights of fallfish from the Petawawa River, Ont., taken in 1936 by J. R. Dymond, were as follows: 10.4 inches (265 mm) and 11.75 ounces (333g); 8.8 inches (225 mm) and 8.5 ounces (241 g); 8 inches (202 mm) and 425 ounces (120 g). Small (1883) noted that the average "full size" in the Ottawa region was "1 to 1½ pounds in weight."

The fallfish inhabits clear, flowing, gravel-bottomed streams and also lakes. The young inhabit the more rapid water upstream but large adults seem to seek large pools and expanded regions of the lower reaches. In Quebec, fallfish are frequently found in lakes but they are more common in rivers and streams in Ontario. In eastern United States waters, Trembley (1960) noted that they were seldom found in water over 82.4° F (28° C), which may not be applicable to Canadian populations.

The food of the fallfish in Canada is practically unknown but we assume that aquatic insect larvae, terrestrial insects (taken on surface), crustaceans, and fishes are important in the diet. They are quick to take an angler's trout fly and, hence, probably do take insects on the surface.

Fallfish fall prey to fish-eating birds in New Brunswick (and doubtless elsewhere within their range) according to reports by White (1953, 1957), who found their remains in the stomachs of eastern belted kingfishers and American mergansers.

Bangham and Venard (1946) examined 67 fallfish in lakes in Algonquin Park, Ont., and found 47 infected variously with nematodes, trematodes, cestodes, and copepods. The most common parasites were the nematode *Rhabdochona cascadilla,* which occurred in 32 specimens, and the trematodes *Allocreadium lobatum* and *Posthodiplostomum minimum* found in 24 and 10 specimens, respectively.

Hoffman (1967) listed a number of trematodes, one cestode, nematodes, acanthocephalans, and crustaceans from various parts of the range.

Relation to man Fallfish, sometimes called silver chub and other names by sport fishermen, are often caught by anglers fly fishing for trout and at times cause considerable annoyance, especially if they occur in numbers. Since adult fallfish attain weights in excess of 1 pound, they may be fished for sport in their own right. The flesh is firm, white, and sweet. We have no information on the use of young fallfish for live bait.

Nomenclature

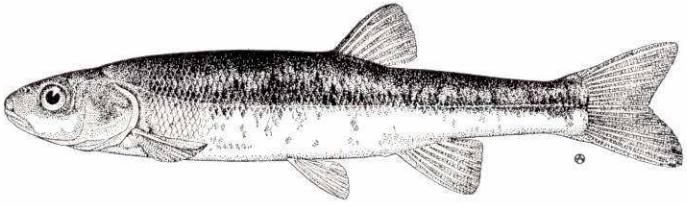
Cyprinus corporalis	— Mitchill 1817: 290 (type locality Wallkill River, N.Y.)
Cyprinus bullaris	— Rafinesque 1817b: 120
Leuciscus nitidus	— DeKay 1842: 209
Leuciscus pulchellus	— Perley 1852: 193
Leuciscus argenteus	— Perley 1852: 194
Leuciscus canadensis	— Fortin 1866: 70
Semotilus corporalis Mitch.	— Cox 1893: 40
Semotilus bullaris (Raf.)	— Cox 1896b: 65
Leucosomus corporalis (Mitchill)	— Jordan, Evermann, and Clark 1930: 117

Etymology *Semotilus* — banner (i.e., dorsal fin); the second part of the word was used elsewhere by Rafinesque to mean 'spotted'; *corporalis* — pertaining to the body (Mitchill called the fish corporal or corporaalen).

Common names Fallfish, American chub, mohawk, white, silvery or roughnosed chub, dace, windfish, corporal, chivin, whiting, chub, shining dace. French common name: *ouitouche*.

PEARL DACE

Semotilus margarita (Cope)



Description Body elongate, average length about 3.5 inches (89 mm), body not deep, almost cylindrical, greatest depth 15.9–21.0% of total length, caudal peduncle long and rather slender. Head small, its length 19.0–23.6% of total length; eye relatively small, its diameter 21.8–30.7% of head length; snout somewhat rounded, its length 26.9–35.2% of head length; interorbital moderate, its width 31.5–38.8% of head length; mouth moderate, upper jaw reaching to a point below anterior nostril, lower lip included by upper lip, which projects slightly beyond snout and lower lip; premaxillaries protractile, and with a small flaplike barbel usually pigmented but variously developed and sometimes entirely lacking on one side, or even both sides; pharyngeal teeth usually 2,5–4,2, but some variability observed, 2,4–4,2, 2,4–4,1. Fins: dorsal 1, its origin behind origin of pelvic fins, small, rays usually 8(100), rarely 7(5); caudal fin shallowly forked, lobes rounded; anal 1, small, rays usually 8(93), sometimes 7(12); pelvics relatively small, rays usually 8(27), sometimes 9(2); no pelvic axillary process; pectorals well developed, anterior rays often stiffened and thickened in males as in *Chrosomus*, rays more often 15(11), or 16(8), but may be 14(1), 17(5), 18(3), or 19(1). The counts seem to be higher in the Maritimes (16–19) than in Manitoba (14–16). Scales cycloid, persistent, specialized darkened scales variously scattered on sides, especially on Maritime specimens, less so on western specimens; lateral line usually complete, sometimes discontinuous in young specimens. Peritoneum silvery, with speckling on dorsal part; intestine with a single loop, its length usually less than body length. Vertebrae 38(2), 39(27), or 40(15).

Nuptial tubercles not well developed, but those on first 6, 7, or 8 pectoral rays are better developed than others, in a single row on

each ray but appearing as a double row when rays divide. A few minute tubercles on head.

Colour Overall colouration dark or dusky silver. Back dark, sometimes almost black, the sides silvery, the belly silver-grey to white. Specialized, darkened scales along sides may be absent but specimens from Ontario and eastward are often densely speckled. Dark lateral band on side distinct on young, and usually terminating with a distinct spot at base of caudal; lateral band indistinct on large specimens but often distinct on caudal peduncle.

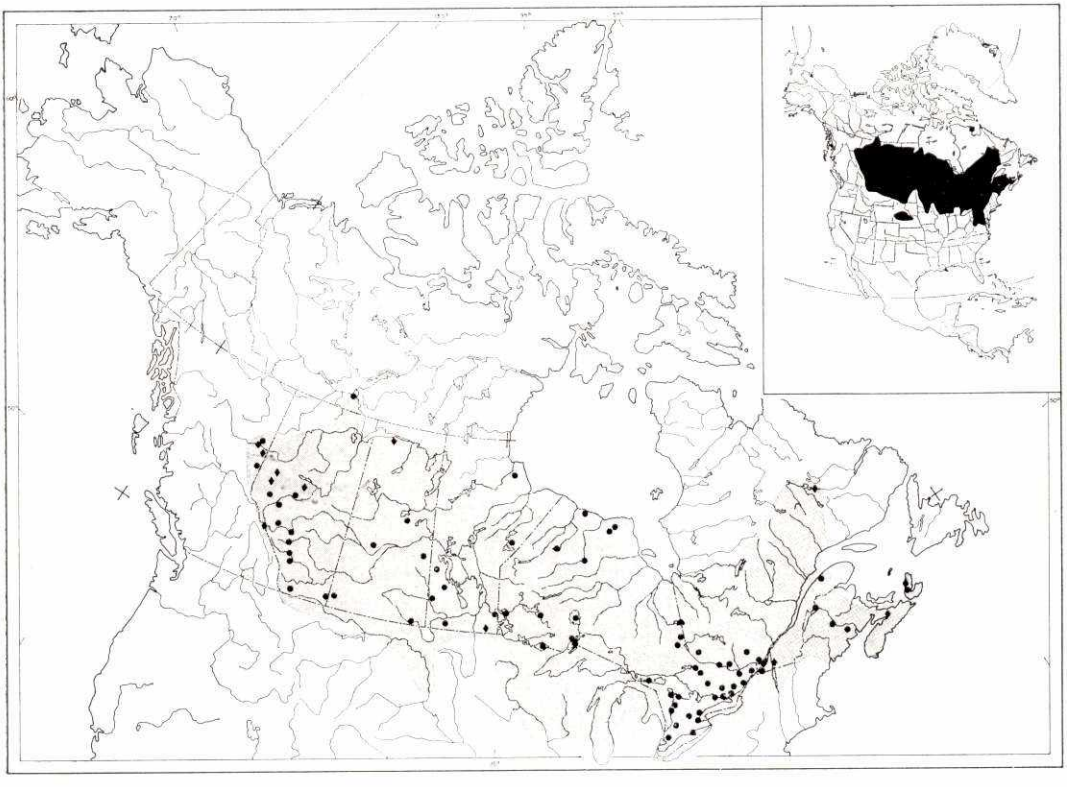
Adult males may be brilliantly coloured from late fall until almost midsummer, with a rich orange-red flush along the flanks commencing at the lower edge of the lateral band and spreading ventrally, leaving only a pale, central strip between head and anal fin but extending onto ventral surface of caudal peduncle.

Systematic notes The nomenclatural history of the pearl dace reflects the interest the species has aroused among ichthyologists, and something of its complexity. *See* Hubbs (1926) for a review of the early nomenclature and a diagnosis of the genus *Margariscus*. Bailey and Allum (1962) presented convincing reasons for the lumping of the genera *Margariscus* and *Leucosomus* (for *L. corporalis*) in the genus *Semotilus*, although many authors had accepted this change earlier (Hubbs and Lagler 1958; Blair et al. 1957; Moore 1968). We are aware of no published records of hybridization involving *Semotilus margarita*. One such reported case involving *Couesius* (Schultz 1941) was thoroughly reviewed by Hubbs (1942), who concluded the specimens in question were misidentified. Hubbs noted that female *S. margarita* and male *Couesius* tend to be intermediate between male *S. margarita* and female *Couesius*.

A number of subspecies have been proposed for the pearl dace: *S. m. margarita* (Cope), the Alleghany pearl dace, the typical subspecies, occurs from Vermont and New York south to Virginia; *S. m. nachtriebi* (Cox) the northern pearl dace, occurs through most of Canada from the Maritime Provinces to British Columbia, and barely enters the Northwest Territories; Hubbs and Lagler (1949) described *S. m. koelzi*, the Harvey Lake pearl dace, from a single lake on Isle Royale, Lake Superior; another subspecies, *S. m. athabascae* (Bajkov), was described by Bajkov (1927) from the Jasper region of Alberta. The primary features distinguishing the various subspecies are the number of scales (larger for *S. m. margarita*, than the others); *S. m. koelzi* differs from all others in having a more slender head. *See also* McPhail and Lindsey (1970) for additional discussion.

A thorough study of the species throughout its Canadian range is required. It is to be expected that northern Canadian populations will exhibit a lower scale count than southern ones as illustrated in the following table giving east–west trend of lateral line scale count of Canadian populations and for *S. m. margarita* and *S. m. nachtriebi*.

	Lateral Line Scales
	49 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78
Semotilus m. nachtriebi	
N.S. (ROM 22842) N=9	1 3 1 4
Ont. (ROM 19790) N=10	2 3 1 1 1 1 1
Man. (ROM 17488) N=10	2 1 1 2 2 1 1
Semotilus m. margarita	← (95% *S. m. margarita* range 49–62)
Semotilus m. nachtriebi	← (95% *S. m. nachtriebi* range 62–78) →



There also appears to be an interesting east–west trend suggested by pectoral ray counts of 29 specimens.

	Pectoral fin rays					
	14	15	16	17	18	19
N.S., South Margaree R.			1	4	3	1
Ont., Frontenac Co.		3	6	1		
Man., Silcox Creek	1	8	1			

Distribution The pearl dace occurs in cool bog ponds, creeks, and lakes, throughout most of Canada and in the United States from Maine south to Virginia, west in Vermont, New York State, Pennsylvania, northern Michigan, most of Wisconsin, in Minnesota, North Dakota, and northern Montana. Relict populations exist in cool springs in South Dakota and Nebraska.

In Canada, the species ranges from Nova Scotia, west through New Brunswick, Labrador, Quebec, Ontario, north to the Lake Nipigon and Lake Abitibi regions, through Manitoba, Saskatchewan, Alberta, to British Columbia where it has been taken in the drainages of the Athabasca, Peace, and Slave rivers. Pearl dace occur in the Northwest Territories from the lower Sass River southward. Its Canadian distribution appears to bear a relation to 55°–60° F July isotherm (Ryder et al. 1964; Loch 1969).

Biology Despite its extensive Canadian range, no thorough study of the biology of the pearl dace appears to have been undertaken. Published accounts about the pearl dace all rely heavily upon observations made by T. H. Langlois on the Pentwater River, and Pine Creek, Michigan, on June 12 and 13, 1928 (Langlois 1929), and few supplementary or corroborating observations have been made, which should surely be a challenge to present day biologists.

The pearl dace spawns in spring. Langlois noted that temperatures of 63° and 65° F (17.2° and 18.3° C) prevailed in Pentwater

River and Pine Creek, respectively. The brilliantly coloured males did not build nests, but maintained territories about 8 inches (203 mm) wide, and seemed not to maintain territories closer together than 6 feet (1.83 m). Spawning took place in clear water 18–24 inches deep on sand or gravel in a weak or moderate current, facing into a current, when present. Males spent much time off territories, but when home, nosed over the bottom as if, Langlois thought, looking for eggs to eat. Invading male dace are pursued or escorted away, but a ripe female may be driven onto the territory. The spawning act apparently occurred when the enlarged pectoral fin of the male was placed beneath the female's body anteriorly, with the caudal fin of the male placed over the caudal peduncle of the female. The male's tuberculate pectoral fin undoubtedly helps him to maintain this position, which possibly functions to stretch the female's ventral surface and aid in extrusion of the eggs. The spawning act, signified by the vibrating bodies of the mated pair, lasted for about 2 seconds, although Langlois did not observe the actual deposition of eggs. Each female repeated the act many times with different males and, hence, must deposit only a few eggs each time. Each egg measured 0.036 inches (9 mm) in diameter, and 1686 eggs were contained in a female 4.25 inches (108 mm) long.

The growth rate of pearl dace is not known but studies by Loch (1969) for a few Ontario populations suggested the following lengths: age 1, 55–65 mm; age 2, 75–95 mm; age 3, 95–120 mm. Females probably grow faster and live longer than males. The pectoral fins exhibit sexual dimorphism at maturity, which was attained at a length of about 65 mm. The largest specimens available to us were caught in Lundy Lake, Temiskaming District, Ont., and measured 6.1 inches (155 mm) long. A large collection from Crevice Lake, Algonquin Park, Ont., contains a number of specimens over 5.25 inches (134 mm) long, but the largest single specimen is one 6.25 inches (158 mm) in total length, reported by Lindsey (1956).

The habitat of the pearl dace in Canada is typically cool, clear headwater streams in the south, bog drainage streams, ponds, and small lakes in the north, and in stained, peaty waters of beaver ponds, in association with *Chrosomus* spp., *Pimephales promelas*, and *Culaea inconstans*.

The food is said to consist of copepods, cladocerans, and chironomids (Carlander 1969), but McPhail and Lindsey (1970) reported the occurrence of beetles, filamentous algae, and *Chara* in dace stomachs.

The pearl dace is probably an important forage species in Canadian waters, but the species is not readily identified in stomach content materials and confirming data are lacking. White (1953) noted its occurrence in the diet of kingfishers in New Brunswick and Nova Scotia, and it is probably also eaten by mergansers inland, although White (1957) found no evidence in Maritime collections.

Bangham and Venard (1946) examined 35 pearl dace from Algonquin Park and found 27 infected variously with trematodes and nematodes. Hoffman (1967) also listed protozoans, trematodes, and a nematode, *Rhabdochona cascadilla*, from this species.

Relation to man The importance of the pearl dace is difficult to assess. It is abundant in bog ponds and slow-moving streams in various parts of the central portion of Ontario and neighbouring Quebec and in many areas is an important bait minnow. It is usually unrecognized and included with finescale dace, redbelly dace, and creek chub, and sold as chub or dace. It is also used as a bait minnow in Alberta.

Nomenclature

Clinostomus margarita — Cope 1869: 377 (type locality tributary of Conestoga River, Lancaster, Pa.)

Leuciscus nachtriebi — Cox, U. O., 1896: 605

Couesius plumbeus Agassiz	— Cox 1896a: 41
	— Cox 1896b: 65
	— Cox 1899: 148
Leuciscus margarita (Cope)	— Jordan and Evermann 1896–1900: 241
Couesius plumbeus rubrilateralis	— Cox 1901: 42
Margariscus	— Cockerell 1909: 217 (as subgenus)
Leuciscus nachtriebi Cox	— Halkett 1913: 62
Leuciscus rubrilateralis Cox	— Cox 1921: 66
Margariscus margarita (Cope)	— Jordan 1924: 70
Leuciscus neogaeus Meek and Clark	— Hubbs 1926: 33
Leuciscus carletoni Kendall	— Hubbs 1926: 33
Semotilus margarita (Cope)	— Bailey et al. 1960: 17

Etymology *Semotilus* — banner (i.e., dorsal fin); the second part of the word was used elsewhere by Rafinesque to mean 'spotted'; *margarita* — a pearl.

Common names Pearl dace, nachtrieb dace, northern pearl dace, northern minnow, northern dace. French common names: *mulet perlé, mulet perlé du nord.*

TENCH

Tinca tinca (Linnaeus)

Description Body thickset, heavy, and laterally compressed, average total length 8–10 inches (203–254 mm), the caudal peduncle characteristically deep and short. Head triangular, its length about 28% of standard body length; eye orange-red in colour, small; snout relatively long; interorbital broad; mouth terminal, small in size with thick lips and a pair of well-developed barbels, one at each corner of the mouth; pharyngeal teeth 0,5–4,0 or 0,5–5,0. Gill rakers about 13. Fins: all fins dark and rounded; dorsal 1, rounded, rays 9; caudal shallowly forked, the lobes rounded; anal 1, rounded, rays 7 or 8; pelvic fins rounded, adult males with thickened second ray, not present in females nor immature fish; pectoral relatively short, rounded. Skin thickened, slimy; the scales small, embedded, 95–105 in lateral line; lateral line complete. Vertebrae 38 or 39.

Colour Overall colouration olive-green, at times dark green or almost black, with golden reflections on the flanks and darker golden reflections on ventral surface. Fins dark. European breeders have developed a golden variety.

Distribution The tench inhabits the flatland rivers and lakes of Europe northward usually to 61°N. In Asia it occurs in the Arctic Ocean drainage including the basins of the Ob and Yenisei, but is rare in Lake Baikal.

Introduced into North America, it now occurs in several areas including the Columbia

River system, streams and lakes in the Puget Sound drainage, and elsewhere in the United States such as the Potomac River and near Baltimore, Md.

In Canada the species occurs only in British Columbia, where it is found in Christina, Tugulnuit, and Osoyoos lakes in the Columbia River system. There are unverified reports of its occurrence on Vancouver Island (Carl et al. 1967). Dymond (1936) wrote that the species was first noted in Christina Lake about 1915.

Dymond (1936) stated tench were originally brought to Seattle for the World's Fair (prior to 1915) (the 1909 Alaska–Yukon Pacific Exposition?), and afterwards dumped into a large goldfish pond on the University of Washington campus. From there they were introduced to the Columbia River system where they made their way into Christina and other lakes of the Columbia system. Carl et al. (1967) stated that first introductions in the area were made about 1895 in small lakes of Spokane County, Wash. and Washington County, Ore.

Biology Little has been written about the biology of the tench in British Columbia waters, but its biology in European waters is well known. There, spawning usually occurs in weedy shallows during June or July, and large numbers of eggs (275,000 per pound of body weight) are deposited. The eggs are small, about 1 mm in diameter. Breder and Rosen (1966) provided a concise review of the European literature on spawning. Tench grow to about 9 or 10 inches (229–254 mm) long and a weight of 0.75 pounds in about 4 years, at which time they may be mature. They are said to have a life expectancy of 20–30 years.

The tench is regarded as a slow-moving, sluggish fish that prefers mud-bottom ponds or the still waters of the lower reaches of rivers where rooted aquatic plants grow in profusion.

Maximum sizes in Canadian waters have not been reported, but Dymond (1936), quoting Schultz, noted that specimens nearly 2 feet long were taken in Union Lake, Wash. Wheeler (1969) gave the weight of the British angling record as 8 pounds 8 ounces (3.85 kg).

The diet is reported to consist mainly of aquatic insect larvae and molluscs; only the young fish consume algae to any degree.

Jenkins (1958) said they are preyed upon by predatory fish like the northern pike, but large tench probably have few enemies except man.

The parasites listed by Hoffman (1967) included a variety of trematodes, nematodes, crustaceans, protozoans, acanthocephalans, and a leech, *Piscicola geometra.*

Relation to man In Europe the tench has a following of devoted anglers and it is also regarded as a useful fish for pond culture, often in association with carp. By others it is esteemed as a food fish. The golden variety is used to stock ornamental ponds. However, it appears to have none of these attributes in British Columbia waters, nor in any North American waters, and is generally ignored.

Nomenclature

Cyprinus Tinca	— Linnaeus 1758: 321 (type locality Europe)
Tinca vulgaris Cuv.	— Day 1880–1884: 188
Tinca tinca (Linnaeus)	— Carl and Clemens 1948: 75

Etymology *Tinca* — Latin name for tench.

Common names Tench. French common name: *tanche.*

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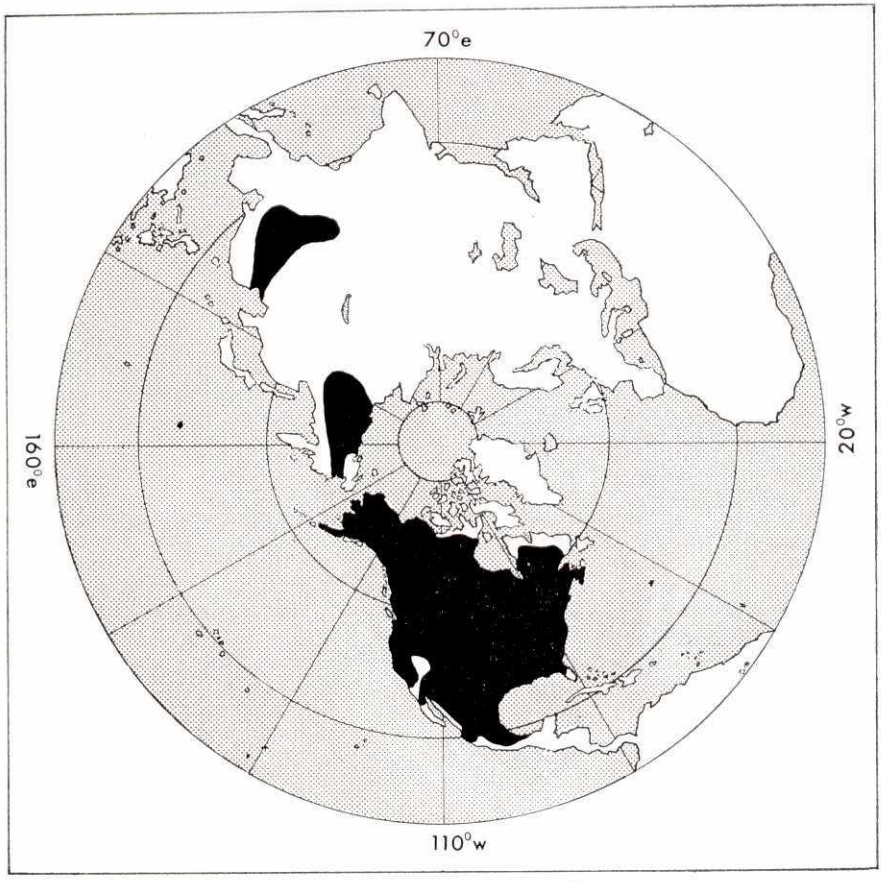
Sucker Family — Catostomidae

Small, to moderately large, subcylindrical, to laterally compressed fishes. Mouth characteristically ventral, subterminal, and protrusible (except in *Ictiobus*). Head short and broad; lips large, thick, usually papillate, lower lip cleft. Jaw teeth absent, lower pharyngeals with numerous, large, comblike teeth in a single row. No barbels. No adipose fin; pelvic fins low; caudal fin forked; and dorsal fin in centre of body. Swim bladder physostomous, large, and with 2 or 3 chambers.

Fishes of rivers and lakes of North America, eastern Siberia, and China. A large family, mainly North American, of 10 genera and about 65 species. One species *Catostomus catostomus* occurs in both Asia and North America.

Known from the Eocene to Recent in Asia and Miocene or possibly Eocene to Recent in North America.



World Distribution of the Suckers

Key to Species

1 Dorsal fin with long base and more than 20 rays, first 4–7 rays of dorsal extended to form pointed or rounded lobe at least as high again as rest of fin; distance from insertion of dorsal to origin of caudal less than dorsal fin base 2

Dorsal fin with short base and fewer than 20 rays, no rounded or pointed anterior lobe, rays a uniform gradation in length; distance from insertion of dorsal to origin of caudal greater than dorsal fin base 3

2 Dorsal fin with moderate anterior lobe, first ray about 3 times as long as shortest dorsal ray; mouth horizontal to oblique, terminal or nearly so, little overhung by snout, mouth larger (maxillary twice eye diameter); caudal fin with shallow fork ..... BIGMOUTH BUFFALO, *Ictiobus cyprinellus* (p. 557)

Dorsal fin with very high, pointed, anterior lobe, first ray at least 4–6 times as long as shortest dorsal ray; mouth horizontal, inferior, and markedly overhung by snout, mouth small (maxillary about equal to eye diameter); caudal fin with deep fork ..... QUILLBACK, *Carpiodes cyprinus* (p. 528)

3 Lateral line present; snout rounded; mouth horizontal, inferior, and overhung by snout; greatest body depth less than one-third the body length to end of scales 4

Lateral line absent; snout broadly pointed; mouth oblique and only subterminal, not noticeably overhung by snout; greatest body depth one-third, or greater than one-third, of body length to end of scales; dorsal fin appears large for body length; wide, horizontal, mid-lateral, black band except in largest specimens; usually no more than 5–6 inches (120–150 mm) in length ..... LAKE CHUBSUCKER, *Erimyzon sucetta* (p. 551)

4 Sides of body with prominent spotted pattern, approximately 10 horizontal rows of dark spots about the size of the pupil, one on each scale ..... SPOTTED SUCKER, *Minytrema melanops* (p. 561)

No such pattern of small spots 5

5 Head large and broad, depression between eyes; eyes very high and past midpoint of head; snout long and markedly turned down; body pattern of dark blotches and 3 wide, oblique bars; usually not over 8 inches (200 mm) in length ..... NORTHERN HOG SUCKER, *Hypentelium nigricans* (p. 554)

Head flat or rounded on top; eyes lower, and approximately in middle of head 6

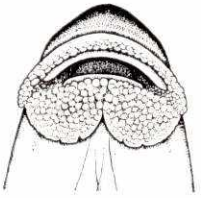
6 Scales small, usually more than 55 in lateral line; swim bladder with 2 chambers; body cylindrical (*Catostomus*) 7

Scales larger, fewer than 50 in lateral line; swim bladder with 3 chambers; body subcylindrical to laterally compressed (*Moxostoma*) 11

7 Scales small, usually over 90 in lateral line (rarely to 87 in *C. columbianus*) ... 8

Scales larger, usually fewer than 90 in lateral line (rarely to 108 in *C. platyrhynchus*) 9

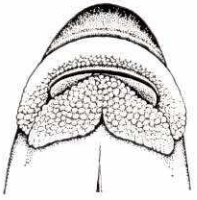
8 Lower lip not completely cleft, 3 rows of papillae cross ahead of the base, 3 or 4 rows of papillae on upper lip; cartilagineous edge of jaws obvious inside lips when mouth open; sometimes a notch at point of lateral connection of upper and lower lips; least caudal peduncle depth less than one-half length of dorsal base; membranous connection between base of pelvic fins and body (*see* illustration in couplet 10); not over 15 inches (375 mm) in length .....



..... BRIDGELIP SUCKER, *Catostomus columbianus* (p. 536)

Lower lip completely cleft, no rows of papillae cross ahead of base, at most 1 row of small papillae on floor of cleft, only 2 rows of papillae on upper lip; cartilagineous edge of jaw not conspicuous without pulling lips back; never a notch at point of lateral connection of upper and lower lips; least caudal peduncle depth more than one-half length of dorsal base; no membranous stays between pelvic fins and body .....
..... LONGNOSE SUCKER, *Catostomus catostomus* (p. 531)

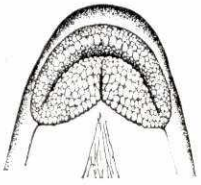
9 Lower lip incompletely cleft, usually 3 or 4 rows of papillae crossing ahead of base; cartilagineous edge of jaws visible inside lips when mouth open; pronounced notch at point of lateral connection of upper and lower lips; anterior margin of upper lip not papillate, no upper lip papillae visible from front; more than 15 oblique rows of scales from lateral line to origin of dorsal; never more than 8 inches (200 mm) in length .....



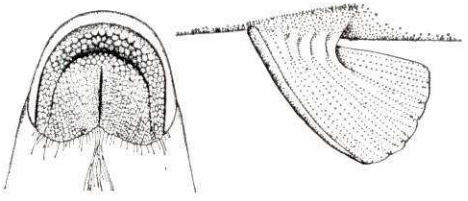
..... MOUNTAIN SUCKER, *Catostomus platyrhynchus* (p. 547)

Lower lip completely cleft, usually no rows of papillae crossing ahead of base (rarely 1 or 2 rows on base in *C. macrocheilus*); cartilagineous edge of jaws not conspicuous; no notch at point of lateral connection of lips; papillae of upper lip visible from front; fewer than 15 oblique rows of scales from lateral line to origin of dorsal; size at least to 24 inches (610 mm) in length 10

10 Lower lip much wider than its height; oblique rows of scales from lateral line to dorsal origin 8–10; dorsal fin rays 10–12; least caudal peduncle depth more than one-half length of dorsal fin base; no membranous connection between pelvic fins and body ..... WHITE SUCKER, *Catostomus commersoni* (p. 538)



Lower lip almost as high as wide; oblique rows of scales from lateral line to dorsal origin 11–14; dorsal fin rays usually 13–15 (rarely 12 or 16); least caudal peduncle depth less than one-half the dorsal fin base; membranous connection between pelvic fins and body ..... LARGESCALE SUCKER, *Catostomus macrocheilus* (p. 544)



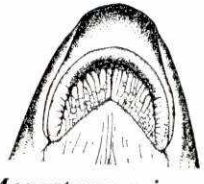
11 Caudal peduncle scales almost always 16, often 15, very rarely 13 or 12 (subgenus *Megapharynx*) 12

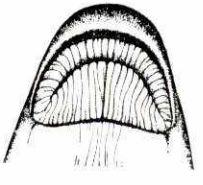
Caudal peduncle scales almost always 12 or 13, very rarely 15 or 16 (subgenus *Moxostoma*) 13

12 Maximum depth into body length to end of scales usually less than 3.5 times, snout length less than post-orbital length; scales across back just anterior to dorsal fin (excluding lateral line scales) 15 or 16; pharyngeal arch very heavy; lower pharyngeal teeth large, molariform, 4–6 on lower half of tooth row..... .....COPPER REDHORSE, *Moxostoma hubbsi* (p. 577)

Maximum depth into body length to end of scales usually about 4 times or more; snout length greater than post-orbital length; scales across back just anterior to dorsal fin (excluding lateral line scales) 12 or 13; pharyngeal arch light; lower pharyngeal teeth smaller, comblike, 12–30 on lower half of tooth row .....GREATER REDHORSE, *Moxostoma valenciennesi* (p. 584)

13 Maximum depth into body length to end of scales 3.5 times or less; plicae of lips with distinct transverse lines, lower lip thin .... SILVER REDHORSE, *Moxostoma anisurum* (p. 564)





Maximum depth into body length to end of scales about 4 times or more; no transverse lines crossing plicae of lips, lower lip thicker 14

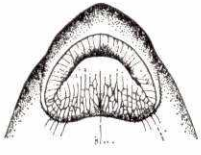
14 Origin of pelvic fins anterior to midpoint of base of the dorsal fin; lateral line scales usually 42–45, scale bases moderately to well darkened; caudal fin reddish in life; pharyngeal arch heavy and triangular; lower teeth large, molariform, increasing in size toward bottom, 6–9 on lower half of tooth row ..... RIVER REDHORSE, *Moxostoma carinatum* (p. 567)

Origin of pelvic fins opposite the midpoint of the base of the dorsal fin; lower pharyngeal less heavy, not triangular; teeth compressed, comblike, and numerous 15

15 Eye diameter equal to about one-half the maximum width of the lips; nostrils above the tip of the maxillary ..... BLACK REDHORSE, *Moxostoma duquesnei* (p. 571)

Eye diameter equal to two-thirds or more of the maximum width of the lips; nostrils behind the tip of the maxillary 16

16 Posterior edge of lower lips nearly a straight line; mouth small, lips not reaching maximum width of snout, mouth overhung by snout; head roundly pointed, 18.5–23.3% standard length



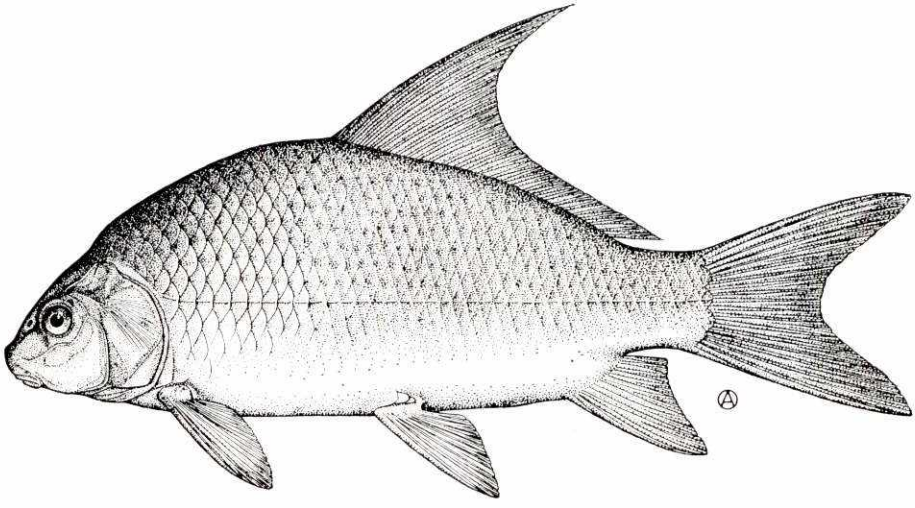
..... SHORTHEAD REDHORSE, *Moxostoma macrolepidotum* (p. 579)

Posterior edge of lower lips a definite obtuse angle; head more flattened at front; mouth larger, lips nearly reaching maximum width of snout; mouth slightly overhung by snout .....

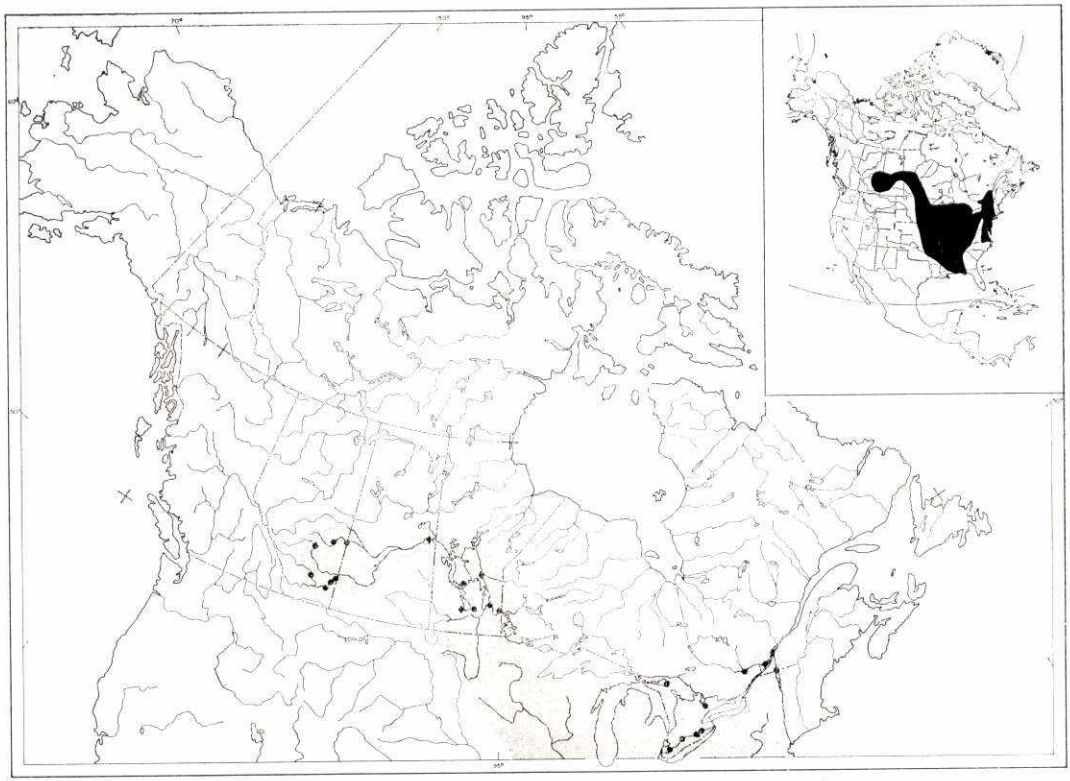
..... GOLDEN REDHORSE, *Moxostoma erythrurum* (p. 574)

QUILLBACK

Carpiodes cyprinus (Lesueur)



Description A large, very deep-bodied, laterally compressed sucker, greatest depth of body at origin of dorsal fin 22.2–28.9% of total length, back highly arched; caudal peduncle laterally compressed, short and moderately deep, 9.0–11.9% of total length; individuals usually 10–15 inches (254–381 mm) in length. Head deep but rather short, about 16% of total length, and narrow; interorbital width 31.2–40.9% of head length, upper surface of head a steep angle; eyes forward of midpoint of head, moderately small, eye diameter about 16% of head length and approximately equal to snout length; skull with anterior and posterior fontanelle; snout short, but about 26–36% of head length, terminating in a rounded point; sucker mouth horizontal, ventral, and small, maxillary reaching anterior edge of orbit; lips with fine, well-marked transverse plicae, the halves of the lower lip meet in an acute angle; no teeth on jaws or roof of mouth, pharyngeal teeth very small, thin, compressed, forming a very fine comb, cutting edges rising to a point. Gill rakers 25–29, short, approximately 2 mm in length. Branchiostegal rays 3, 1 on epihyal, 2 on ceratohyal, paddle-shaped. Fins: dorsal 1, soft rayed, origin slightly ahead of midpoint of body, base very long, 25.5–30.4% of total length, dorsal edge deeply crescentric, anterior rays much produced, as much as 5 or 6 times longer than last rays, anterior height almost equal length of base, and about 28% of total length, 25–30 rays; caudal moderately long and wide, well forked, tips somewhat pointed, approximately 18 rays; anal moderately long, anterior height twice that of base length, pointed, and edge slightly crescentric, 7–9 rays, usually 7; pelvics abdominal, low, near midpoint of body, pointed, base wide with axillary process, 8–10 rays; pectorals low, only moderately wide, tips pointed, usually 15 rays. Scales cycloid, large, 35–41 in lateral series, exposed portion higher than long; lateral line at level of eye, complete and almost straight; intestine very long with 6–9 coiled loops. Vertebrae 38–40. According to Huntsman (1967) in southern populations males only bear nuptial tubercles as follows: absent from the top of the head, covering the sides of the head from the level of the top of the eye, the ventral area of the



head from the mouth to the anterior branchiostegals, on the first dorsal ray, pectoral rays 1–9, pelvic rays 1 and 2.

Colour The dorsal surface, head and upper sides are buff to light brown, the sides are a shiny silver and the ventral surface cream to white; all fins are transparent to dusky, the ventral fins lighter in colour than the dorsal fin.

Systematic notes The confusion which arose from the use of names such as *C. thompsoni*, *C. velifer*, and *C. forbesi* particularly for western populations was discussed in Hubbs (1930a) and in Bailey and Allum (1962).

Distribution The quillback is restricted to North America. It occurs in the east from the St. Lawrence River south along the coast to about the Roanoke River, Va. West of the mountains, it extends through New York south to Alabama, west to Oklahoma, north through the eastern parts of the states from Kansas to the Dakotas, west in Canada to central Alberta.

In Canada, it occurs in the east in the St. Lawrence–Richelieu River, Lake Champlain, Ottawa River to about the level of Ottawa, apparently absent from Lake Ontario, but present in Lake Huron and Georgian Bay. In the west it occurs from Lake of the Woods west through south and central Manitoba, west in the Saskatchewan River, almost to the headwaters of the South Saskatchewan River in Alberta. Not often seen but apparently more abundant in Lake Champlain and in the western area than in Ontario. Although known earlier from Manitoba and Alberta, it was first recorded from Saskatchewan in 1946 (Sprules and Doan 1947).

Biology Virtually nothing is known of the biology of this species in Canada, but some statistics are available in Minnesota for

populations of this species in Lake of the Woods. Little information on its biology is available anywhere.

Quillback migrate to spawning areas, often in streams or overflow areas of bends of rivers or bays of lakes, in April and May where they randomly deposit eggs over sand or mud bottoms. No nest is built and no care given the young. In the south, young reach a length of 4 inches (102 mm) by the first fall. Quillback are 4–6 pounds in weight at sexual maturity. Range of total length at various ages in the Des Moines River, Iowa, was given by Vanicek (1961) as follows:

Age	TL	
	(*inches*)	(*mm*)
1	3.3– 6.1	84–152
2	5.2–10.7	132–272
3	7.4–13.2	188–335
4	7.0–14.2	178–361
5	8.7–13.6	221–345
6	14.7–15.1	373–384
7	13.3–17.3	338–439
8	16.4–18.1	417–460
9	–	–
10	16.8	427

See also Fish (1932) and Mansueti and Hardy (1967) for details and illustrations of early development of young.

Growth in Canada is doubtlessly slower than this. Trautman (1957) gave maximum size in Ohio as 24–26 inches (610–660 mm) length and 9–12 pounds. In Canada maximum size is probably 15–18 inches (381–457 mm) in length.

The habitat of the quillback ranges from the clear lacustrine waters of the Great Lakes to turbid river waters in the prairies.

The food is said to be immature insects, other invertebrates and organic material contained in bottom sediments. It is said to be a competitor for invertebrate food with the channel catfish where the two occur together.

The young are probably preyed on by a large variety of predatory fishes but the larger adults, especially in turbid environments, probably escape predation by other fishes.

Hoffman (1967) listed, under the names *Carpiodes cyprinus* and *C. thompsoni* the following parasites: Protozoa, *Myxosoma rotundum*; Cestoda, *Hypocaryopyllaeus paratarius*, *Spartoides wardi*; Nematoda, *Rhabdochona cascadilla* and *Camallanus ancylodirus*. Dechtiar in 1967 and 1968 described two new parasites from this species, a trematode, *Neodiscocotyle carpioditis* and an acanthocephalan, *Neoechinorhynchus carpiodi*.

Relation to man The quillback is of no particular importance to man. It is a commercial species wherever it is abundant, particularly in the Mississippi River. In Ontario, the catch is included in the statistics for suckers or for coarse fish. The flesh is white, flaky, sweet, and very tasty, particularly in the spring. Its suitability as a food fish is marred by the large number of bones which makes it hard to process (by machine or by hand) and to eat. Suckers of any kind, regardless of the actual quality of their flesh, have never been favoured by the Canadian consumer.

In the United States they are caught by anglers using doughballs as bait or by snagging them with bare hooks. There is no indication of any angling for them in Canada.

Nomenclature

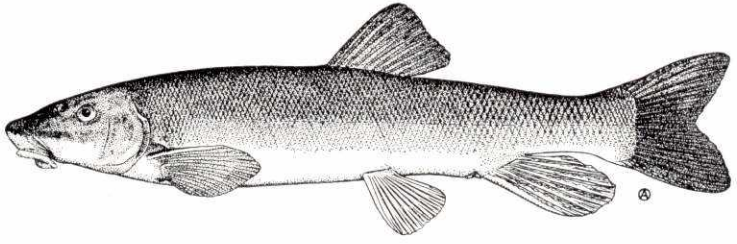
Catostomus Cyprinus — LeSueur 1817d: 91 (type locality Elk River and other tributaries of Chesapeake Bay)
Labeo cyprinus — Richardson 1836: 109
Carpiodes Thompsoni — Agassiz 1855: 76
Carpiodes Cyprinus — Small 1883: 38
Carpiodes velifer — Thompson 1898: 214
Catostomus cyprinus Thompson — Bean 1903b: 98
Carpiodes cyprinus cyprinus (LeSueur) — Hubbs and Lagler 1947: 46

Etymology *Carpiodes* — carp like; *cyprinus* — after the island of Cyprus from whence the carp was supposedly introduced into Europe. Both a reversal of the names of the carp *Cyprinus carpio*, names allude to its similarity to that species.

Common names Quillback, lake quillback, quillback carpsucker, eastern carpsucker, carpsucker, quillback sucker, long-finned sucker, broad mullet, mullet, carp, lake carp, white carp, silver carp, drum. French common name: *couette*.

LONGNOSE SUCKER

Catostomus catostomus (Forster)



Description An elongate, cylindrical, torpedo-shaped body, almost round in cross section; not deep, greatest depth between paired fins, 14.2–18.3% of total length; caudal peduncle only moderately long and deep, depth 6.4–8.8% of total length; usually 12–14 inches (305–356 mm) in length. Head moderately long, about 20% of total length, moderately broad, interorbital width 35.2–46.1% of head length, rounded on top, naked; eye small, diameter 38.4–66.6% of snout length, high and beyond midpoint of head; snout long, 38.4–48.2% of head length, bulbous, ending in a rounded point, dorsal surface sometimes concave over mouth; mouth ventral, well behind tip of snout, protrusible, suctorial, moderately small, gape extending no more than to midpoint of snout; lips large with coarse, long, oval papillae; no teeth in mouth, pharyngeal teeth in single row, comblike but ascending length, 37–45 + 35–46 according to McPhail and Lindsey (1970). Gill rakers short and fleshy, 23–30. Branchiostegal rays 3. Fins: dorsal 1, soft rayed, origin ahead of midpoint of body, height slightly greater than base, base 9.4–12.0% of total length, edge somewhat emarginate, 9–11 principal rays; caudal only moderately long, moderately forked, tips rounded points; anal long, its height about 2.5 times length of base, tip pointed to rounded, rays prominent, 7 principal rays; pelvics abdominal, only moderate in length, base fairly wide (fin length twice base length), axillary process present but small, fleshy stays at base (noticeable in large individuals only), fin square to rounded, 9–11 prominent rays; pectorals low, horizontal, somewhat stiff, 16–18 rays, tips broadly pointed. Scales small, cycloid, crowded towards head, larger on caudal peduncle, 99–108 in lateral series in material examined, apparently to 120 in total,

scales not visible to naked eye on peduncle of individuals less than 3 inches (76 mm) in length; lateral line complete, inconspicuous, almost straight and at midpoint of body. Peritoneum variable, silver to shiny black; intestine long, undifferentiated, 2 or 3 coils, stomach scarcely differentiated; no pyloric caeca. Vertebrae, including Weberian ossicles, 45–47.

Nuptial tubercles developed, on breeding males only, on lower lobe of caudal fin, anal fin, and head.

Colour The adults are generally dark, with strong countershading. The back, upper sides, and head to below the eyes, are dark olive with brassy reflections, or grey to almost black, the lower sides and the ventral surface of head and body are cream to white. At breeding time, the males and females have a broad, horizontal, midlateral band of vivid rose or wine which continues on to the snout, that of the male is more vivid. The upper surface of the body of males is almost black, that of females green-gold to coppery brown. The undersurface of the head including the mouth, is often yellow to orange. The ventral surface of the body is white to pink. The unpaired fins are dusky to dark, sometimes edged in pale red, the paired fins amber, suffused with pale pink.

The young are dark in colour, somewhat mottled on the back.

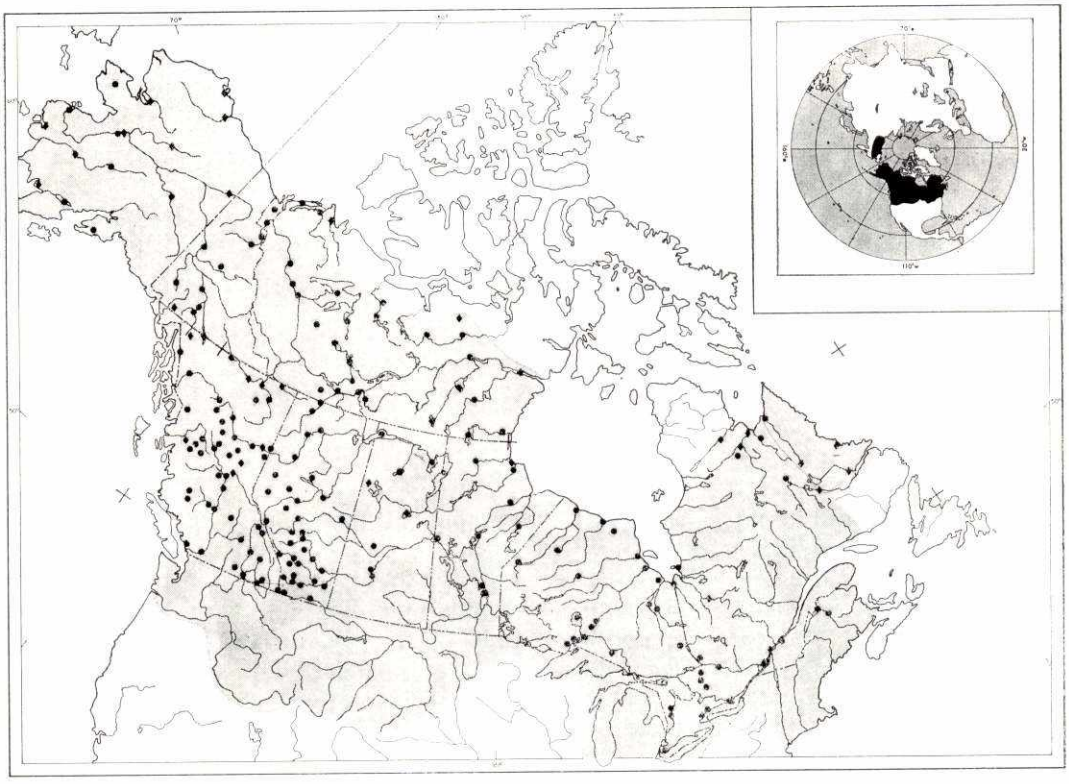
Systematic notes This species, like the white sucker, is extremely variable, and was once thought to be several subspecies such as *retropinnis*, *griseus*, *richardsoni*, and *rostratus*. It is known in various places over its range in a semidistinct dwarf form, known in the east as *C. c. nannomyzon*, as *C. c. lacustris* in Jasper Park, and as *C. c. pocatello* in the western United States. McPhail and Lindsey (1970) spoke of two morphological forms in the northwest, those in the Bering Sea drainages with 23–29 (usually 25 or 26) gill rakers and those in eastern Canada and waters as far west as the Mackenzie River with 25–30 (usually 27 or 28) gill rakers. Populations in New Brunswick appear to differ from those in Ontario but this may be simply a reflection of the great variability over the entire range.

Distribution This is the only North American sucker which occurs in Asia as well. It is present in Arctic drainages of Siberia from the Yana, Kolyma and Anadyr rivers. In North America it occurs from central Quebec and western Labrador south to Maryland, west through Pennsylvania, north to Minnesota, absent from all but the upper Mississippi in Minnesota, to northern Colorado, north through Washington to Alaska.

In Canada, especially in the northwest, the longnose sucker is more general in occurrence than even the lake trout and the northern pike. It occurs from New Brunswick, Quebec north to Povungnituk, and central Ungava, western Labrador, generally throughout the rest of the provinces and territories other than northeastern Keewatin and extreme southwestern British Columbia. Not present in the Arctic islands or Newfoundland.

Biology The biology of this species in Canada is not so well documented as that of the white sucker but more information is available than for many other species. Useful summaries of information were written by Harris (1962) and Geen et al. (1966) and much of the following is taken from these two accounts.

Longnose suckers spawn in the spring, in streams where available, but otherwise in shallow areas of lakes. They enter spawning streams as soon as stream temperature exceeds 41° F (5° C) usually in mid-April to mid-May. The spawning run of this sucker begins and reaches a peak several days before the run of white suckers in the same stream. Longnose suckers move upstream between noon and midnight with the greatest number moving in the evening hours. Spawning often takes place in stream water 6–11 inches (152–279 mm) deep, with a current



from 30 to 45 cm per second and a bottom of gravel 50–100 mm in diameter. During spawning, which takes place during the period 6 AM to 9 PM, a female moves from quiet water near shore into a group of males near stream centre. Two to four males crowd around one female, clasping her with, or beating against her with, their anal fins, and thrash about. Spawning act lasts for 3–5 seconds and occurs as often as 6–40 times per hour. After depositing eggs, the sexes separate and return to their previous stream positions. No nest is built, the white, adhesive, demersal eggs are laid in small numbers and adhere to the gravel and substrate. Ripe eggs in the ovary are yellow, 2.8–3.0 mm in diameter, and invested with a thin gelatinous coating. Egg number ranges from 17,000 to 60,000 per female. As early as 5 days after the migration begins, some adults are leaving the spawning streams, so the spawning period is of short duration. Mortality of adults during the spawning run is probably no more than 10–25%. Eggs hatch experimentally in 8 days at 59° F (15° C) and 11 days at 50° F (10° C), but hatching probably takes 2 weeks in nature at the prevalent stream temperatures. The young remain in the gravel 1–2 weeks before emerging and in June, or about 1 month after spawners first appear, fry are moving down to the lake. At this time, they are 10–12 mm in length. Fry in Great Slave Lake in 1950 had grown to a maximum of 80 mm by the end of August. Growth rate in older longnose suckers was calculated at approximately 15–20 mm per year. Most published accounts of ages and age–length relations are based on ages estimated from scales. On the bases of a critique by Beamish and Harvey (1969) of aging by scales in white suckers, these published ages may be less than actual by as much as 5 years. Published age–length relations for various Canadian populations are as follows: