Bowfin Family—Amiidae

One species of bowfin is known from Wisconsin and North America.

By the late Palaeozoic period (200 million years ago) the first holostean fish, a form similar to the living *Amia*, had appeared, and from fishes such as these the teleosts evolved (Moy-Thomas and Miles 1971). Ancestral bowfins were especially well represented in middle Mesozoic strata, over 100 million years ago. Today there is only one living family, Amiidae, which is restricted to North America, and within this only one species, *Amia calva*, remains. This primitive fish is a phylogenetic relict, the lone survivor of a large family now found only as fossils in the rocks of Europe and the United States.

Amia has a rather primitive skeleton, partly bone and partly cartilage. It has a double skull: the outer bony, the inner cartilaginous but becoming bony around the openings through which the cranial nerves pass. The bony gular plate under the tip of the lower jaw is a skeletal oddity, as are the unicornlike clavicles in the pectoral girdle, peculiar serrated appendages believed to be remnants of organs which were larger and performed some function in more or less remote ancestors (Liem and Woods 1973).

Both bowfins and gars have kidney tubules opening directly into the coelomic cavity. This condition, common in the embryos of many fishes, persists in the adults of only primitive species; other adult freshwater rayfin fishes have their kidneys closed off from the body cavity.

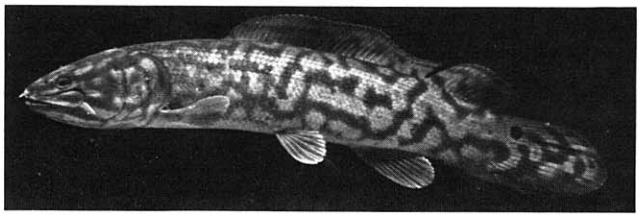
On the other hand, *Amia* exhibits evolutionary advances: a gas bladder used as a primitive lung; an egg transport system similar to that of the shark and of terrestrial vertebrates; cellular elements in the headbones

which produce all types of blood cells, thereby anticipating the blood-making function of the bone marrow of higher vertebrates; and a highly specialized reproductive habit in which parental care plays a conspicuous role. It is the only primitive ganoid showing such a highly specialized reproductive habit.

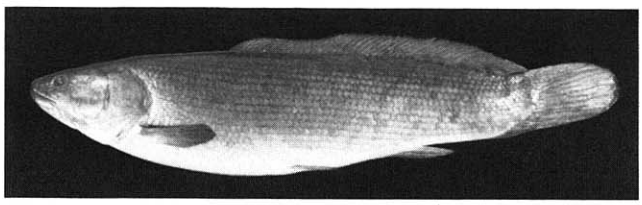
Bowfin

Amia calva Linnaeus. *Amia*—ancient name of a fish, probably the bonito, *Sarda sarda*; *calva*—bald.

Other common names: dogfish, mudfish, grindle, John A. Grindle, grinnel, lake lawyer, lawyer, cottonfish, blackfish, speckled cat, beaverfish, scaled ling, spot-tail.



Immature (Wisconsin DNR photo)



Adult female 632 mm, Crystal R. (Waupaca Co.), fall 1977

DESCRIPTION

Body moderately long, stout, oval in cross section. Adult length 500 mm. Head flattened above, head length into TL 3.8–4.9. Anterior nares or nasal tubes 2, prominent barbel-like structures on snout (9.5 mm long in 645-mm fish). Teeth numerous, caninelike; some short, peglike on upper and lower jaws. Gular plate heavy. Scales "polygono cycloid," large, 63–70 in lateral line. Dorsal fin long, soft-rayed, low, its length into TL 2.1–2.4. Caudal fin rounded, abbreviate-heterocercal (vertebrae moving into dorsal portion of fin). Chromosomes 2n = 46 (Ohno et al. 1969).

Back and sides olive-colored, often with dark, netlike mottling; belly cream-colored to white. Paired fins and anal fin bright green. Up to time of maturity both sexes with a round-to-oval black spot at the base of the upper caudal rays.

Sexual dimorphism: Mature male with black spot on upper caudal rays rimmed with orange-yellow. Mature female without black spot on peduncle; probably an inhibitory action of an ovarian hormone (Zahl and Davis 1932); female generally larger than male.

The caudal spot is an illustration of a deflective mark in a fish: a mark which deflects the attack of an enemy from a more or less vital part of the body to some other part (Lagler et al. 1962).

DISTRIBUTION, STATUS, AND HABITAT

The bowfin occurs in the Mississippi, Lake Michigan, and Lake Superior drainage basins. In the Mississippi River system it is distributed in the Mississippi and Wisconsin rivers, in their larger tributaries, and in the glacial lakes of the southeastern and northwestern sectors of the state. In the Lake Michigan watershed it occurs in the Fox and Wolf rivers, in their interconnecting lakes, and in lower Green Bay of Lake Michigan. Except for a single report from Milwaukee, Greene (1935) did not encounter this species in the Lake Michigan watershed. He had neither records nor reports from the Wolf-Fox system. This species may have been introduced into the Fox-Wolf system through fish rescue and transfer operations from the Mississippi River during the 1930s, or it may have made recent entry via the Fox-Wisconsin Canal at Portage. In the Lake Superior watershed it has been reported only from the St. Louis River (Sather and Johannes 1973) and Middle River (Moore and Braem 1965). In Wisconsin the bowfin is at the northern limit of its range.

In Wisconsin the bowfin is uncommon to common in large rivers and lakes. It is rare in Lake Winnebago (Priegel 1967a). This species is secure in Wisconsin.

The bowfin inhabits lakes and large sluggish rivers, generally in clear water with abundant vegetation. The smallest stream with a bowfin record is the Des Plaines River (Kenosha County), which, at the collection site, is a wide, sluggish stream, just above several miles of marsh (Greene 1935).

BIOLOGY

In southern Wisconsin spawning occurs from late April to early May (Cahn 1927); upstate it occurs as late as early June (Priegel 1963d). Optimum temperature for nest construction and spawning is 16–19°C (61–66°F) (Scott and Crossman 1973). The male builds a nest by biting off the vegetation in an area 46–76 cm (1.5–2.5 ft) diam in water from 61 to 152 cm (2–5 ft) deep. When he has cleared away the weeds, a bed of soft rootlets, sand, or gravel in a trough 10–20 cm (4–8 in) deep remains for the eggs. A female is attracted to the nest and spawning takes place, usually at night. The female lies on the bottom of the nest, the male circles about her for 10 or 15 minutes, sometimes nipping her snout or sides. The male then takes up a position beside the female, both fish violently agitate their fins, and eggs and milt are released over a period of less than 1 minute.

Richardson (1913) gave 2,000–5,000 eggs as the normal number per nest. Eddy and Underhill (1974) reported as many as 64,000 eggs in the ovaries of a

Range of the bowfin
- ● Specimens examined
- ▲ Wisconsin Fish Distribution Study (1974–75)
- ○ Literature and reports
- ○ Greene (1935)

53-cm (21-in) fish. Bowfin eggs are slightly elliptical, 2.8 × 2.2 mm (Breder and Rosen 1966).

After one or more females have spawned in the nest, the male guards the eggs for the 8 to 10 days required for hatching (Purkett 1965). Upon hatching, the 8-mm-long larvae attach themselves to rootlets by an adhesive organ on their snouts or lie on their sides in the bottom of the nest until they are 9 days old and about 12 mm (0.5 in) long. The adhesive organ is no longer used, and the larvae will swim, begin feeding, and follow the male in a close school, often referred to as a ball of young. If one becomes separated from the parent, it swims in close circles until its protector reappears.

While in this vulnerable milling mass, the young are generally carefully guarded by the male. Some of the most unusual records of fish attacks are attributed to male bowfins protecting their young. Kelly (1924) reported that a 356-mm (14-in) fish, guarding 30–40 young, rushed him while he was standing on the bank. The attack carried the fish out of the water 203 mm (8 in) up a slightly sloping grassy bank and was repeated several times. When a pole was placed in the water, the fish attacked it and bit the end of it.

Cahn (1927:26) described the defense of the young by the male: "While guarding the young, the male dogfish will attack anything that threatens the precious mass of youngsters. I have had the parent attack nets, rakes, sticks—anything I thrust toward the ball of young; a vicious attack, a strike at the intruding object, a dash away to a distance of about six feet, a swift turn and another vicious attack. During this performance by the old fish, the school breaks up in every direction, the young going to the bottom and scurrying toward deeper water under the protection of the vegetation." Lagler et al. (1962) noted that the adult will create diversionary splashes in a direction away from the mass of young while the little school moves away.

Adults have also been known to take flight (Doan 1938). A vigorous sweep of a male's tail not only sent it out of sight but also threw the swarm of young fish to the bottom, where they were effectively screened from sight in the newly muddied water. After about

5 min the adult forced its way, unseen, through the bottom debris and became visible only when it raised its head up in the vicinity of the young. They immediately left their hiding places and collected again in a free-swimming school about the parent.

When the young fish reach a length of about 102 mm (4 in), some 2–2½ months after the males begin their nest-constructing activities, the juvenile school, having become progressively looser, breaks up. The fact that the young are rarely seen after the schools break up suggests they move to deeper water or to dense vegetation.

Growth is rapid; some young exceed 203 mm (8 in) during their first year of life. The ages and calculated growth at each annulus in the table below are tentative. The scale annuli were difficult to identify, and sample sizes were not large enough to check the validity of our determinations.

Noland (1951) reported a 737-mm (29-in) fish from Lake Wingra (Dane County) which weighed 3.9 kg (8 lb 10 oz); a 4.1-kg (9-lb) fish was caught from the Mississippi River at La Crosse in August 1978. Large bowfins may weigh in excess of 6.8–9.1 kg (15–20 lb) (Purkett 1965, Scott and Crossman 1973). A fish 109 cm (43 in) long was reported from New York (Rimsky-Korsakoff 1930). According to Carlander (1969), bowfins have been kept in captivity for periods of 20 years, 24 years, and 30 years.

Schneberger (1937b) encountered a school of 5,500 young which were 45–70 mm (1.75–2.75 in) long in a small bay off Lake Minocqua Thoroughfare near Woodruff. An analysis of 30 stomachs disclosed damselfly nymphs, *Hyallela*, chironomid larvae, and plankton crustaceans. Phytoplankton, especially filamentous algae, was found in each specimen. Ten bowfin young were placed in an aquarium and a dozen 19-mm (0.75-in) largemouth bass fry were put into the tank. The bass were viciously attacked by the small bowfins, and in a few seconds all were consumed. Schneberger concluded, however, that bowfins of this size in their native habitat have not yet become piscivorous.

In southeastern Wisconsin, Cahn (1927) reported that the bowfin's diet varies between fish and crayfish. He found many species of minnows, bluegills, pumpkinseed, largemouth and smallmouth bass, and perch—"in fact, small specimens of all of the game or food fishes." Pearse (1918) noted that 16 bowfins (383–465 mm long) from Lakes Mendota, Monona, and Wingra had 90.1% fish remains and 9.4% crayfish remains in their alimentary tracts. Other animals eaten are small rodents, snakes, turtles, frogs, large insects and their larvae, and leeches (Lagler et al. 1962, Harlan and Speaker 1956). The bowfin is an opportunist rather than a selective predator. It often feeds at night.

The bowfin's voracious feeding habits are commonly mentioned in the literature. Gluttony, the inclination to eat long after the normal capacity of the animal has been reached, has been described for the bowfin in aquariums (Lagler et al. 1962). Eddy and Underhill (1974) noted that one bowfin in their aquarium attacked another about half its size and carried the victim in its mouth for 24 hours before completely swallowing it.

The reputation of the bowfin's gluttony has grown to the point of exaggeration, and although it purportedly "has strong sharp teeth and is said to bite a 2-lb fish in two at a single snap," this is hardly likely. The bowfin is also capable of prolonged fasting; one was inadvertently left in an aquarium without food and was discovered a year later, still alive though quite gaunt (Eddy and Underhill 1974).

The air-breathing habit begins early in life, and when the ball of young fish is undisturbed, individuals will occasionally leave the school and surface for a gulp of air. Horn and Riggs (1973) noted that at temperatures of 4.4–10°C (40–50°F) air breathing is negligible. At 10°C and below, the bowfin is relatively inactive and is almost exclusively a water breather. Above 10°C the rate of air breathing consistently increases as the temperature increases. Air-breathing activity is greatest between 18.4 and 29.6°C (65 and 85°F) and during the 35.3°C (96°F) period—the critical

Date	No. of Fish	TL (mm)	Calculated TL at the Annulus (mm) 0	1	2	3	4	5	6	7	8	Location
2 July 1934[a]		45–70	45–70									Minocqua Thoroughfare (Oneida Co.)
13 July 1962	1	122	122									Wisconsin R. (Grant Co.)
13 July 1962	3	178–512		180	337	389	416	427				Wisconsin R. (Grant Co.)
23 Jan. 1968	8[b]	504–704		207	358	448	519	573	619	678	701	Wisconsin R. (Adams Co.)
28 Oct. 1967	1	251		153	190							Wolf R. (Outagamie Co.)
20 July 1975	1	320		177	253							Taylor L. (Waupaca Co.)
18 Sept. 1973	1	380		100	201	302						Beaver Dam R. (Dodge Co.)
9 June 1968	1	610		195	363	490	538	563	598			Green Bay (Brown Co.)

[a] Source: Schneberger 1937b.

[b] Includes four males, 585–690 mm (23.0–27.2 in) TL, all age VI; three females 604–704 mm (23.8–27.7 in) TL, ages VI–VIII; and one individual 504 mm (19.9 in), sex undetermined.

thermal maximum for this species. With increasing temperature and activity, the rate of oxygen depletion from the gas bladder increases progressively and the air-breathing rate increases. The bowfin has a higher breathing rate during darkness, correlated with an increase in the fish's activity.

That it is possible for the bowfin to survive prolonged air-breathing periods seems to be indicated by an incident reported from Alabama (Green 1966). A shallow pond that had been drained for half a year was filled with water and stocked during February and March with five sexually mature bowfins (two males, three females) taken from a nearby river slough. When the pond was drained on 22 April, 51-mm (2-in) young were seen, along with two bowl-shaped nests, suggesting that both male bowfins had incubated broods. Over a 21-day period, from 23 April to 11 May, this pond was dry. Seepage from other ponds made the bottom moist in many areas, but there was no accumulation of water. On 12 May the pond was refilled and stocked with about 150 goldfish. When it was drained again on 28 August, 24 bowfins were recovered with the goldfish. These bowfins averaged 406 mm (16 in) and 680 g (1.5 lb). Evidently some young had survived a prolonged air-breathing period.

Neill (1950) reported having unearthed an aestivating bowfin in a chamber 102 mm (4 in) below the ground surface and 203 mm (8 in) diam, 0.4 km (0.25 mi) from a river, the flood level of which had previously reached that location. Greenbank (1956) noted that, with a lowering of water level in the Mississippi River, bowfin, carp, northern pike, and crappies moved with the resultant current out of the backwaters. The fish appeared to be moving actively and were not merely swept along with the current. Some bluegills and largemouth bass, however, tended to remain in the backwaters, there to become trapped by the lowered water level.

Adult bowfins usually live in deep water, coming into shallows at night and during the breeding season. In winter they have been found closely huddled in gravelly pockets among water weeds (Coker 1930). Bowfins swim effortlessly, both forwards and backwards, by deliberate undulations of their elongated dorsal fins.

IMPORTANCE AND MANAGEMENT

The bowfin is host to the glochidia of the mollusk *Megalonaias gigantea* (Hart and Fuller 1974).

Most bowfins are caught while the angler is fishing for other species. Anglers discover that this fish is a rugged fighter that strikes hard and fights better than some highly rated sport fish; it is worth seeking for angling fun. When a large bowfin is hooked it will frequently sound and lie on the bottom like a water-soaked log. Spearing for bowfins may occur early in the year as the ice opens up and the bowfins congregate about the openings. I have seen more than 50 large bowfins 1.8–3.6 kg (4–8 lb) that had been speared and discarded on either side of a causeway on Petenwell Flowage (Adams County).

The bowfin is taken commercially by setlines, gill nets, seines, buffalo nets, and slat nets from the Mississippi River. During 1956–1965, a total of 30,770 kg (67,843 lb) were harvested from Wisconsin waters; during 1966–1975, 28,580 kg (63,006 lb). The largest catch was 5,626 kg (12,403 lb) in 1961. Its value to the commercial fisherman in 1975 was $0.04 per kilo.

Small bowfins make colorful, fascinating, and easily maintained aquarium subjects.

Reports as to the edibility of the bowfin are conflicting. Some describe its flesh as "soft, pasty, not especially palatable, unfit for use unless prepared in some special manner," while others say it is "very palatable, passably palatable, one of the best of all smoked fishes." V. Hacker (pers. comm.) noted that if bowfin flesh is frozen for 30–40 days before brining and smoking, it becomes hardened and makes very desirable eating. MacKay (1963) reported that it may be marinated in spices and vinegar before cooking, baked in highly seasoned dressing, or smoked. Scott and Crossman (1973) reported that the flesh is dry and has a mild flavor; when molded into patties, dipped in egg and bread crumbs or corn meal, it makes reasonably good eating.

Because the bowfin is not generally accepted as a food fish and because it feeds extensively on other fishes, it usually is considered undesirable. But since it inhabits waters likely to be populated by panfish or nongame fishes, the bowfin is often an asset. It may be quite effective in preventing stunting in sport fish populations (Purkett 1965, Scott and Crossman 1973, Berry 1955, Walden 1964).

The bowfin is frequently part of the fish fauna in many excellent sport and panfish waters in Wisconsin. In fact, the quality of such waters may be attributable in part to the presence of this species. Some fishery managers are considering the possibility of using this species, as well as the gar and the burbot, in lakes and ponds which are plagued with stunted panfish populations. On the basis of the scanty evidence we have today, it is possible that under certain circumstances the bowfin may be an essential part of a healthy aquatic ecosystem.