Polyodon spathula

(American paddlefish or paddlefish)

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By John Jerome

Kingdom: Animalia
Phylum: Chordata
Subphylum: Vertebrata
Class: Actinopterygii
Order: Acipenseriformes
Family: Polyodontidae
Genus: Polyodon
Species: **Polyodon spathula**

Geographic Range

Polyodon spathula (American paddlefish) is currently found in 22 states that are part of the Mississippi River drainage (Mims, 2001). American paddlefish distribution is now restricted to this system of large, slow-moving rivers. In the past, *P. spathula* was located in 4 more states in this drainage, the Great Lakes, and Canada (Graham, 1997). The many dams that have been added throughout the Mississippi River drainage have limited the ranges of many populations of these fish (Wills, 1993). Due to these unnatural blockages, migratory breeding behavior has been disrupted, and many areas previously sustaining paddlefish must be annually stocked by local conservation agencies (Graham, 1997). (Graham, 1997; Mims, 2001; Wills, 1993)

Biogeographic Regions: nearctic (native).

Habitat

American paddlefish are mainly freshwater fish but can survive in brackish water (Billard, 2001). They generally reside in large rivers with deep water (greater than 6 meters) and slow moving currents (less than 5 cm/s) (Zigler, 2003; Southall, 1984). Turbid (muddy) water is preferred by *P. spathula*. During migratory breeding events, *P. spathula* needs

access to areas with sand or gravel bars (Wills, 1993). (Billard and Lecointre, 2001; Southall and Hubert, 1984; Wills, 1993; Zigler, Dewey, and Knights, 2003)

These animals are found in the following types of habitat: temperate; freshwater.

Aquatic Biomes: lakes and ponds; rivers and streams; brackish water.

Physical Description

Mass
70 kg (high); avg. 18 to 45 kg
(154 lbs; avg. lbs)

Length
2.50 m (high)
(8.2 ft)

American paddlefish are clearly distinguishable from other North American fish by the presence of an extended snout, or rostrum. This rostrum is covered with electroreceptors to locate zooplankton and facilitate migratory behavior. American paddlefish are large, reaching maximum lengths of up to 2.5 meters and weighing from 18 to 70 kg. Males are generally larger than females (Wilkens, 2002). Large gill rakers are present in these fishes for zooplankton consumption from turbid waters (Russell, 2002). They also have a cartilaginous skeleton, heterocercal tail, and lack scales (Wills, 1993). (Russell and Neiman, 2002; Wilkens, Hoffman, and Wojtenek, 2002; Wills, 1993)

Some key physical features: ectothermic; heterothermic; bilateral symmetry.

Sexual dimorphism: male larger.

Development

After fertilization, developing American paddlefish may be seen through their transparent roe, or eggs. In 24 hours the notochord develops, and a heartbeat is apparent by day four. By the fifth day, young *P. spathula* hatch and begin their larval stage of life. They are then carried somewhere downstream by slow moving river currents (Wills, 1993). Once gill rakers fully form, juvenile paddlefish can effectively filter feed (Mims, 2001). Female American paddlefish are not fully mature until they reach 12 to 14 years of age and males are mature at ages of 6 to 7 years (Wills, 1993). (Mims, 2001; Zigler, Dewey, and Knights, 2003)

metamorphosis; indeterminate growth.

Reproduction

Breeding interval
American paddlefish breed every 2 to 3 years.

Breeding/spawning seasonBreeding season
American paddlefish spawn in the late winter and spring.

Number of offspring
many thousands (average)

Time to hatchingGestation period
5 days (high)

Age at sexual or reproductive maturity (female)
10 to 12 years; avg. 11 years

Age at sexual or reproductive maturity (male)
6 to 7 years; avg. 6.50 years

Paddlefish are broadcast spawners whereby multiple males swim near and release milt onto the eggs liberated by a female. The eggs are very sticky and thus adhere to a substrate such as gravel or sand (Wills, 1993). A spawning migration occurs within the Mississippi River system making paddlefish a potamodromous species. During the peak of the breeding season in the spring, large shoals of male and female fish form in specific breeding areas to spawn (Billard, 2001). (Billard and Lecointre, 2001; Wills, 1993)

Mating systems: polygynandrous (promiscuous).

Female American paddlefish are very particular about when they will release their eggs for reproduction. It has been noted that spawning generally occurs only every 2 to 3 years based upon certain environmental stimuli. At a specific spring photoperiod, there must be a rise in the water level of the river accompanied by a water temperature of approximately 55 to 60 degrees Fahrenheit (Wills, 1993). (Wills, 1993)

Key reproductive features: iteroparous; seasonal breeding; gonochoric/gonochoristic/dioecious (sexes separate); sexual; fertilization (external); broadcast (group) spawning; oviparous.

Beyond the production of roe and milt, female and male American paddlefish provide nothing in the form of parental investment. The yolk sack of larval padlefish is consumed after hatching which may be considered a form of pre-fertilization provisioning by the female (Wills, 1993). These fishes are an excellent example of a species with a life history strategy designed to maximize success by producing many more eggs than will survive, rather than providing parental care. (Wills, 1993)

Parental investment: no parental involvement; pre-fertilization (provisioning).

Lifespan/Longevity

Longest known lifespan in wild
55 years (high)

Expected lifespan in wild
20 to 30 years

American paddlefish are relatively long-lived, they may live up to 55 years. The average lifespan as estimated in dentary studies seems to be about 20 to 30 years (Wills, 1993). (Wills, 1993)

Behavior

Relatively little is known of *P. spathula* behavior towards conspecifics or members of different species. More is known about American paddlefishes physiological behavior in terms of feeding and respiration. American paddlefish can often be seen swimming around with their very large mouths wide open. This is a behavior that allows the fish to filter feed and ventilate their gills (ram ventilation) at the same time (Burggren, 2003). It is also known that American paddlefish swim in a fairly primitive manner involving undulation of nearly the entire body (Wills, 1993). (Burggren and Bemis, 1992; Wills, 1993)

Home Range

Polyodon spathula ranging behavior has been inferred from radio tagging experiments. These show that paddlefish generally restrict their movement to a certain home range, but that they frequently stray from this area, especially during spring breeding seasons (Zigler, 2003; Jennings, 1993). During the breeding season, American paddlefish migrate upstream to gravel or sand bars, but they generally never leave the freshwater of the Mississippi River basin (Wills, 1993) (Jennings and Wilson, 1993; Wills, 1993; Zigler, Dewey, and Knights, 2003)

Key behaviors: natatorial; motile; migratory.

Communication and Perception

The large rostrum (paddle) of *P. spathula* is covered with electroreceptors (Russell, 2002). This paddle is essentially a

highly sensitive antenna used to gather information about the surrounding environment through changing electrical fields. This electric sense is used by American paddlefish to locate prey and successfully migrate during spawning seasons (Wilkins, 2002). This system is so sensitive that juveniles can locate single zooplankton from up to 9 cm away by sensing the miniscule electrical pulses given off by the animal's muscle contractions (Wilkins, 2002; Wills, 1993). It is unclear how *P. spathula* individuals communicate during spawning, but they may use a combination of visual and tactile cues. (Russell and Neiman, 2002; Wilkens, Hoffman, and Wojtenek, 2002; Wills, 1993)

Communicates with: visual; tactile.

Perception channels: visual; tactile; chemical; electric.

Food Habits

Polyodon spathula is a faunivore specialized for filter feeding. As described above, American paddlefish use electroreceptors to locate zooplankton in turbid water (Wilkins, 2002). Examples of animals in the *P. spathula* diet are copepods, cladocerans such *Daphnia pulex*, and ephemeropteran nymphs (Hoxmeier, 1997). *Polyodon spathula* possesses huge gill rakers along with jaws that are anatomically independent from the neurocranium (Carroll, 2003). These features allow for a larger surface area to be filtered by American paddlefish. (Carroll and Wainwright, 2003; Hoxmeier and DeVries, 1997; Wilkens, Hoffman, and Wojtenek, 2002)

Primary Diet: planktivore.

Animal Foods: insects; aquatic crustaceans; zooplankton.

Behaviors: filter-feeding.

Predation

Known predators

- Humans
- plantivorous fish (on larvae and eggs)
- birds (on larvae and eggs)

It is speculated that the large size and extended life span of *P. spathula* is an adaptation to avoid predation. Producing high concentrations of paddlefish offspring in a single season may be a predator satiating mechanism used to maximize the chances of survival for a smaller, but significant proportion of *P. spathula*. When American paddlefish are in their larval stage they are easy prey for many different birds and fishes, but at maturity their only real predators are humans (Wills, 1993). (Wills, 1993)

Ecosystem Roles

American paddlefish are predators of zooplankton and prey to other fishes, birds, and humans. Also, silver lampreys have been found to use American paddlefish as hosts (Cochran, 2004). Beyond these relationships, relatively little is known of the role of American paddlefish in their ecosystem. (Cochran and Lyons, 2004)

Economic Importance for Humans: Negative

There are no known adverse affects of *P. spathula* on humans.

Economic Importance for Humans: Positive

Perhaps to the benefit of humans and the detriment of American paddlefish, these fish are highly valuable in many ways. Due to their large size and succulent flesh, *P. spathula* has long been utilized as a source of meat. Also, being closely related to sturgeons (family Acipenseridae), American paddlefish produce highly coveted roe, or caviar. In the 1980's a trade embargo of Iranian imports severely limited the amount of caviar that was imported to the United States

from the Caspian Sea. As the demand for caviar increased, American paddlefish suffered heavy population losses as the illegal acquisition of their roe became a highly profitable endeavor (Wills, 1993). (Wills, 1993)

Beyond *P. spathula* being a source of caviar, their skin is thick, scaleless, strong, and tans well, making it a marketable product. There is also a growing interest in the immune system of American paddlefish. Despite their extremely simple immune system, they rarely, if ever, get cancer due to their cartilaginous skeleton. Cartilage prohibits blood flow to cancerous cells that is necessary for their growth, thereby stopping the spread of cancer. Therefore, American paddlefish have been a useful and promising test subject in the field of aquatic pharmacology (Wills, 1993). (Wills, 1993)

Since American paddlefish are extremely beneficial to humans in many ways, they are currently being farm raised in the U.S. (Mims, 1999), and as far away as Russia, Romania, and Moldavia (Vedrasco, 2001). Most of the fish at these farms are produced for their valuable meat and caviar (Vedrasco, 2001). (Mims and Shelton, 1999; Vedrasco, Lobchenko, and Billard, 2001)

Ways that people benefit from these animals: food; body parts are source of valuable material; research and education.

Conservation Status

IUCN Red List: http://www.redlist.org: Vulnerable.

US Federal List: http://endangered.fws.gov/wildlife.html: No special status.

CITES: http://www.cites.org/eng/append/appendices.shtml: Appendix II.

Polyodon spathula populations are most threatened by dams throughout the Mississippi River basin. These cause a separation of American paddlefish populations which limits gene flow and thus genetic variability. Dams also prevent the natural migratory spawning behavior of American paddlefish (Wills, 1993). Due to their highly valuable meat and roe, *P. spathula* has been over-harvested in the past. This has lead to more regulations on paddlefish harvesting, and many states now actively stock areas of river with American paddlefish (Graham, 1997). (Graham, 1997; Wills, 1993)

Other Comments

Polyodon spathula was first described by J. Walbaum in 1792 (Walbaum, 1792). (Walbaum, 1792)

Contributors

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