Anglerfish

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Anglerfishes are fish that are members of the teleost order **Lophiiformes** /ˌlɒfiːəˈfɔrmiːz/.[1] They are bony fish named for their characteristic mode of predation, in which a fleshy growth from the fish's head (the esca or illicium) acts as a lure.

Anglerfish are also notable for extreme sexual dimorphism seen in the suborder Ceratioidei, and sexual parasitism of male anglerfish. In these species, males may be several orders of magnitude smaller than females.[2]

Anglerfish occur worldwide. Some are pelagic, while others are benthic; some live in the deep sea (e.g., Ceratiidae) while others on the continental shelf (e.g., the frogfishes Antennariidae and the monkfish/goosefish Lophiidae). Pelagic forms are most laterally compressed, whereas the benthic forms are often extremely dorsoventrally compressed (depressed), often with large upward-pointing mouths.

Anglerfish

Temporal range: 130–0Ma

Pre O S D C P T J K Pg N

Early Cretaceous – Recent

Humpback anglerfish, *Melanocetus johnsonii*

Scientific classification

Kingdom:	Animalia
Phylum:	Chordata
Class:	Actinopterygii
Subclass:	Neopterygii
Infraclass:	Teleostei
Superorder:	Paracanthopterygii
Order:	**Lophiiformes** Garman, 1899

Contents

Evolution

A mitochondrial genome phylogenetic study suggested the anglerfishes diversified in a short period of the early to mid Cretaceous, between 130 and 100 million years ago.[3]

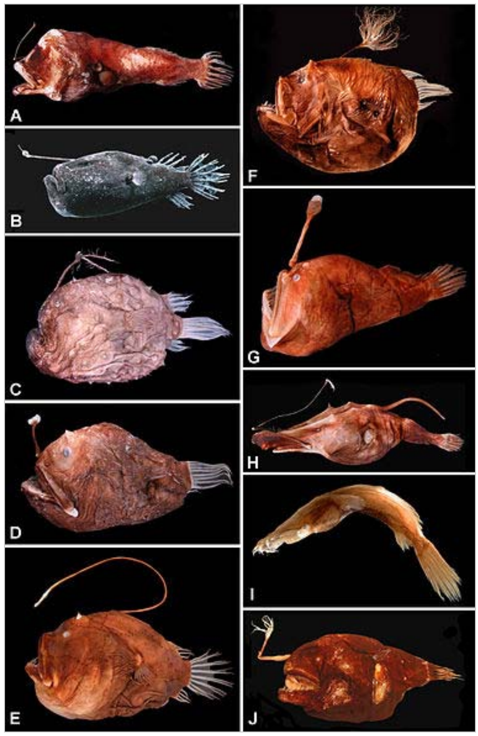
Ranging in color from dark gray to dark brown, these carnivores have huge heads that bear enormous, crescent-shaped mouths full of long, fang-like teeth angled inward for efficient prey grabbing. Their length can vary from 8.9 cm (3.5 in) to over 1 m (3 ft) with weights up to 45 kg (100 lb).[4]

Classification

FishBase,[1] Nelson, [5] and Pietsch[2] list 18 families, but ITIS[6] lists only 16. The following taxa have been arranged to show their evolutionary relationships.[2]

- Suborder Lophioidei
  - Lophiidae (Goosefishes or monkfishes)
- Suborder Antennarioidei

  - Antennariidae (Frogfishes)
  - Tetrabrachiidae (Four-armed frogfishes)[7]
  - Brachionichthyidae (Handfishes)
  - Lophichthyidae (Boschma's frogfish)[7]
- Suborder Chaunacoidei
  - Chaunacidae (Sea toads)
- Suborder Ogcocephaloidei
  - Ogcocephalidae (Batfishes)
- Suborder Ceratioidei
  - Centrophrynidae (Prickly seadevils)
  - Ceratiidae (Warty seadevils)
  - Himantolophidae (Footballfishes)
  - Diceratiidae (Doublespine seadevils)
  - Melanocetidae (Black seadevils)
  - Thaumatichthyidae (Wolf-trap seadevils)
  - Oneirodidae (Dreamers)
  - Caulophrynidae (Fanfin seadevils)
  - Neoceratiidae (Needlebeard seadevil)
  - Gigantactinidae (Whipnose seadevils)
  - Linophrynidae (Leftvent seadevils)



(A) *Centrophryne spinulosa*, 136 mm SL
(B) *Cryptopsaras couesii*, 34.5 mm SL
(C) *Himantolophus appelii*, 124 mm SL
(D) *Diceratias trilobus*, 86 mm SL
(E) *Bufoceratias wedli*, 96 mm SL
(F) *Bufoceratias shaoi*, 101 mm SL
(G) *Melanocetus eustalus*, 93 mm SL
(H) *Lasiognathus amphirhamphus*, 157 mm SL
(I) *Thaumatichthys binghami*, 83 mm SL
(J) *Chaenophryne quasiramifera*, 157 mm SL.

Anatomy

Most adult female ceratioid anglerfish have a luminescent organ called the esca at the tip of a modified dorsal ray (the illicium, or "fishing rod"). The organ has been hypothesized to serve the obvious purpose of luring prey in dark, deep-sea environments, but also serves to call males' attention to the females to facilitate mating. The source of luminescence is symbiotic bacteria that dwell in and around the esca. In some species, the bacteria recruited to the esca are incapable of luminescence independent of the anglerfish, suggesting they have developed a symbiotic relationship and the bacteria are unable to synthesize all of the chemicals necessary for luminescence. They depend on the fish to make up the difference. Electron microscopy of these bacteria in some species reveals they are Gram-negative rods that lack capsules, spores, or flagella. They have double-layered cell walls and mesosomes.[8]

In most species, a wide mouth extends all around the anterior circumference of the head, and bands of inwardly inclined teeth line both jaws. The teeth can be depressed so as to offer no impediment to an object gliding towards the stomach, but prevent its escape from the mouth. The anglerfish is able to distend both its jaw and its stomach, since its bones are thin and flexible, to enormous size, allowing it to swallow prey up to twice as large as its entire body.

Behavior

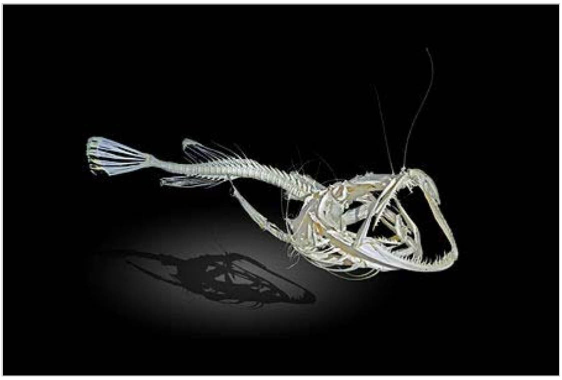
Swimming and energy conservation

Many anglerfish species are deep-sea dwellers, which poses a challenge to ecologists who hope to study and observe the fish. Anglerfish morphology reflects the value of energy conservation for these organisms which often live in extremely prey-scarce environments.[9] Some researchers suggest this is why many ceratioids minimize their energy use by remaining lethargic and using a lie-and-wait hunting strategy.[10] Anglerfish are particularly well suited to conserve energy because they are able to hunt and forage while remaining lethargic, devoting just 2% of energy intake to swimming.

In one rare ROV observation of an *in-situ* anglerfish, researchers observed several rapid swimming and avoidance behaviors. In 74% of the video footage, the fish was observed passively drifting. Occasionally, it would also exhibit rapid burst swimming. While drifting, the fish weakly beat its pectoral fins in a behavior known as sculling.[10] The sculling behavior observed is suggested as necessary to keep the fish in a neutral position in the water and to counteract any displacing currents.[11] The bursts of fast swimming typically last less than five seconds. The swimming behavior in this video is similar to that seen in other *in-situ* footage of a ceratioid anglerfish.[10]

Another *in-situ* observation of three different whipnose anglerfish showed unusual upside-down swimming behavior. Fish were observed floating upside-down completely motionless with the illicium hanging down stiffly in a slight arch in front of the fish. Notably, the illicium was hanging over small visible burrows. The observers suggested this is one effort to entice prey and is another example of low-energy opportunistic foraging and predation. When the ROV approached the fish, they exhibited burst swimming, still upside-down.[12]

Predation



Skeleton of the angler fish, *Lophius piscatorius*: The first spine of the dorsal fin of the anglerfish acts as a fishing rod with a lure.

The name "anglerfish" derives from the species' characteristic method of predation. Anglerfish typically have at least one long filament sprouting from the middle of their heads, termed the illicium. The illicium is the detached and modified first three spines of the anterior dorsal fin. In most anglerfish species, the longest filament is the first. This first spine protrudes above the fish's eyes and terminates in an irregular growth of flesh (the esca), and can move in all directions. Anglerfish can wiggle the esca to make it resemble a prey animal, which lures the anglerfish's prey close enough for the anglerfish to devour them whole. The jaws reflexively shut upon contact to the tentacle.

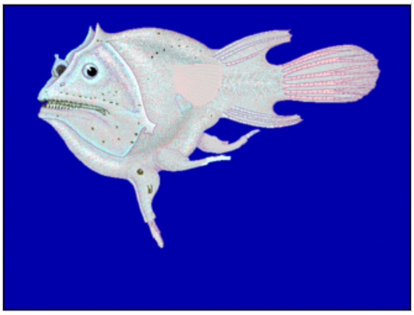
Some deep-sea anglerfish of the bathypelagic zone emit light from their escae to attract prey. This bioluminescence is a result of symbiosis with bacteria. Although the mechanism by which they are harnessed by ceratioids is unknown, the bacteria have been speculated to enter the esca from the seawater through small pores. Once within it, they can multiply until their density is such that their collective glow is very bright.[13]

Because anglerfish are opportunistic foragers, they show a range of preferred prey with fish at the extremes of the size spectrum, whilst showing increased selectivity for certain prey. One study examining the stomach contents of threadfin anglerfish off the Pacific coast of Central America found these fish primarily ate two categories of benthic prey: crustaceans and teleost fish. The most frequent prey were pandalid shrimp. Interestingly, 52% of the stomachs examined were empty, supporting the observations that anglerfish are low energy consumers.[14]

Reproduction

Some anglerfish, like those of the ceratioid group (Ceratiidae, or sea devils), employ an unusual mating method. Because individuals are locally rare, encounters are also very rare. Therefore, finding a mate is problematic. When scientists first started capturing ceratioid anglerfish, they noticed that all of the specimens were female. These individuals were a few centimetres in size and almost all of them had what appeared to be parasites attached to them. It turned out that these "parasites" were highly reduced male ceratioids. This indicates the anglerfish use a polyandrous mating system.

In certain ceratioids, parabiotic reproduction is required. Free-living males and non-parasitized females in these species never have fully developed gonads. Thus, males never mature without parasitizing a female and die if they are unable to find one.[2] At birth, male ceratioids are already equipped with extremely well-developed olfactory organs[15] that detect scents in the water. Males of some species also develop large, highly specialized eyes that may aid in identifying mates in dark environments. The male ceratioid lives solely to find and mate with a female. They are significantly smaller than a female anglerfish, and may have trouble finding food in the deep sea. Furthermore, the growth of the alimentary canals of some males becomes stunted, preventing them from feeding. Some taxa have jaws that are never suitable or effective for prey capture.[15] These features necessitate that the male quickly find a female anglerfish to prevent death. The sensitive olfactory organs help the male to detect the pheromones that signal the proximity of a female anglerfish.



Linophrynidae: *Haplophryne mollis* female anglerfish with atrophied males attached

Antennariidae: striated frogfish, *Antennarius striatus*

However, the methods by which anglerfish locate mates are variable. Some species have minute eyes unfit for identifying females visually, while others have underdeveloped nostrils, making it unlikely that they effectively find females using olfaction.[2] When a male finds a female, he bites into her skin, and releases an enzyme that digests the skin of his mouth and her body, fusing the pair down to the blood-vessel level.[15] The male becomes dependent on the female host for survival by receiving nutrients via their shared circulatory system, and provides sperm to the female in return. After fusing, males increase in volume and become much larger relative to free-living males of the species. They live and remain reproductively functional as long as the female lives, and can take part in multiple spawnings.[2] This extreme sexual dimorphism ensures, when the female is ready to spawn, she has a mate immediately available.[16] Multiple males can be incorporated into a single individual female with up to eight males in some species, though some taxa appear to have a "one male per female" rule.[2]

Parasitism is not the only method of reproduction in anglerfish. In fact, many families, including Melanocetidae, Himantolophidae, Diceratiidae, and Gigantactinidae, show no evidence of male parasitism.[17] Females in some of these species contain large, developed ovaries and free-living males have large testes, suggesting these sexually mature individuals may spawn during a temporary sexual attachment that does not involve fusion of tissue. Males in these species also have well-toothed jaws that are far more effective in hunting than those seen in parasitic species.[17]

Finally, some researchers suggest sexual parasitism may be an optional strategy in some species of anglerfishes.[2] In the Oneirodidae, females have been reported in *Leptacanthichthys* and *Bertella*, which were parasitized, and others which were not, but still developed fully functional gonads.[18] One theory suggests the males attach to females regardless of their own reproductive development if the female is not sexually mature, but when both male and female are mature, they will spawn then separate.[2]

One explanation for the evolution of sexual parasitism is that the relatively low density of females in deep-sea environments leaves little opportunity for mate choice among anglerfish. Females remain large to accommodate fecundity, as is evidenced by their large ovaries and eggs. Males would be expected to shrink to reduce metabolic costs in resource-poor environments and would develop highly specialized female-finding abilities. If a male manages to find a female, then parasitic attachment is ultimately more likely to improve lifetime fitness relative to free living, particularly when the prospect of finding future mates is poor. An additional advantage to parasitism is that the male's sperm can be used in multiple fertilizations, as he stays always available to the female for mating. Higher densities of male-female encounters might correlate with species that demonstrate facultative parasitism or simply use a more traditional temporary contact mating.[19]

External video

- Angler Fish (https://www.youtube.com/watch?v=Z-BbpaNXbxg) – *YouTube*
- Weird Killer of the Deep (https://www.youtube.com/watch?v=XUVerZsbYiw) – *YouTube*
- The anglerfish: The original approach to deep-sea fishing (https://www.youtube.com/watch?v=VqPMP9X-89o) – *YouTube*
- 3D scans reveal deep-sea anglerfish's huge final meal (https://www.youtube.com/watch?v=AW93uB5fDLQ) – *YouTube*

The spawn of the anglerfish of the genus *Lophius* consists of a thin sheet of transparent gelatinous material 25 cm (10 inches) wide and greater than 10 m (33 feet) long.[20] The eggs in this sheet are in a single layer, each in its own cavity. The spawn is free in the sea. The larvae are free-swimming and have the pelvic fins elongated into filaments. Such an egg sheet is rare among fish.

Threats

Northwest European *Lophius* spp. are listed by the ICES as "outside safe biological limits".[21] Additionally, anglerfish are known to occasionally rise to the surface during El Niño, leaving large groups of dead anglerfish floating on surface.[21]

In 2010, Greenpeace International added the American angler (*Lophius americanus*), the angler (*Lophius piscatorius*), and the black-bellied angler (*Lophius budegassa*) to its seafood red list, which is a list of fish commonly sold worldwide which have a very high likelihood of being sourced from unsustainable fisheries.[22]

Human consumption

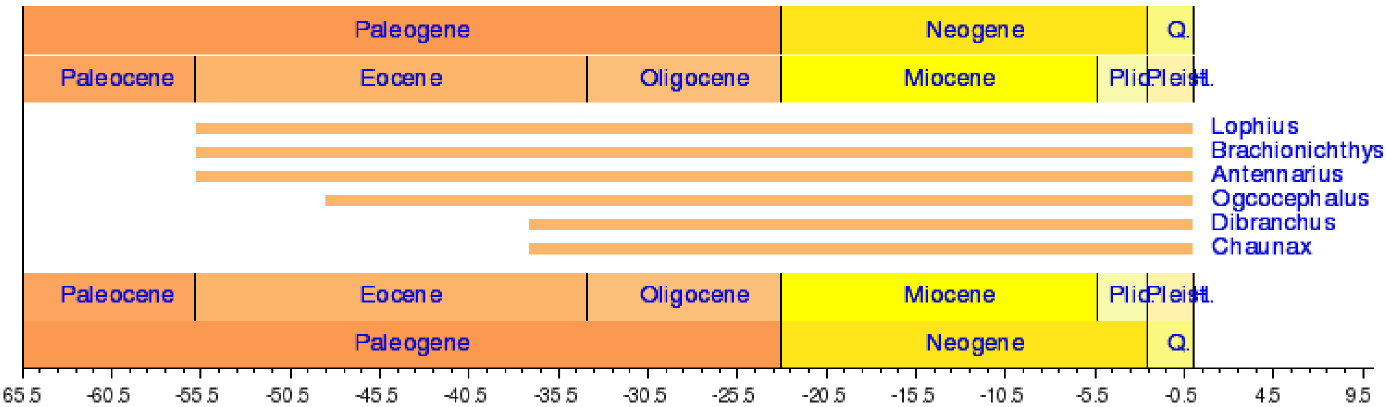
Wikimedia Commons has media related to ***Anglerfish dishes***.

One family, the Lophiidae, is of commercial interest with fisheries found in north-western Europe, eastern North America, Africa, and East Asia. In Europe and North America, the tail meat of fish of the genus *Lophius*, known as monkfish or goosefish (North America), is widely used in cooking, and is often compared to lobster tail in taste and texture. In Asia, especially Korea and Japan, monkfish liver, known as ankimo is considered a delicacy.[23]

Timeline of genera

Anglerfish appear in the fossil record as follows:[24]

Melanocetus johnsonii



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External links

- Tree of Life web project: Lophiiformes (http://tolweb.org/Lophiiformes)
- Anglerfish photos (http://deepseacreatures.org/anglerfish)

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