Form and Function Background

Introduction

Over time fish, as well as other animals, have adapted or changed to survive in their environment. Although different fish species have different appearances, the function of their outside body parts is similar. Moreover, the outside body parts, or external anatomy features, of fish can tell us a lot about a species such as where it lives in the water, how it finds food, and how it protects itself from predators.

External Anatomy Features

Common external anatomy features of fish include: dorsal fin, anal fin, caudal fin, pectoral fins, ventral fins, gills, lateral line, nares, mouth, scales, and body shape.

Fins

All fish have external appendages called fins. Like human limbs, fins provide fish with balance, steering, and protection. Fins are either single along the centerline of the fish; the dorsal fin, anal fin, and tail fin, or paired fins; the pectoral fins and ventral fins.[i] Pectoral fins help fish balance. The top fin or dorsal fin is also used in balance but its main function is usually protection. The ventral fin and anal fin are located on the bottom or belly of fish and help with steering as well as balance. The tail fin, also called the caudal fin, helps propel the fish forward.

Gills

Located on either side of the fish, gills provide oxygen to fish from the water. A fish "breathes" by closing the gills and opening its mouth to take in water. The water is then forced through the gill chambers, over feather-like gill filaments that absorb oxygen from the water and remove carbon dioxide from the blood. The water is then passed out through the open gills. Some fish have spines located on the operculum as a defense mechanism to protect them from predators.[ii]

Lateral Line

Running down the length of a fish's body is the lateral line. This organ is used to feel low vibrations in the water. The lateral line is made up of a series of microscopic holes located just under the scales of a fish.[iii]

Nares

All fish can smell. Located on a fish's snout are paired holes, or nares used for detecting odors in the water. Some fish, like catfish and eels, have a heightened sense of smell. The nares are made up of many capsules, each containing numerous chemical receptors. Water flows through the nares as the fish swims or while they are facing into a current. Behind the nares, in a chamber, are sensors (chemical receptors) that detect chemicals that are dissolved in the water. Once an odor is detected, the nerves send signals to the fish's brain that interpret the smells. These smells might attract a fish or keep it at bay depending on whether the fish interprets the smell to represent food or danger.[iv]

Eyes

Almost all fish have eyes, and some fish can see in color. Studies have found that Pacific salmon and rainbow trout have color vision that is similar to a human's. Color vision is the ability to recognize and see objects in color. This is based on how well an organism absorbs, reflects or transmits light of different colors. One requirement for color vision is that color detectors, known as cones, are present in the retina of the eye. Also, the brain must be wired to interpret the information it receives from the cones. Color vision in humans requires three different kinds of cones: red, green and blue. Common goldfish are another example of a fish species with the ability to see colors. Scientists have found that common goldfish have four kinds of cones: red, green and blue like humans, as well as ultraviolet. Other fish species may have the capability of seeing in color, based on the different kinds of cones they possess. However, finding cones in an eye, whether in a fish or other animal, does not mean that they have the ability to see in color.[vi]

Scales and Slime

Most fish have scales covering the length of their body. Scales protect fish from injury, much like skin on the human body. On top of these scales is a mucus covering known as the slime layer. Slime protects fish from bacteria and parasites in the water. Anglers should be careful not to remove the slime layer when handling a fish.[vii]

Body Shape

A fish's body shape, as well as the shape and size of certain external features, can tell you a lot about that fish. For example, the body shape of a fish can indicate where that fish lives in the water and what type of swimmer it is. In addition, tail fin shape also signifies a fish's swimming abilities. For instance, a sharp forked tail like that of a shark implies a fast swimmer, whereas a rounded tail means the fish is good at turning. {See Figure 1- Body Part Shapes}

Mouth

The mouth parts of a fish will vary in size and may or may not contain teeth, depending on what the fish eats. The location of the mouth on a fish's body can also give us a clue as to what the fish's diet consists of. A superior mouth, a mouth pointing upward, means the fish will usually eat food located above it; where as a fish with an inferior mouth, a mouth pointing downward, will usually eat food located below it. {See Figure 1- Body Part Shapes}

Form, Function, and Adaptations

Although fish species may look very different from one another due to adaptations, their body parts serve similar functions. Here are a few examples:

Fluke

Fluke or summer flounder is a flat-lying saltwater fish that lives on the sea floor. When born, fluke look like any other fish, swimming upright. About a week to a month into its life, one eye rotates to the other side of the head, to join the other eye. This adaptation allows fluke to lie flat on the ocean floor and wait for its food, thus called a lie-and-wait predator. Fluke also have many sharp teeth which allow them to eat smaller fish that swim above. Although this fish looks different then most fish, the fins (caudal, pectoral, etc.) still have the same functions.

Largemouth Bass

Largemouth bass live towards the bottom of freshwater bodies and are therefore darker in color. Their greenish brown tint helps them to camouflage with the surrounding aquatic vegetation to protect them from predators swimming above. When swimming through the water, their white bellies help to camouflage them with the sky above. Largemouth bass have no teeth, and can swallow their food whole. Adult largemouth can easily consume smaller fish, frogs, and even baby ducks. Although the mouth parts of largemouth bass are different than many other freshwater predators, they serve the same function, to consume food.

Sea Robin

With several adaptations to protect its self against predators, the sea robin is perhaps one of the most interesting fish. Because of its odd external characteristics, many humans consider the sea robin to be a trash fish, when in fact it is fine for human consumption. Sea robins are a bottom dwelling fish, with very large pectoral fins. The large pectoral fins make the fish look larger to predators swimming through the water. As additional defense against predators, sea robins have a very sharp dorsal fin and spines on its gill covers. Sea robins can also make a quiet barking sound to scare off predators. Although the sea robin physically looks different from other species, its fins still help to balance its body, steer through the water, and protect it against predators.

Relationship to Fishing

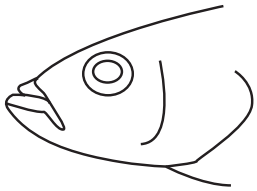
Knowing what a fish eats, where it lives, and how it defends itself against predators, can help us when fishing to target that species or to handle our catch. Depending on where a fish lives in the water changes how and where

Figure 1.

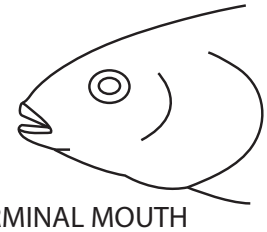
Examples: Body Part Shapes of Fish

Artwork by Nim Lee and Sarah Bruner

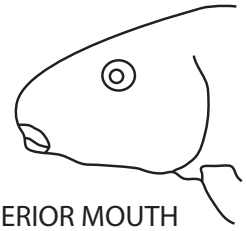
MOUTH SHAPES



SUPERIOR MOUTH
- Eats food above it
- May eat at the water's surface

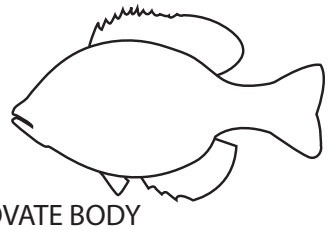


TERMINAL MOUTH
- Eats food in front of it

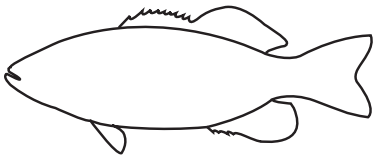


INFERIOR MOUTH
- Eats food below it
- May eat off of the bottom

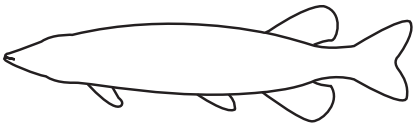
BODY SHAPES



OVATE BODY
- Slow swimmer
- Difficult for predators to swallow

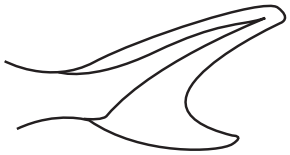


FUSIFORM BODY
- High speed swimmers

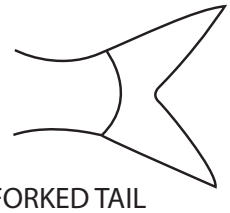


ELONGATE
- Hides in rocks and weeds

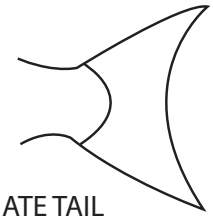
CAUDAL / TAIL FIN SHAPES



HETEROCERCAL TAIL
- Fast swimmer
- Constantly moving

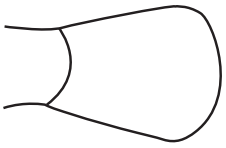


FORKED TAIL
- Fast swimmer

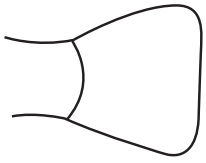


LUNATE TAIL
- Long distance swimmer

POINTED TAIL
- Slow swimmer
- Bottom wriggler



ROUNDED TAIL
- Good at turning
- Fast for short distances



TRUNCATE TAIL
- Good at turning
- Slower swimmer

anglers fish for that species. For example, black sea bass prefer to live in and around structure, meaning rocks, dock pilings, etc. Therefore, anglers targeting sea bass fish in these areas and in many cases go offshore to find reefs or wrecks to fish on. Similarly, catfish have a heightened sense of smell and lack superior vision. Therefore by knowing what the catfish eats, anglers can better target them by using baits with a strong odor, called stink baits.

Additional Resources

"Freshwater Fish Identification." Environmental Protection Agency. http://www.epa.gov/bioiweb1/html/fish_id.htm.

Vocabulary

- Anal Fin: Last bottom fin on a fish; located near the anal opening; used in balance and steering
- Caudal/Tail Fin: Fin on end of fish; used to propel the fish
- Dorsal Fin: Top or backside fin on a fish; used for balance and protection
- External Anatomy: The outside body parts
- Gills: Organ a fish uses to obtain oxygen from the water
- Gill Filaments: Gill filaments absorb the oxygen from the water, and release carbon dioxide
- Lateral Line: Organ a fish uses to "feel" low vibrations; tiny microscopic pores
- Nares: Organ a fish uses to smell; similar to nostrils
- Pectoral Fin: Chest fins on a fish; used for balance
- Scales: Protective cover on a fish; similar to skin
- Slime: Covers scales; layer protects from bacteria, parasites, etc.
- Ventral Fin: Bottom or belly fins on a fish; used in balance and steering
- Vertebrate: Organism with a backbone

---

i "Fish Anatomy." Florida Fish and Wildlife. 2008. 5 December 2008 <http://floridafisheries.com/fishes/anatomy.html>.

ii "Fish Anatomy."

iii "Fisheries Biology and Management" Maryland Department of Natural Resources (MD DNR). 10 October 2008 <http://www.dnr.state.md.us/education/envirothon/FISH%20ANATOMY.pdf>.

iv "Catch a Whiff of This" Virginia Department of Game and Inland Fisheries 17 February 2009 < http://www.dgif.state.va.us/fishing/sarep/PDF/aqua_catch_a_whiff.pdf>.

v "How to select lure colors for successful fishing." Fish of the Great Lakes Wisconsin SeaGrant. 2 February 2002. 19 February 2009 <http://www.seagrant.wisc.edu/greatlakesfish/lure.html>.

vi "Ask a Scientist." Cornell Center for Materials Research. 5 December 2001. 18 February 2009 <http://www.ccmr.cornell.edu/education/ask/index.html?quid=295>.

vii "Fish Anatomy."