Fact Sheet: Fish Adaptations

Region
North Coast, Gascoyne Coast, West Coast, South Coast, Indian Ocean Territories

Summary
Fish have adapted to live in an enormously wide range of aquatic habitats. Adaptations are features that increase the animals’ likelihood of surviving in their habitat.

Adaptations may be categorised as:

- structural, e.g. body cover, body shape, camouflage, appendages and mouth parts;
- functional/physiological, e.g. buoyancy, poisons and colour change; and
- behavioural, e.g. schooling, escaping, care of young and warning signals.

Consider the adaptations of a globefish (Figure 1) – it has spines (a structural adaptation), poisons in the skin, (a physiological adaptation) and it inflates its body to make it look bigger than it really is (a behavioural adaptation).
Structural adaptations

Structural adaptations are physical characteristics that aid in survival and reproductive success.

Body shape
Fish live in a medium that is close to eight hundred times denser than air, yet some can travel at speeds of up to 100 km/h, walk in a leisurely fashion across the seabed, or maintain balance in turbulent waters. The shape of a fish’s body tells a lot about where it lives, how it feeds and how it moves (speed, acceleration and manoeuvrability) through the water.

Flat-shaped fish (such as wobbegong and flounder) are benthic fish that live and feed close to the sea floor. They do not swim continuously and therefore have no need to be streamlined. These types of fish often have colour patterns and/or textures that allow them to blend in with the seabed and ambush prey.
Fish that live in reef or coral crevices (e.g. butterfly fish) have deep, flat bodies that are highly agile so they can move around without bumping into rocks and reefs.

Long slender fish (e.g. moray eels and cobbler) are able to hide under rocks and among coral, where shorter, stouter-shaped fish would have difficulty in going.

Slow-moving fish with rounded bodies are often protected by spines or armour plating, and may also have poisonous flesh (e.g. blowfish and white-barred boxfish), owing to their lack of manoeuvrability.

Fish with more elongated bodies (e.g. Western Australian salmon) are able to swim very fast for a long time and thus have less need for any special body protection.

Fish body shapes can be broken up into three distinct groups— extreme accelerating (e.g. mulloway), extreme cruising (e.g. tuna) and extreme manoeuvring (e.g. angelfish). There are a wide range of shapes in between – as shown in Figure 2.
Figure 2. The shape of a fish helps it hunt prey, avoid predators and move through its habitat.

Tail shape
The tail or caudal fin is connected with the speed and strength of a fish’s forward movement. Its shape provides clues about the type of swimmer it is and how it moves through the water.

Mouths to feed
Figure 4. Examples of different mouth shape adaptations

The mouth size and shape provides a good clue to what fish eat. The larger it is, the bigger the prey it can consume. Large jaws signify that the fish may engulf its prey, while fish with protruding jaws can suck their prey in like a vacuum cleaner.

The position of the mouth can also indicate whether a fish consumes prey from the surface.
(above it), sea floor (below it), or in front of it.
Figure 5. The position of a fish’s mouth can provide some clues to the possible diet and prey of each species.

**Body cover**
Some fish have developed a specialised body cover for avoiding potential predators. Examples include:
• Armour – slow swimming fish such as a seadragon, seahorse or boxfish have a body armour made up of bony plates.

• Spines – some fish have venomous spines e.g. stonefish, lionfish and estuarine cobbler.

• Slime/mucous – Anemone fishes have a mucous covering that protects them from the sting of anemone tentacles. When parrotfish sleep at night, they often secrete a mucous sleeping bag around themselves, believed to hide their scent from predators.

• Scales – scales provide external protection from predators, as well as parasites and other injuries. The size of a fish scale determines whether the fish is a fast or slow swimmer. Fish with small scales (e.g. tuna) are more streamlined and fast swimmers to catch their prey, whereas fish with large scales are typically slow swimmers in comparison.

Eyes
In general, deep-water fishes have large eyes, allowing them to absorb as much light as possible in the dark. Shallow-water fishes generally have smaller eyes. The positioning of the eyes is also related to the survival of the fish. Prey species typically have eyes on the sides of their heads allowing a wide field of view to spot predators. Predators, on the other hand, usually have eyes closer together on the front of their head to provide better depth perception to help locate and capture prey. A flounder has both eyes on the same side of its head because it lies flat on the sandy bottom.

Colouration
Coloration in fish is extremely important for their survival. Most bony fish have excellent colour vision and display a wide variety of colours and patterns. Skin colouration can have many functions including camouflage, to communicate aggression or fear, attract a mate, signal territorial ownership, threaten rivals, warn of venomous spines or other defence systems.

Many fish mimic their surroundings using colouration and markings that help them to blend in with the surrounding habitat. Some fish display a form of camouflage known as countershading where the fish’s colouration is darker on the top side and lighter on the bottom side of the body. The darker side helps blend in with the substrate or deeper water below, while the lighter side helps blend in with the water and sunlight above.

Some fish have elaborate light patterns or patterns of luminescent spots. These are useful in courtship displays, establishing territories or to identify the same species. Some fish are even able to change colour by altering the distribution of pigment in specialised cells called chromatophores.

Sharks and rays cannot see colour. As a result, they are plain-coloured creatures in blues, greys and browns. If patterned, they usually have simple spots and speckles.
Physiological adaptations

Physiological adaptations are internal features of an organism that enable them to survive in
their environment.

**Venom**

Many species of fish possess spines that aim to act as protection from predators. In addition, many also increase their chances of survival with venom that is inflicted upon predators and/or prey as pressure is applied to the venom gland. Stonefish, lionfish and stingrays all exhibit venomous spines.

**Poison**

Poisonous fish are those that are toxic to eat (e.g. toadfish). They possess poison in glands in the body that when eaten by predators (including humans) causes illness and/or death.
Figure 7. Toadfish are a species that are poisonous to most predators. (Image: Carina Lancaster)

**Buoyancy**
Density increases the deeper into the ocean one travels so fish have adapted to live at certain depth profiles. Most fish have swim bladders which they use to change their density, allowing them to exist at different depths in the ocean.

Fish that live at depths of the ocean have adapted to this environment by having dense bony bodies without swim bladders.
**Colour change**

Some species of fish have the ability to change colour. Colour change may be permanent, or it may be rapid and temporary.

Some species change colour as they mature from juveniles to adults e.g. McCulloch’s scalyfin. Many species that change sex, also feature a change in colour e.g. Western blue groper (Figure 8).

![Male and female Western blue groper](image)

**Figure 8.** Male (left) and female (right) Western blue groper exhibit different colours.

The small-toothed flounder can change its colour to camouflage in with the surrounding habitat while some species exhibit fright colours which occur when a fish is startled e.g. Blue-lined emperor.

Some species of fish have the ability to bioluminate (emit light). Bioluminescence may be used to attract a mate, attract prey, deter or confuse predators or aid sight in the dark.

**Thermoregulation**

Most fish are poikilothermic, that is their body temperature varies in response to the temperature of their surrounding environment. Some fish, such as tuna, are ‘warm blooded’ and can regulate their body temperature. This allows them to migrate across a much wider range (and water temperatures) than they would otherwise, and also dive to depths in excess of 500m to expand their hunting territory.

**Gas exchange**

Although they live in the aquatic environment, fish do require oxygen. Fish extract oxygen and
diffuse out carbon dioxide using gills. Gills rely on water flowing over them to ensure maximum oxygen uptake.

Most bony fish maintain water flow over the gills by ‘drinking’ water and instead of swallowing it, pushing it out over the gills. Fish that are very active, e.g. sharks, cannot get enough oxygen in this manner and so instead swim with their mouths open, letting water pass in and flow directly over the gills.

**Osmoregulation**
In the marine environment, the body fluids of fish are less salty than the surrounding environment so water diffuses out through the skin and gills. As a result, marine fish have to ‘drink’ continuously to avoid dehydration. They also only produce a small amount of urine.

In freshwater, the tissues and body fluids of fish are saltier than the surrounding environment, so water enters the fish through the skin and gills. Freshwater fish do not have the need to ‘drink’, but they do produce large volumes of urine.

All fish regulate the movement of water through a semipermeable cell membrane, a process called osmosis. Water diffuses through the membrane from a less concentrated solution to a more concentrated solution.

**Change in sex**
Some species of fish are born one sex and remain that for their life, however sex change in the fish world is not uncommon. Many species, including wrasse and parrotfish, are born female and upon reaching maturity, change into males.

In some other species, e.g. barramundi, fish are born as males and change into females (Figure...
Figure 9. Barramundi are all born male and change into females. (Image: Department of Fisheries)

Behavioural adaptations

A behavioural adaptation is an action that an animal carries out to increase their chances of survival and reproduction. Behavioural adaptations may be instinctive or learned.

Warning signals
Some species of fish use their spines to protect themselves. Laying flat, the spines allow the fish to retain its streamlined shape, but in the event that they need to ward off predators, spines are raised and pointed outward as a deterrent.

Schooling
Large groups of fish that swim together as one unit is called a school. This behaviour increases the chance of survival as it is harder for the predator to target one fish. A school of small fish may also appear to be one large animal, also discouraging predators.

Salmon form large schools composed of thousands of individuals (Figure 10). They work
cooperatively to ‘herd’ baitfish to more easily feed.

Figure 10. A school of salmon off the West Australian coast. (Image: © Scott Coghlan)

Some species aggregate (group) to increase the chances of successful reproduction e.g. pink snapper.

**Paternal care**
Most fish species give no care to their eggs or young, releasing their eggs in to the water to disperse widely with the currents, whilst some provide various form of parental care. For example, some aquatic animals guard and hide their eggs (e.g. clownfish, estuary cobbler), while some protect, feed and raise their offspring until such time that they are independent e.g. humpback whales.

**Migration**
Migration in animals usually occurs on a seasonal basis and is the relatively long distance movement of individuals. A number of fish are known to migrate for various reasons.

Western Australian salmon migrate westwards along the southern coast to the lower west coast of Australia where they spawn during autumn months. After spawning, adult fish migrate back to the south coast of Australia. Similarly, barramundi undertake a spawning migration in the north, moving downstream from freshwater to coastal estuaries and river mouths to spawn.

The largest fish in the sea, whale sharks (Figure 11) are known to migrate very long distances, however little is known about their migration patterns. They are known to aggregate at major feeding locations around the world, including Ningaloo Reef in Western Australia and Belize on the eastern coast of Central America. It is believed that they migrate and aggregate in groups of roughly the same age, size and sex. Researchers from the Smithsonian Tropical Research Institute tracked a female whale shark from the eastern Pacific to the western Indo-Pacific for over 20,000 kilometres – the longest whale shark migration ever recorded.

Satellite tagging of whale sharks during their seasonal aggregation at Ningaloo Reef has shown they may travel more than 2000 kilometres off the Western Australian coastline, beyond the Cocos (Keeling) Islands.
Figure 11. The largest fish in the sea, whale sharks, are known to migrate very long distances (Image: Matt Pember)

Territoriality
An area that an individual or group defends is its territory. Species may be defending a breeding area, food source or shelter. E.g. damselfish are fiercely territorial.

References:


Vocabulary

Adaptation

Evolutionary process whereby a population becomes better suited to its habitat or changing environment.

Barbel

A fleshy filament hanging from the mouth of certain fishes, used for sensing food in mud or sand at the bottom of a river or ocean.

Behavioural

A specific response of a certain organism to a specific stimulus or group of stimuli.

Camouflage

Colouration or patterns of an animal that help them to blend with their natural surroundings.

Caudal fin

Tail fin of fishes and some other vertebrates for propulsion.

Countershading

The colouration pattern found in open water animals, usually the upper surfaces are darkly coloured and lower surfaces are lighter or silvery.

Demersal

Bottom dwelling, or living near the ocean floor.

Dichotomous
Divided or dividing into two parts or classifications.

**Dorsal**
The upper side of an animal.

**Dorsal fin**
Fin located on the upper side of fishes and some other vertebrate animals, used for stabilisation and manoeuvrability.

**Functional**
Pertaining to the function of an organ or part, or to the functions in general.

**Fusiform**
Streamlined, torpedo-shaped body.

**Habitat**
Area or environment in which an organism usually lives or occurs.

**Mimicry**
The resemblance of one organism to another or to an object in its surroundings for concealment and protection from predators.

**Pectoral fin**
Pair of fins situated just behind the head in fishes that help control the direction of movement.

**Pelagic**
Associated with the surface or middle depths of a body of water.

**Structural**
Of, or relating to the physical makeup of a plant or animal body.

**Toxin**
A poisonous substance produced by living cells or organisms; a biologically produced poison.

**Venom**
Toxins used by animals, usually transmitted by a sting or a bite.
Related resources

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