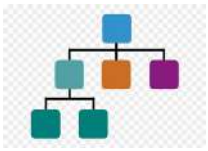


CHAPTER 4
Taxonomy – A Foundation

Fish Taxonomy. -what is it? Is everyone a Taxonomist?

Taxonomy is basically the science of correctly naming species. The term has often been confused **with fish identification**, which basically refers to the use of the latest taxonomic information to identify fishes. The job of the Fish Taxonomist is to name and classify species in a way that makes it easier for fisheries scientists, and other "users", to correctly identify fish species during their work. In other words, fish taxonomy is practiced by very few, whereas fish identification is practised daily by many people.

Why do we need fish collections in fish taxonomy?

Any researcher who wishes to make an in depth study of the taxonomy, anatomy of fishes, reproductive biology or feeding habits of a particular species, needs to learn the details of the fish and its skeleton. This saves the time, expense, and conservation issues associated with capturing fresh specimens. For many species, capturing fresh specimens is often difficult or impossible, such as those which migrate, are found in the deep sea or are endangered.

The collection serves much as a library, with specimens being loaned and returned. Unlike a library however, the collection becomes more valuable after specimens have been studied and returned.

Collections and storage

Software

Symbiota can be found at: https://symbiota.org/docs/symbiota-introduction/symbiota-help-pages/

Arctos is yet another example to consider and is not very costly yet very comprehensive. It is used in various natural history museums: https://arctos.database.museum/

Specify, which is used at the Zoology Museum of USP, in São Paulo, Brazil

SeSam, the great piece of collection database from the Senckenberg Museum in Frankfurt, http://zmb.sesam.senckenberg.de

Descriptive characters in taxonomy

Mouth:

The position of a fish's mouth can tell you a lot about the feeding habits, living style and type of behaviour it exhibits. Fishes mouth types are broadly divided based on three categories midwater feeders, surface feeders and bottom-feeders.

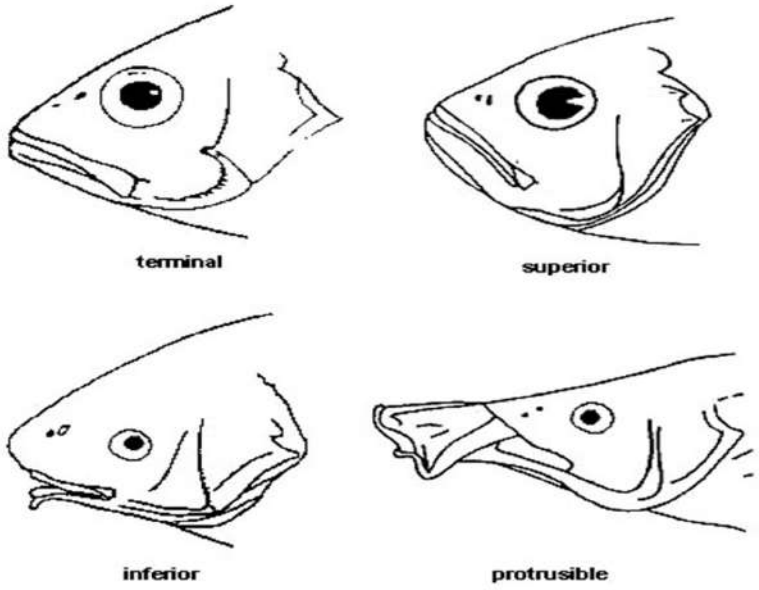
Mouth types:

Terminal: Fish with a terminal mouth position have a mouth in the middle, or centre of the head. These fish are mostly predators who either chase their food or feed on what is seen in front of them. The terminal mouth position is the "normal" position of mouth for most of the fishes inhabiting the middle levels of the water column of oceans or lakes.

Superior: This kind of fish has scoop-like mouth which is designed to feed on prey that swims above the fish (on the surface of the water), such as insects or plankton.

Inferior: Bottom feeding fish generally have inferior or sub-terminal mouths. Mouths located under the fishes head that are adapted for scavenging or grazing on algae, molluscs or bottom dwelling invertebrates.

Protrusible: Protrusible or protractile mouth in fish is a structural arrangement of the jaws that enables the animal to extend the mouth at will. When fully protruded, the cavity of the mouth is enlarged to form a funnel-like space facilitating the uptake of food. Fishes with feeds on small invertebrates in hidings has protrusible mouth.



Different mouth patterns (Source: Florida museum)

Teeth

These serve as a very important taxonomic character. Generally, five types of teeth are recognised in fish based on their cardiform, villiform, caniniform, incisiform and molariform.

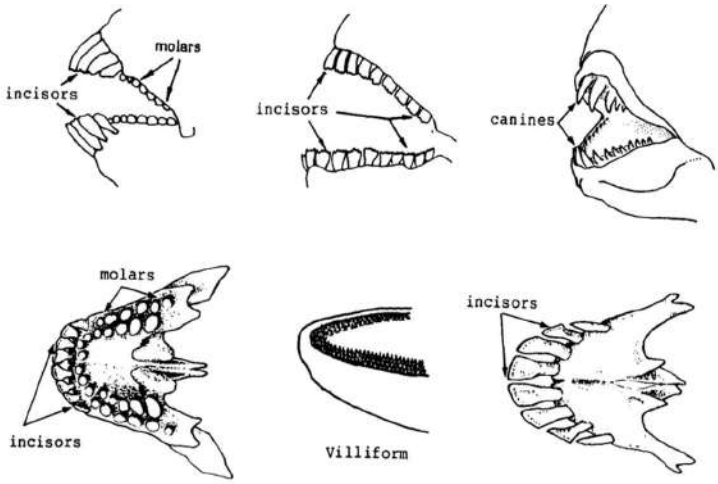
Teeth types: The following teeth patterns are encountered in the fishes mentioned in the book.

Canine teeth: They are sharp, highly pointed teeth seen in predatory fishes which are seen to attack and hold prey in their sharp teeth. The teeth are also used to tear of flesh from the prey. Sharks are best examples of fishes with canine teeth.

Incisor teeth: Incisors are used for cutting and they come in variety of shapes. These are flattened tooth with chisel like or saw edges.

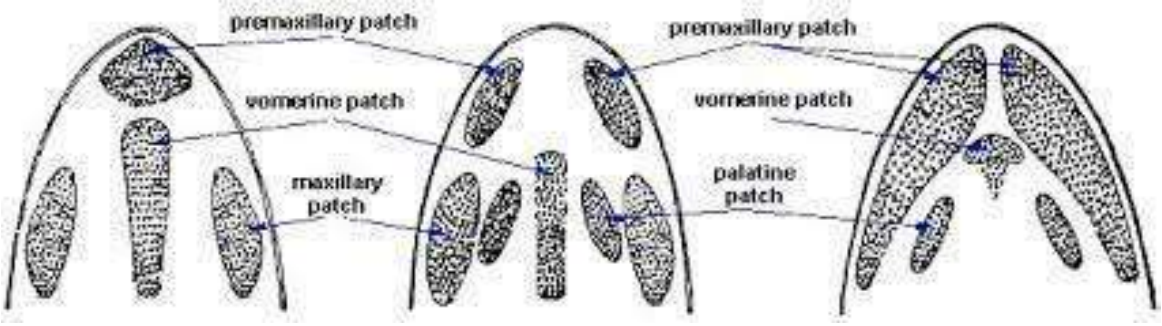
Molar teeth: These are blunt, rounded, broad tooth adapted for crushing and grinding shellfish. They are generally found in bottom dwelling fish.

Villiform teeth: Villiform teeth are elongated teeth they are very long, slender and crowded having the appearance of velvet or fine bristles of a brush. They are more common on deep see fishes used for stabbing and direction.



Common Teeth patterns (Source: Edwards et al. 2001)

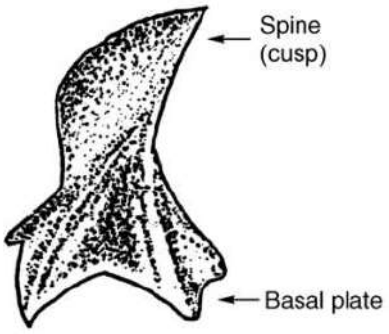
Dental plates: Teeth fused to form beak like plates.



Body Scales

Fish scales constitute the external covering of almost all fish species. The structure and configuration of scales can be used to determine the species from which they came. The type of scale will affect the behaviour of a fish--larger, heavier scales providing more protection but restricting movement, and smaller, lighter scales offering more freedom of movement but less protection. There are four different types of fish scale, each with their own characteristics and variations.

Placoid Scales: Placoid scales are formed of a rectangular base plate that is embedded within the skin of the fish and some of spine externally. The interior of the scale is a pulp that receives blood from the fish's vascular system, while the outside is made of an enamel-like substance called vitrodentine. The shape of the spines can vary greatly depending on species. However, almost all give the fish a rough texture. Sharks and rays are examples of fish with placoid scales.

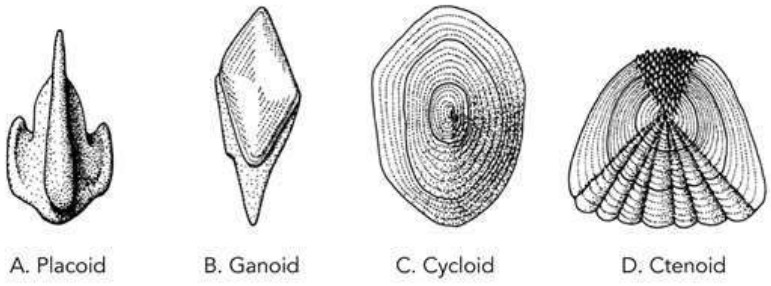


(**Source: Diane Elliot, 2011)**

Ganoid Scales: Ganoid scales have a bony base layer similar to that of cosmoid scales. and are modified cosmoid scales. However, they differ in that their outer layer is made of an inorganic bone salt called ganoine and that they are diamond-shaped and interconnected. Between ganoid scales are peg-and-socket joints that articulate. Ganoid scales are found on sturgeons, bowfish, paddlefishes and gars.

Cosmoid Scales: Cosmoid scales evolved from placoid scales fusing together. This is because cosmoid scales have two base plates and similar external spines composed of vitrodentine. The base plates are made from bone and new bone is added as the fish grows. Lungfishes and coelacanths have cosmoid scales.

Cycloid and Ctenoid Scales: Cycloid and ctenoid scales have different shapes but the same composition and positioning. Both are composed of collagen and calcium carbonate, rather than bone, and both are overlapping. This means that they are more flexible than the other types of scales. While the edges of cycloid scales are smooth, those of ctenoid scales have tiny teeth-like protrusions called ctenii, giving them a rougher texture. The majority of bony fish have cycloid or ctenoid scales.



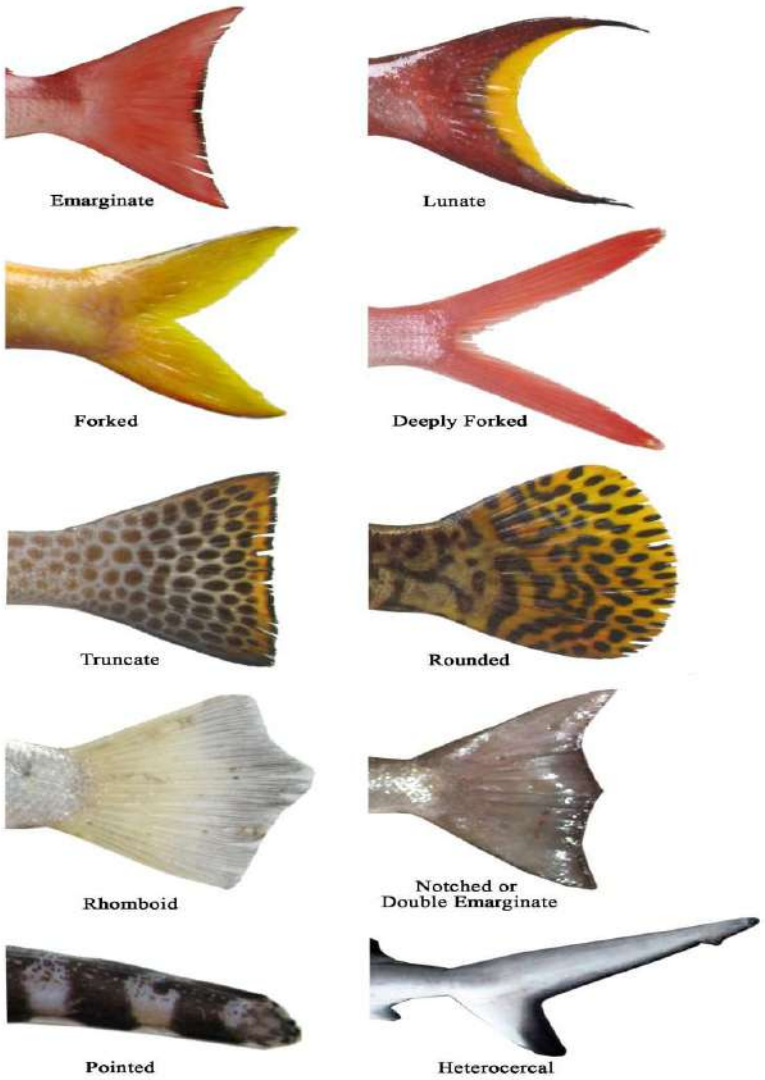
Different types of scale (Source Image from Living Ocean, CRDG, University of Hawaii at Manoa)

Caudal Fin types: The caudal fin is the tail fin, located at the end of the caudal peduncle and is used for propulsion. Types of Caudal fin in our collection.

Heterocercal: the vertebrae extend into the upper lobe of the tail, making it longer. Eg., sharks.

Homocercal: the vertebrae extend for a very short distance into the upper lobe of the fin, but the fin appears superficially symmetric. Most modern fishes are homocercal tailed fishes.

i. **Round:** ending in round shape
ii. **Truncate:** ending in vertical edge
iii. **Forked:** ending in two prolonged edges
iv. **Emarginate:** ending in a slight inward curve
v. **Lunate:** ending in crescent shape
vi. **Rhomboid:** ending in rhomboid shape.



Morphometrics: Measurements must be accurate, point to point and measured using digital vernier callipers in a straight line

(a) **Total length (TL)**: Distance measured from tip of snout to outer free tip of caudal fin. This measurement gives the total length attained by the fish.

(b) **Standard length (SL):** Distance from tip of snout or upper jaw tip (mouth should be in closed position) to the posterior margin of the hypural bone i.e. last vertebra. This measurement is used for all taxonomic calculations since the tip of the caudal rays are often damaged during collection.

(c) **Body depth (BD_1, BD_2):** The maximum girth of the body along the dorso-ventral axis is taken as body depth. In bony fishes, it is measured as the distance from the base of the first dorsal fin ray downwards in a straight line (BD_1). The second measurement for body depth is the distance from base of the first anal fin upwards on a perpendicular axis (BD_2).

(d) **Head length (HL):** The distance from tip of snout or upper jaw to the outer most tip of the operculum.

(e) **Eye diameter (ED):** The horizontal distance at the center of the orbit is taken from the bony anterior to the posterior orbit.

(f) **Jaw length**: Measurements of upper and lower jaw are taken.
Upper jaw length (UJL) is the distance from tip of premaxillary bone to the outermost end of maxillary bone.
Lower jaw length (LJC) is the length of lower jaw from tip of lower jaw to the end of the bone.

(g) **Dorsal fin length (DFL):** This is the maximum length of the dorsal fin when stretched. Measurements are taken at both the longest spine and at the soft dorsal tip.

(h) **Anal fin length (AFL):** The maximum length of the fin when stretched; this is measured at the soft rayed part.

(i) **Pectoral fin length (P_1FL):** This is the maximum length of the pelvic fin when stretched; measurements are taken at the extreme tip of the fin.

(j) **Pelvic fin length (V_1FL)**: This is the maximum length of the pelvic fin when stretched; measurements are taken at the extreme tip of the fin.

(k) **Caudal fin length (CFL)**: Taken as the distance from base of first caudal fin ray to the outermost tip of caudal region.

(l) **Dorsal fin base length (DFBL)**: The distance from base of first dorsal fin ray to the last fin ray in a straight line.

(m) **Anal fin base length (AFBL)**: The distance from base of first anal fin ray to the last fin ray in a straight line.

(n) **Pectoral fin base length (PFBL):** The distance from base of first pectoral fin ray to the last fin ray in a straight line.

(o) **Pelvic fin base length (V_1FB)**: The distance from base of first pelvic fin ray to the last fin ray in a straight line.

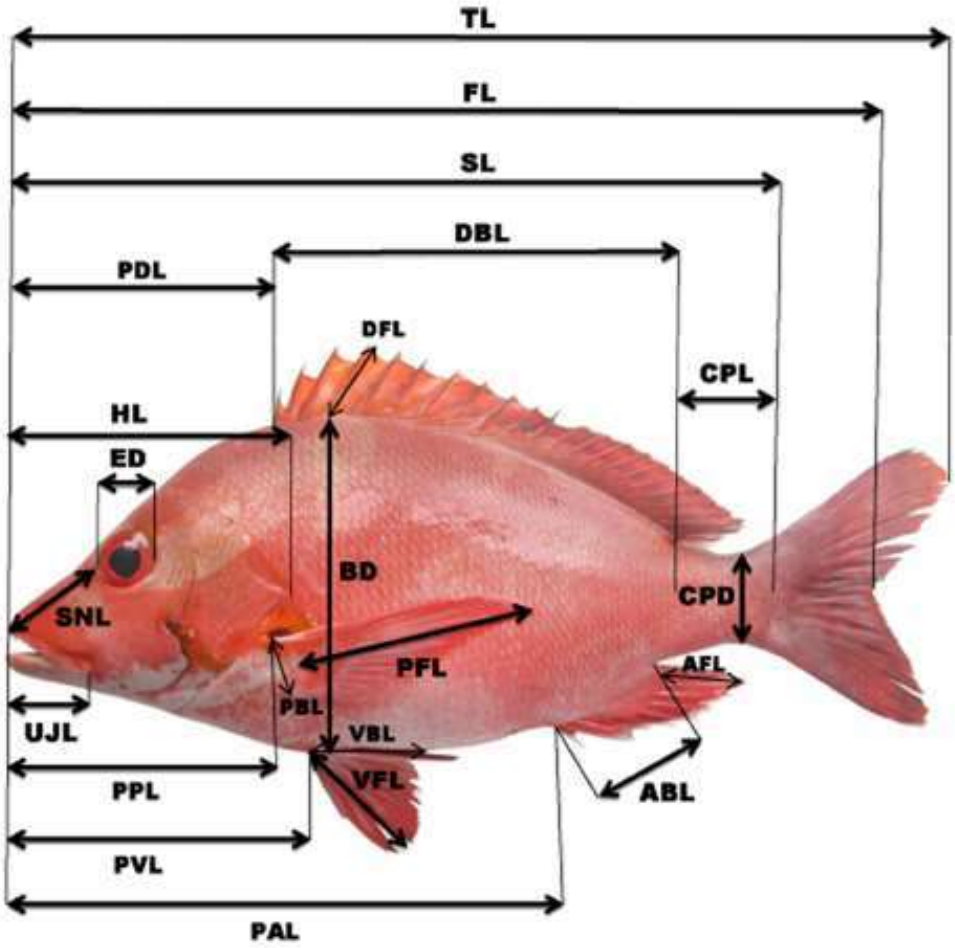
(p) **Caudal fin base length (CFB)**: The distance from base of first caudal fin ray to the last fin ray in a straight line.

(q) **Caudal peduncle length**: the distance from the base of the last dorsal ray to the origin of the caudal fin ray in a straight line.

(r) **Caudal peduncle base:** The vertical distance across base of the caudal fin.

(s) **Preorbital length (POL)**: Distance from tip of snout to anterior tip of the diameter of orbit.

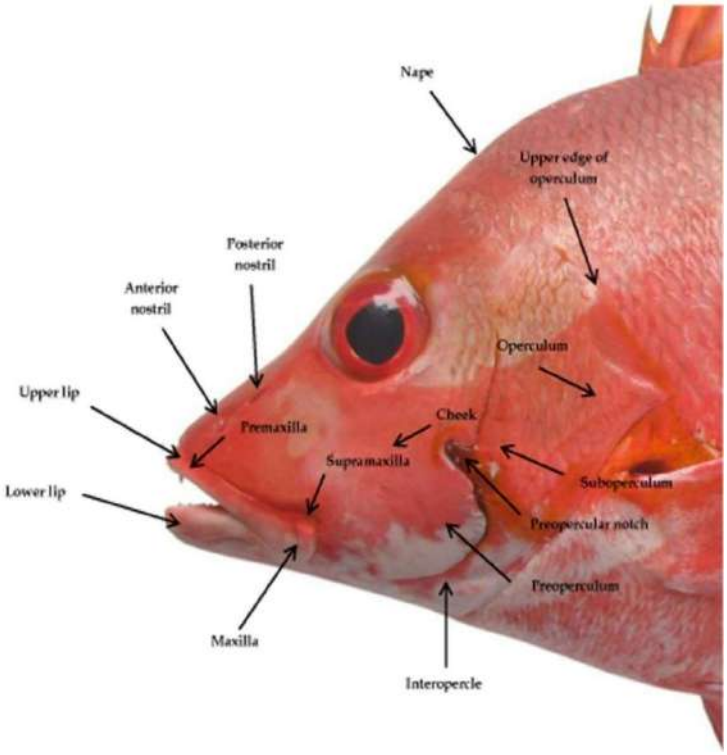
(t) **Post orbital length (PBL)**: Distance from posterior tip of orbit to outer free tip of operculum.



TL – Total Length
SL – Standard Length
FL – Fork Length
HL – Head Length
ED – Eye Diameter
SNL – Snout Length
UJL – Upper Jaw Length

BD – Body Depth
DFL – Dorsal Fin Length
DBL – Dorsal Base Length
PFL – Pectoral Fin Length
PBL – Pectoral Base Length
VFL – Ventral Fin Length
VBL – Ventral Base Length
AFL – Anal Fin Length

ABL – Anal Base Length
CPD – Caudal Peduncle Depth
CPL – Caudal Peduncle Length
PDL – Pre-dorsal Length
PPL – Pre-pectoral Length
PVL – Pre-ventral Length
PAL – Pre-anal Length



Parts of the head

Meristic Counts: Counts are generally taken on the left side of fish.

- **Finray/Spine counts**: Both spine and ray counts are taken on all fins. Dorsal fin counts are written in Roman numerals and rays counts in Arabic numerals eg. X, 6-8., if the spinous and soft-rayed portions of the fin are continuous, the counts are separated by a comma. If the fin is divided into two parts, a plus sign (+) separates the counts, eg. D IX + 4-6. If only a single fin ray is given instead of a range, the count is taken as usual with no variations.

- **Spines** are hardened, stiff, unsegmented, unpaired, unbranched fin rays. Spine counts are characteristic of the genus and does not normally vary between species of same genus.

- **Rays** are soft, flexible structures that may be branched or unbranched at the tips. The last ray of the dorsal and anal fins is sometimes branched at the base and is to be counted as one ray.

- **Scales**: Scales are calcified structures seen on the outer surface of the body of fish for its protection. Scales counts are variable and the range and average count is normally given in the description.

- **Lateral line scale count** is the number of pored scales in the lateral line. The count begins with the first scale at the outer upper end of operculum and ends with at the caudal fin base.

- **Lateral scale count** is taken as the number of scales from the lateral line to the base of the first spine of the dorsal fin excluding the lateral line scale.

- **Predorsal scale count** is the number of scales on the middle line from the origin of the first dorsal fin to the occiput.

Body shape:

The simplest way to identify fishes is by their physical shape and appearance. Different species have different profiles when viewed from the side, top or front. Some are slim and elongated others fat and rounded. Based on their lifestyle and feeding habitat their body shape differs.

Fusiform: Fusiform, or streamlined fish like the barracuda or jack are capable of swimming very fast. They usually live in open water.

Laterally compressed: Fish that are laterally compressed (flattened from side to side) usually do not swim rapidly (some schooling fish are an exception). However, they are exceptionally manoeuvrable. Many, like the angelfish, are found near coral reefs. Their shape allows them to move about in the cracks and crevices of the reef. A flounder is a laterally compressed fish that lies on its side on the bottom. Both eyes migrate to the left or right side early in development.

Depressed: Depressed fish (flattened from top to bottom), like stingrays, live on the bottom.

Eel-like: Eel-like fish have a snake-like body shape. The electric eel and moral eels are good examples of fish with this body shape.

Others: Many fish like the boxfish and porcupine fish do not fit into any of these categories. They are slow swimmers with special protective mechanisms.

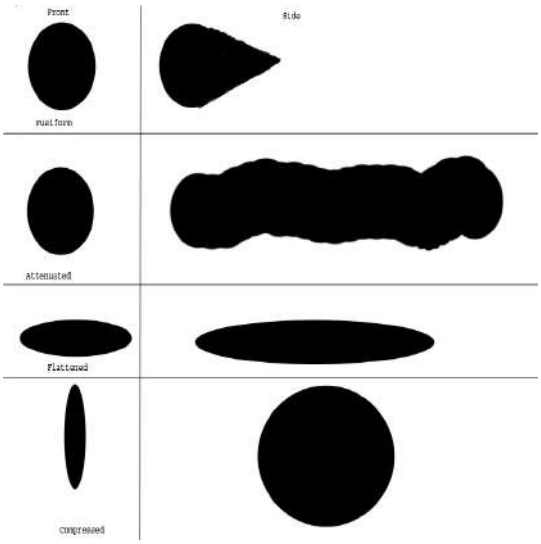
A) Eel-like, greatly elongated, attenuated

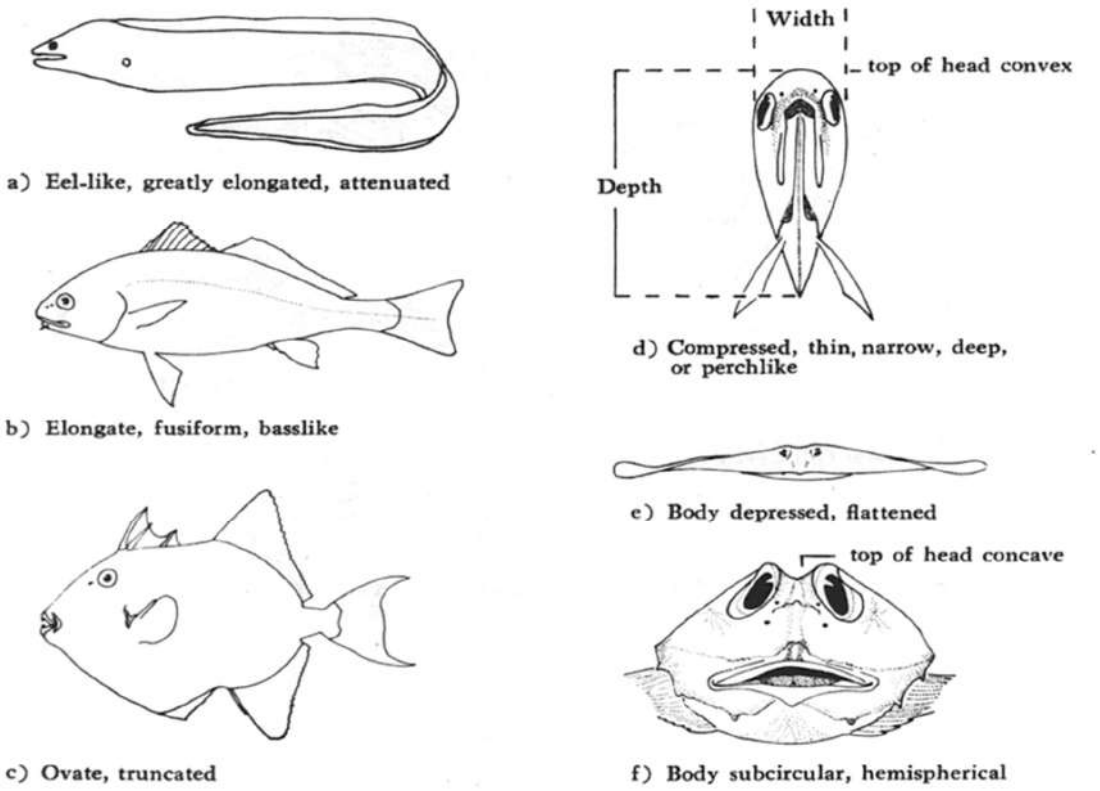
B) Elongated, Fusiform, basslike

C) Ovate, truncated

D) Body depressed, flattened

Body Shapes





Colour patterns: Reef fishes in particular have wide and varied colour patterns on their body which makes them highly suitable for life in reef habitats.

Red is a common colour in reef fish. However, most fish that have this coloration live in dark or deep water, or are nocturnal (active at night). In deep waters and in coralline areas, red light is filtered out quickly so red is a good camouflage. At night red-coloured objects appear grey. The squirrelfish has this kind of coloration.

Camouflage: Here, the fish takes on the appearance of the environment. This makes the fish invisible to other fish as well as other predators. This is achieved by

Disruptive: This is in the form of stripes, spots and helps the fish avoid being eaten by confusion. This is a form of camouflage. The patterns and lines break up the outline of the fish or help it to blend into the background. The brightly patterned fish of coral reefs blend in with the corals despite their brilliant colours. Eg. Moorish idol exhibits disruptive coloration.

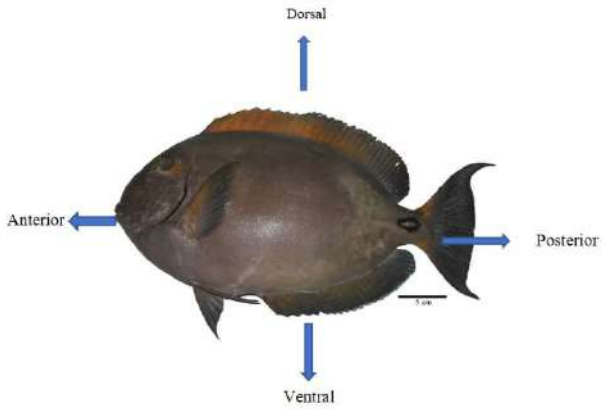
Counter Shading: This is primarily seen in marine fish where the top half of the fish is darker in colour than the bottom half.

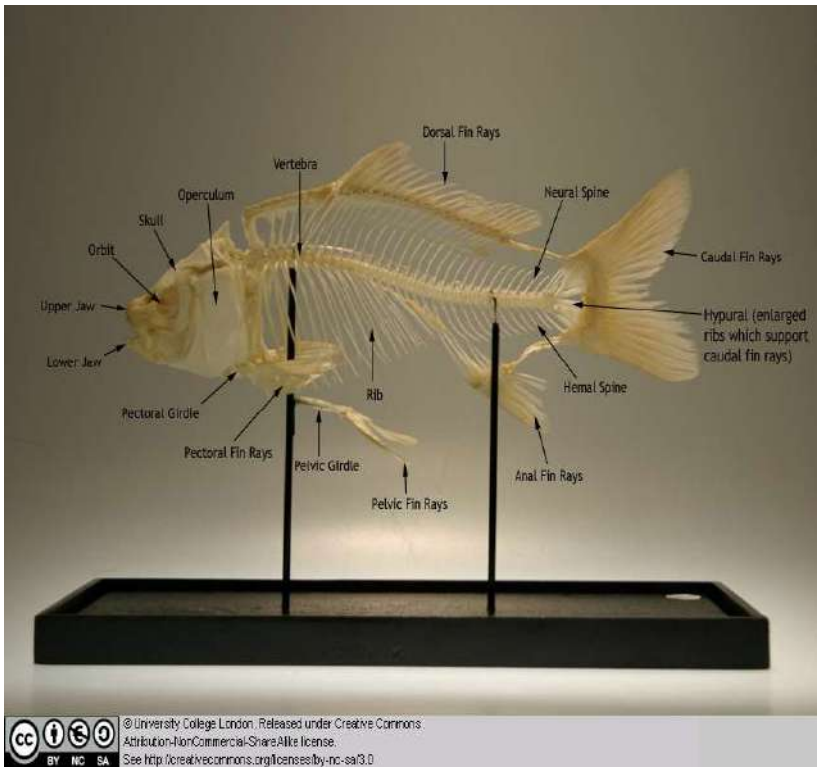
Poster Colouration: This is the most characteristic colouration pattern usually found in reef fish. The fish is characterized by different bright colors. This helps reduce predation on reefs and could be also used as a form of communication.

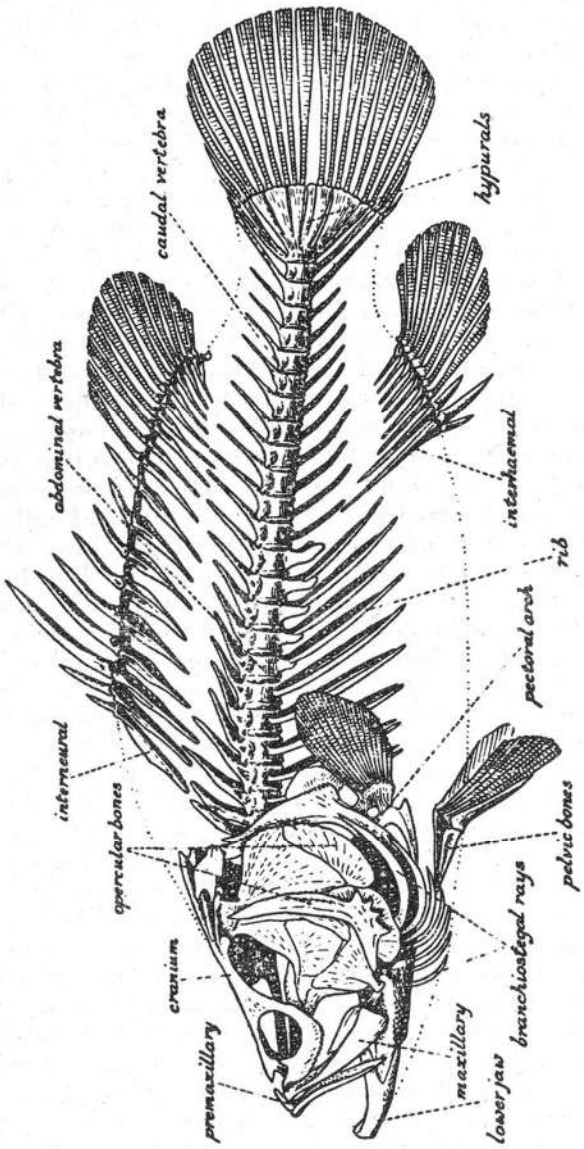
Warning Colouration: Many fish use bright colours to "advertise" the presence of poisonous spines or some other defensive mechanism. Eg. the Nave surgeonfish has two bright orange spots near the base of the tail that advertise the presence of razor sharp spines.

Mimicry: Here, nontoxic individuals mimic toxic individuals; non-aggressive fish look like aggressive species; predators can mimic prey species (ex. Sabertooth Blenny). Eye spots are a form of mimicry. The eye spot, usually found near the tail, draws attention away from the real eye which is a target that a predator might strike. The eye spot may cause the predator to attack the wrong end and allow the fish to escape alive.

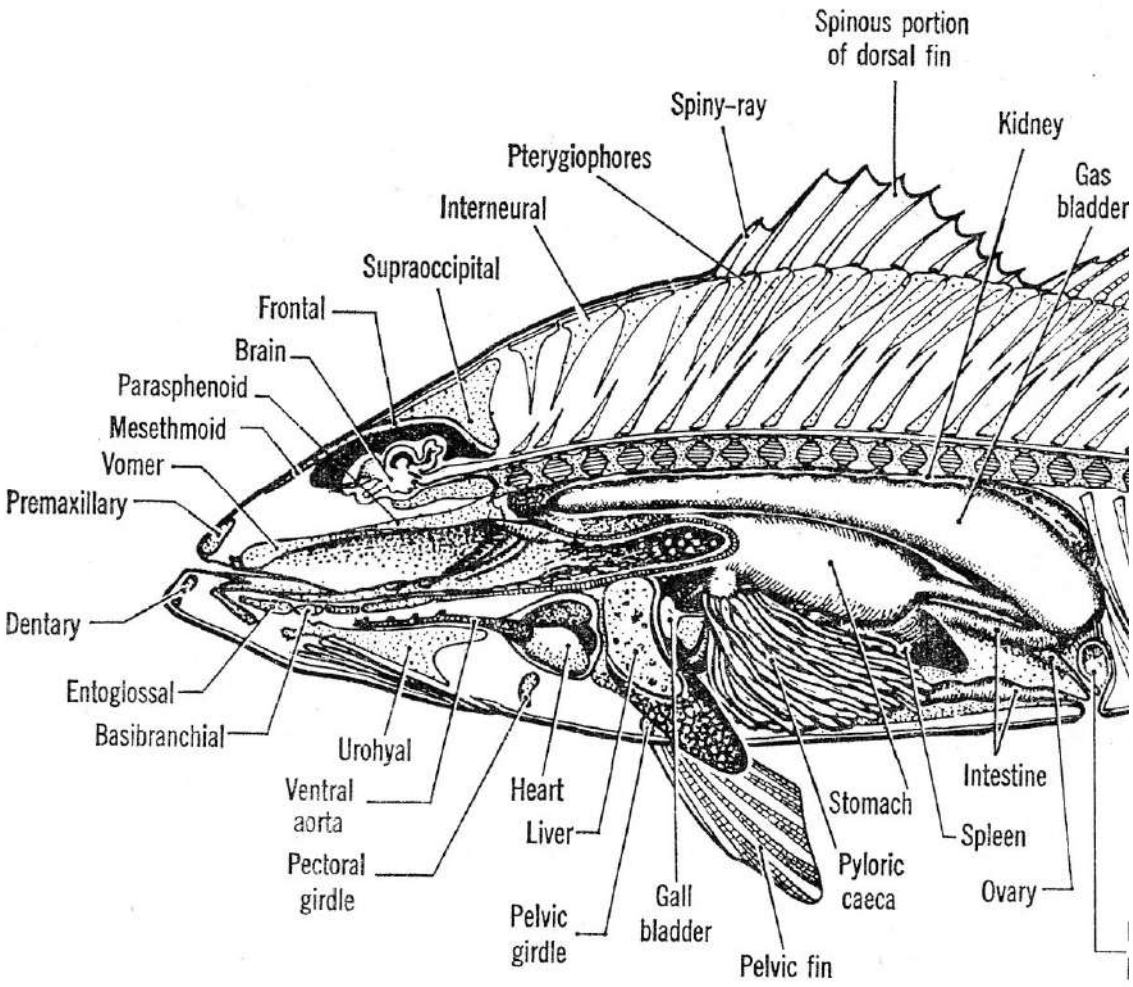
Typical parts of a Fish







Skeleton of a Nile Perch from Norman, 1947 Image



Source: Internal anatomical features of a Largemouth Bass, *Micropterus salmoides*. The image is from Lagler, Bardach & Miller (1964) - (Source: Lagler, 1954).

Further reading:

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