SECTION V
GENERAL ICHTHYOLOGY

35. GENERAL

This section will acquaint the novice fisherman with the dominant characteristics and features of fish. The more prominent parts of the fish and their functions will be discussed in some detail from a novice viewpoint.

36. ANATOMY AND STRUCTURE

a. A fish may be defined as a cold-blooded vertebrate with a backbone, permanent gills, and fins. There are more than 15,000 known species ranging in size from less than 1 inch to longer than 70 feet. Fish adapted to their many environments vary greatly in shape, methods of locomotion, and body structure. Fast-moving fish are usually sleek and streamlined, while those that inhabit the bottom regions are often flattened or depressed laterally.

b. A fish body has a supporting framework or connective tissue that holds the body parts together and provides a place of attachment for the muscles.

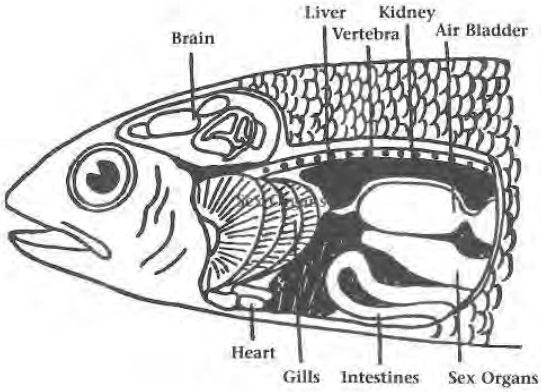
(1) The skeleton is composed of modified connecting tissue. Three types of muscles contribute to the movement and body functions of the fish:

(a) Smooth (for example, involuntary gut muscle).

(b) Skeletal (for example, in large body muscles).

(c) Cardiac (in the heart).

(2) Practically the entire body from the head back is a mass of muscle that provides the force for swimming. Other specialized muscles, developed in the fish embryo, control the movement of eyes, mouth, gills, and associated structures.



c. **The head:** Most of the obvious sense organs are located on the head: a pair of eyes – the nostril – often barbels (Whiskers). Fish can smell and taste not only with their mouth and nose, also with other parts of the body. The position of the mouth itself can vary:

If lower jaw is longer than the upper jaw, the position is called superior.

If the upper jaw is longer than the lower jaw, the position is called inferior.

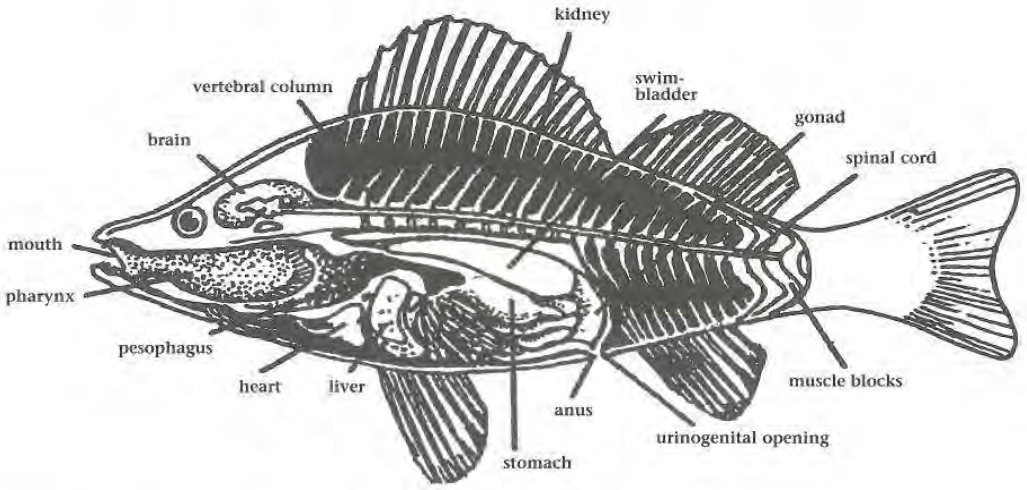
If the upper and the lower jaw have the same length, the position is called terminal.

During the spawning season, the male Salmonids develop a longer lower jaw with a kype, which is also called **"spawning hook"**.

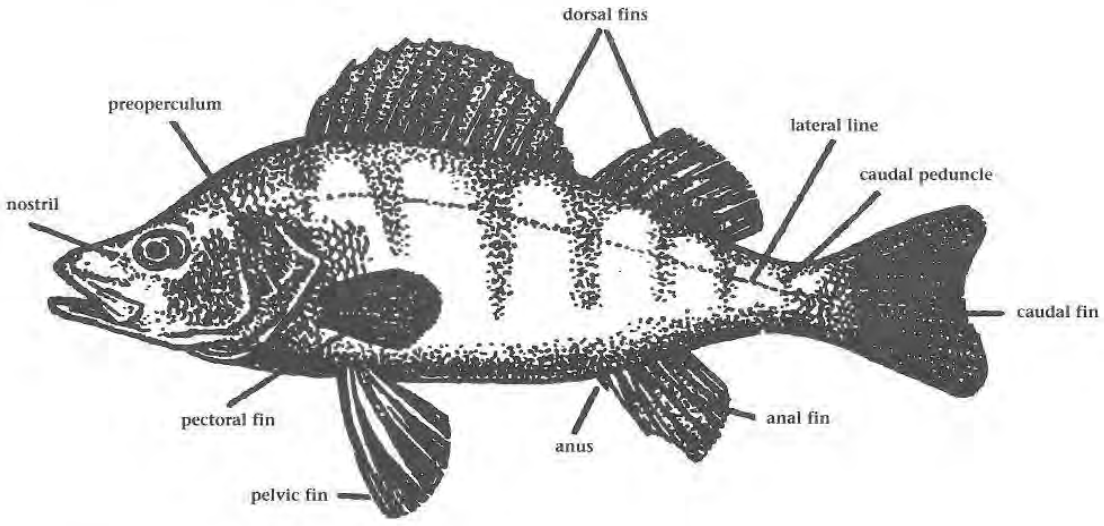
Associated with the mouth are several bones of taxonomic importance:

Cyprinids for example have "gullet teeth" (pharyngeal bones). They use them to crack mussel's and snails.

Salmonids for example have vomer bones (with teeth), to get a better grip on the baitfish.



Main internal organs of a typical fish (side view)



Main external features of a typical fish (side view)

37. FINS

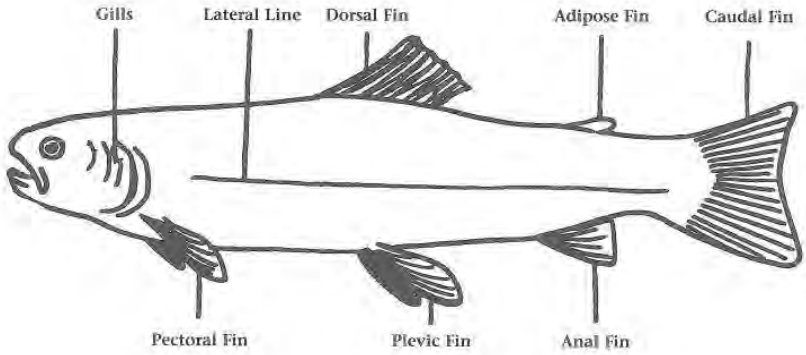
a. Dorsal. The dorsal fin, which may be spiny or soft, is located along the back and is important in maintaining balance. Some fish (for example, Pike-Perch) have two dorsal fins, and others have three, but not in European fresh water. These multiple fins may be joined or separated from each other.

b. Anal. The anal fin is located between the anus and the tail on the underside of the fish and, like the dorsal, helps the fish maintain balance. Most fish have a single vertical fin, but a few not European species may have a pair.

c. Caudal. Commonly referred to as the tail fin, the caudal fin is found in a great variety of shapes, sizes, and structures. Its most important function is to provide sudden bursts of speed, but in some fish it is also important for normal locomotion.

d. Pectoral and Pelvic. The pectoral and pelvic fins are paired fins corresponding to the arms and legs of higher vertebrates. Their chief function is for steering, although the pelvic fins are used by some fish to maintain balance. The pectoral fins normally are located ahead and higher on the underside of the fish than the pelvic fins.

e. Adipose. The adipose fin is the primary identifying characteristic of the salmonid family of fish. It is a small, fatty fin located between the dorsal and the tail. Th adipose has no long supporting rays and no known function.



38. SCALES

The bodies of fish, with few exceptions, are entirely or partly covered with protective scales. There are many scale shapers, ranging from circular to diamond-shaped to rhomboid to hexagonal. Fast swimming fish usually have small scales, while the more inactive fish develop larger, heavier scales as protective devices. Catfish and some of the eel species have no scales. Scales are of four general types:

a. Denticles. Denticles found on sharks and skates are tooth-like, forming the roughened skin of the fish.

b. Cosmoid Scales. Cosmoid scales are found on living fossil, the coelacanth.

c. Ganoid Scales. Ganoid scales are the hard, plate-like scales found on gars and sturgeons.

d. Bony-Ridged Scales. Bony-ridged scales, cycloid, round, or comb-like, are common to most bony fish. Cycloid scales, peculiar to herring, trout, and minnows, have rings that are similar to those in trees and can be used to judge the fish's age. Paragraph 49 further explains age determination.

39. SLIME AND SKIN

a. Slime. The body covering of fish, unlike mammals', is made of living cells as far as the outermost layer. A coating of slime over the entire body protects the fish against disease and parasites, reduces friction, and helps make the fish watertight. Without the slime coating, liquids would flow uncontrollably through the body wall. Care should be exercised, when handling with fish to be released, to save the slime coating protecting the fish.

b. Skin. Color cells in the skin control skin color, shade, and pattern. The skin of some species holds venom glands, mucous glands, and electrical organs. Photophores in the skin of other species produce bioluminescence.

40. GILLS

a. Fish must be able to extract life-giving oxygen from the water surrounding them. They must simultaneously dispose of carbon dioxide produced by respiration taking place in their cells. This exchange of gases, or respiration, takes place in the gills. The blood carries carbon dioxide from the cells to the gills and returns with oxygen. The blood in the gills must come into close contact with the water for the gas exchange to take place.

b. Most bony fish have four pairs of gills protected by a gill cover. Water taken in through the mouth is forced across the feathery gill filaments and out through the gill chamber. The amount of oxygen extracted by the fish depends on its environmental adaptation, metabolic activity, and the water temperature. Trout thrive only in clear, cold, flowing waters with a high oxygen content.; carp do well in muddy, still waters with a lower oxygen content.

41. AIR BLADDER

a. Most species have an air bladder, also called a gas or swim bladder, lying below the kidney. The air bladder acts as a hydrostatic or flotation organ, adjusting the weight of the fish by equalizing its water displacement so that it neither rises nor sinks.

b. Some species (for example, whitefish) possess a two-chambered air bladder enabling them to assume a slant position advantageous when feeding on the bottom. The walls of the partitioned air bladder vary in thickness and respond differently to exterior pressure changes. The posterior (rear) part is normally larger and thinner walled; the anterior (forward) chamber is usually smaller and thicker walled, making it more resistant. As atmospheric pressure falls, gas fills the posterior chamber more rapidly. The posterior half of the fish becomes lighter than the anterior half, and the fish assumes its distinctive feeding position.

c. High barometric pressure prevailing during fair weather apparently causes the air bladder to contract, increasing body weight. The fish sinks, and prospects for a good catch are minimal. Falling barometric pressure increases the chances of a good catch by causing the air bladder to expand, decreasing body weight and causing fish to rise. Westerly breezes often signal improved fishing prospects because these winds usually accompany falling barometric pressure.

42. BLOOD

Fish are cold blooded and, unlike warm-blooded mammals, do nor maintain a constant body temperature. Fish blood temperature varies with the temperature of surrounding waters.

43. LATERAL LINE

Fish are more complex creators than normally is imagined. The lateral line in many species is a single grooved line running along either side of the body from head to tail, containing various sense organs. This line acts as a device to detect variations in water pressure, and fish would be in grave difficulty without it.

a. The lateral line of many fish has regular perforations and a shallow canal beneath it that contains sense cells and nerves endings. With the aid of these cells and nerve endings, the fish knows, even in complete underwater darkness:

(1) Distance to banks or rocks or other obstacles.

(2) Proximity to other fish in the school.

(3) Water temperature.

(4) Rate of flow.

b. Fish similarly may register alien vibrations entering their waters (for example, screws of passing ship or motorboat, footsteps on the lake or riverbank, a fisherman knocking out a pipe on the side of the boat). The more excitable fish (for example, trout) respond to temperature changes of 0.03 degrees (°) centigrade (C). This reaction shows that the lateral line is extremely sensitive.

44. HEARING

a. Fish have a hearing sense, but it differs from that of humans. Fish need to communicate with each other, not only to spawn, but also to migrate and move together in schools in search of food.

b. Fish have an internal ear with the usual tubes and the same liquid-filled spaces that are found in other animals, including humans. The inner ear of all animals has two functions, to hear and to maintain balance. For fish, however, the inner ear is believed to serve primarily to maintain balance because fish have no externally visible ears and, most important, no organ in the head to connect the internal ear with the outside world, as do whales and dolphins.

45. SIGHT

Fish with the largest eyes usually have the greatest vision. The ball shape of the eyes and their position on both sides of the head allow fish a wide view, both in the vertical and horizontal planes. Fish lack eyelids, and the constant rinse of water keeps their eyes always alert, even during rest periods. Bottom feeders (for example, eel, tench, carp, and sheatfish) have small eyes and do not see well. These species develop other senses to compensate for their underdeveloped eyes. Fish eyes are color sensitive. During spawning time, the males of some species show especially bright courting colors. The range of color detection for fish eyes is greater than it is with human eyes. Fish can even detect ultraviolet colors. The intensity of light changes when fish move to deeper regions, into hideouts, or among water plants. The fish eye is always at full capacity for light consumption. During rest, the eyes are set for short range. Fish must pull their eyeballs back to see objects at long range, somewhat like focusing a camera lens. Fish can estimate the distance between themselves and other objects with reasonable accuracy.

46 SMELL

Fish have a well-developed sense of smell. Olfactory (smell) organs are located between the eyes and the point of the mouth. They help a fish distinguish between its own species and others. Many fish release a strong-smelling liquid when hurt and by doing so warn other fish. Some fish can detect objects by smell even when the solution is diluted as much as 1 part in 233,000,000. Fishermen should be careful particularly when handling baits and lures to ensure that nicotine, insect oil, and other strong odors do not destroy bait effectiveness.

47. TASTE

The sense of taste is very well developed in fish. Taste organs are located not only in the mouth, on the lips, and on the gill bones and whiskers, but also along the sides of the body (lateral line). The fishermen does not always need to offer the lure optically in front of the fish; the lure may be dragged along the sides of the body where the fish can detect it by sense of taste.

48. TEMPERATURE SENSITIVITY

a. Most fish species have a very well developed temperature sense. It has been proven that some fish respond to change of 0.03 °C to 0.07 °C. Each fish species has a preferred temperature, one at which the fish consumes the least energy. Trout favor 10 to 15 °C, char 7 to 11 °C, and carp 21 °C.

b. Freshwater fish can be divided into two main groups:

(1) The eurythermic fish (for example, perch, bullhead, burbot, pike, and minnow) van tolerate both cold and arm water. Eurythermic is the ability of an organism to tolerate a wide range of temperature.

(2) The cold stenothermic fish (for example, salmon, brown trout, char, whitefish, and grayling) require a low water temperature. Stenothermic describes the ability of an organism to tolerate only a small range of temperature. Salmonid fish are most sensitive to high water temperature. 34 °C for newly hatched salmon or trout for short periods are fatal or short periods. It has been shown scientifically that at extremely high or low water temperatures (above 20 °C and below 5 °C), salmon cannot overcome obstacles such as waterfalls and powerful rapids, which they normally pass with ease.

49. REPRODUCTIVE ORGANS

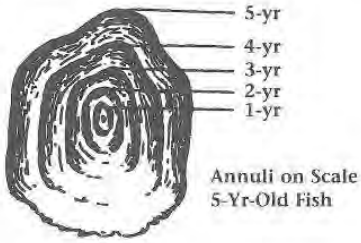
a. A female fish, in piscatorial terminology, is a spawner and the male fish a milter. The eggs are called roe.

b. The female fish produces a relatively large number of roe. Her reproductive system consists of two ovaries suspended dorsally (along her back) in the body cavity where the roe develop. The ovaries are usually saclike, round in cross section, and covered with a connective tissue. The testes of the male are a pair of long, white sacs occupying a position corresponding to that of the female ovaries. Spermatozoa are formed in the testis sacs.

To determine the age of a fish is generally difficult and different structures are used for identification.

50. GROWTH RINGS ON SCALES

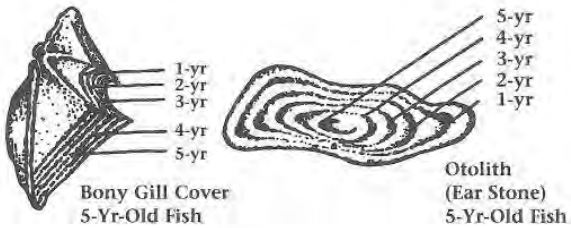
The age of a fish can be determined, with reasonable accuracy, by counting the number of winter annuli (bands) on its scales. During summer when growth is rapid, the circuli (growth rings) are wider apart, but in winter when food is scarce and growth retarded, the circuli are close together, appearing as a thickened band or annulus. When summer growth conditions are poor, false annuli may appear. As the scale grows, circuli form concentrically around the nucleus (the part of scale under the skin) similar to tree ring formation.



Annuli on Scale
5-Yr-Old Fish

51. GROWTH RINGS ON GILL COVER AND EAR STONE.

The age of species that are difficult to analyze may be determined by the cross section of the vertebrae, or the bones of the gill cover. The ear stone, or otolith, also may be used to determine age. All of these parts will show bandlike markings similar to those found on a scale.



Bony Gill Cover
5-Yr-Old Fish

Otolith
(Ear Stone)
5-Yr-Old Fish

52. SEX DETERMINATION GENERAL

Determining the sex of fish can be extremely easy in some species and very difficult in others. Some species show secondary sexual characteristics during their entire life, and others only during spawning time. Highly desirable and inexpensive natural propagation in adequate quantity requires suitable measures to maintain a proper sex ratio among the various game fish species. Brood fish must be protected sufficiently by special rules during the premature spawning activity.

53. SEXUAL DIFFERENTIATION

In some cases, it is possible to determine the sex of a fish only by opening it and examining the gonads (sex organs). But in some species, particularly fresh-water forms, the males clearly differ from the females.

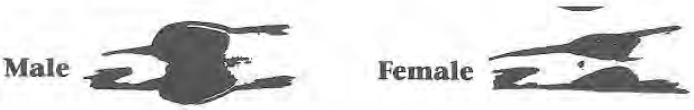
a. Only adult male grayling fish displays a larger dorsal fin than the female (fig 41). The posterior dorsal rays are curved, giving the appearance of being larger than they are.

Male **Female**

b. The pectoral fins of northern suckers are developed much better in males than in females.

Male **Female**

c. The sex of 2-year-old or older tench can be determined by the condition of the pelvic fins (fig 43). The outer pelvic fin rays in males are very hard. Both pelvic fins, greatly elongated and fanlike, extend over the male's vent. Pelvic fins in females lack the spiny rays, are shorter and pointed, and do not extend over the vent.



Male **Female**

d. The belly of several male white fish, pike-perch, and grayling is dark (ashy colored), while the female's is white.

e. Eels longer than 20 inches are most likely to be females because males generally do not grow longer than 16 1/2 inches.

f. Male trout and salmon develop a distinct hook or kype on the lower jaw. Most male trout and salmon also show intensified coloring at spawning time.

Male **Female**

g. The sex of carp can be determined by examining the anus: the male's triangular and concave; the female's is bowl-shaped and sometimes convex.

54. FISH MANAGEMENT TECHIQUES

a. Game fish should be examined carefully as the spawning season approaches to determine the stage of the ripening milt and roe. If well developed, the brood fish should be spared regardless of open season, and the species protected immediately by adjusting local rules. Closing the season early is advisable when the legal protection period does not correspond with the actual spawning period of a particular game fish species.

b. Fishermen should be able to distinguish the sex of fish and should keep an accurate catch record, including sex notations. On discovering early spawning activity, the sportsman must refrain from taking precious and ripe brood fish. This means no further fishing for the species involved, although the fish may still be in season. The fisherman also should act to ensure undisturbed spawning. Fishermen should realize that they generally would catch more females than male specimens shortly after spawning season has ended. Females weakened by their egg laying activity are usually mire voracious during this critical period, feeding heavily on all kinds of food in an effort to regain their physical strength rapidly.

c. A sound fish management program must have the support of all fishermen to be effective. Awareness of fish sex is a good and simple way for fishermen to avoid upsetting the sex balance.

Proportionate Growth: The relationship between annual body length and size of scale in a cyprinid fish