

Classical Taxonomy

Morphological characters

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Introduction

- The nature of adipose eyelids, its development, extension of maxillae, position of nostrils, nature of operculum whether serrated or not, presence of pores around the mouth region and barbels, its numbers, type of mouth, the arching of lateral line, naked area of breast region, pigments, bands on the lateral side, etc., are to be studied carefully in large number of specimens covering different length groups.
- Sometimes a morphological character attributed by a taxonomist as valid one for a species at a given length, may prove to be invalid at larger length groups or at smaller length groups. Hence, the taxonomists have to study the morphological characters at all length groups covering large number of specimens .
- The colour pattern in most of the fishes changes after death. Ichthyotaxonomists should not give more importance to colouration. While studying colourations, the specimens available at fish markets must not be studied and the colour pattern will also change when the fish is preserved. Similarly the number of bands on the body, the spots and pigmentation have to be studied only in fresh specimens.

Morphological character use in ichthyotaxonomy

- To separate a family taxon, genus taxon in addition to their use in identifying species taxon.
- To separate closely related genera and species

Example -1

The order, Pleuronectiformes includes six families and all these families could be separated using the following morphological characters

1. *Psettodidae* – (i) Spiny rays present, (ii) eyes on left side or right side only, (iii) dorsal fin origin well posterior to eye.
2. *Pleuronectidae* – (i) Pelvic without spine, (ii) eyes only on right side, (iii) preopercle margin exposed, its hind margin free and visible.
3. *Citharidae* – (i) Eyes on one side (left or right), (ii) pelvic with one spine and five rays.
4. *Bothidae* – (i) Eyes only on left side, (ii) edge of preopercle margin free and visible, (iii) separate caudal fin.
5. *Soleidae* – (i) Pelvic without spine, (ii) preopercle margin exposed, its hind margin hidden by skin, (iii) eyes only on right side.
6. *Cynoglossidae* – (i) No free preopercular margin, (ii) eyes on left side, (iii) caudal fin

Example – 2

The genera in the family, Ariidae (marine catfishes) could be separated using the following morphological characters.

1. *Osteogeneosus* – one pair of stiff and semiosseous maxillary barbells (mental barbells absent)
2. *Batrachocephalus* – only 1 or 2 pairs of soft, minute rudimentary mental barbells (maxillary barbells absent)
3. *Arius* – three pairs of slender barbells (one pair maxillary and 2 pairs mandibular)

Example – 3

- The presence of ventral scutes separate the closely related genera such as *Stolephorus*, *Thryssa* and *Thryssina*.
- If scutes are present between pectoral and pelvic fins, the species of such type comes under the genus, *Stolephorus*.
- If the scutes are not present before the pectoral, such species are placed under the genus, *Thryssina* and when scutes are present before and behind pelvic, fin, such species are placed under the genus, *Thryssa* and *Setipinna*
- Species coming under the genus, *Thryssa* have the first pectoral fin ray normal, whereas in the species coming under the genus, *Setipinna*, the first ray is filamentous.

Example – 4

- Some morphological characters may also change in accordance to length groups.
- In the genus, *Atule* of the family, *Carangidae*, the earlier authors while separating this genus with closely related genera, *Alepes* emphasized the extension of adipose eyelids.
- In the genus, *Atule* the adipose eyelid covers the entire eye except the central slit.

- But in larger length groups, the ventral part of the eye is also covered with adipose eyelids.
- Hence this character is applicable only in smaller specimens. In the genus, *Alepes* the adipose eyelid covers three fourth of the eye on all length groups

Fish Diagnostics

Fish identification depends mostly on the external morphological characters of the fish. Two main features are commonly used: morphometric and meristic characters. Of these the first as the name indicates utilises the morphological or external characters and the second the counts or the numbers. Depending upon the group of fish these vary. For instance in the case of fish without scales the number or counts of scales does not arise. However the more commonly adopted measurements are detailed below. These are the essential data one has to take but many more can be added but their utility should be kept in mind.

Main Organs

The main organs in a fish are situated in the head region. The body carries the fins, digestive, reproductive and other systems. Before explaining them it is better to have an idea of the body parts of a fish which are used in identification. Fish may be with or without scales and spines but the major body configuration remains the same.

Head Region

1. Snout. 2. Lips. 3. Mouth. 4. Jaws. 5. Teeth 6. Barbels. 7. Nostrils. 8. Eyes. 9. Operculum, gills. 10. Median groove. 11. Pectoral girdle. 12. Occipital process.

Depending upon the habits and habitats of the fish, variations in structure and shape are present in these organs; These are detailed below.

Snout

The anterior most part of a fish, which in most cases is rounded or obtuse. Variations are (i). Pointed and sharp (Eels Fig. 12 A). (ii). With a groove across on top. (*Shismatorhynchos* (*Nukta*) *nukta* Fig. 12 B). Some as *Garra nasuta* have a proboscis developed (Fig. 12 C) (iii). Tubular with jaws at tips. (Pipe fish. Fig. 12 D). (iv) Smooth in most cases covered with thin or thick skin but in some tubercles may be present (Fig. 12E *Gonoproktopterus*, *Barilius* species) (v). Overhanging the mouth (Fig. 12 F Engraulids).

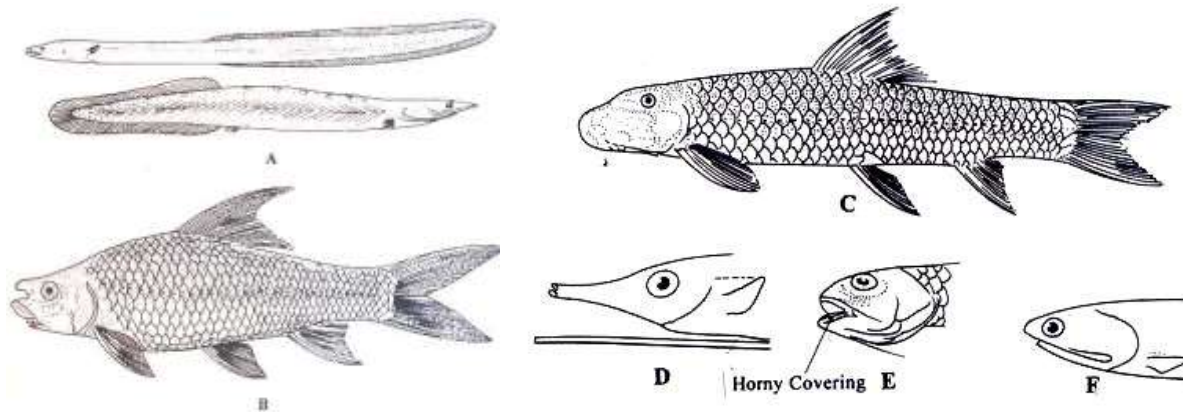
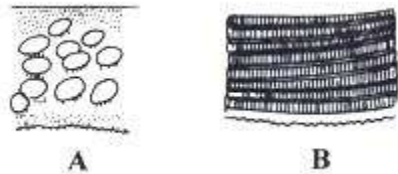


Fig.12. Shape of snout. A. Pointed and sharp. Eel. B. With a groove across on top. *Schimatorhynchos* (*Nukta*) *nukta*. C. With a well-developed proboscis *Garra nasuta*. D. Tubular with jaws at tips. Pipe fish. E. With tubercles. F. Overhanging.

Lips

The premaxillary and maxillary bones of the upper jaw are covered by the upper lip and the mandible on the lower jaw by the lower lip. Mostly these lips are thin smooth membranes but in some they may be with pores (Fig. 13A), stripes (Fig. 13B) as in *Labeo dero* and *L. dyocheilus* respectively or modified to form a sucker-like disc as in Garro species (Fig. 13 E). In some as in the Mahseer the lower and upper lips are continuous around the jaws and the labial fold (fold formed by the lips) is uninterrupted by the isthmus (Fig. 13 C) or interrupted (Fig. 13D). The lower lip may even be prolonged as a flap called the mentum. In *Tor progenius* the upper lip is modified as a fan shaped structure. (Fig. 13 F). Depending upon the position of the mouth the lips may also be terminal or inferior as they are adherent to the jaws.

Lip Structure



Lip

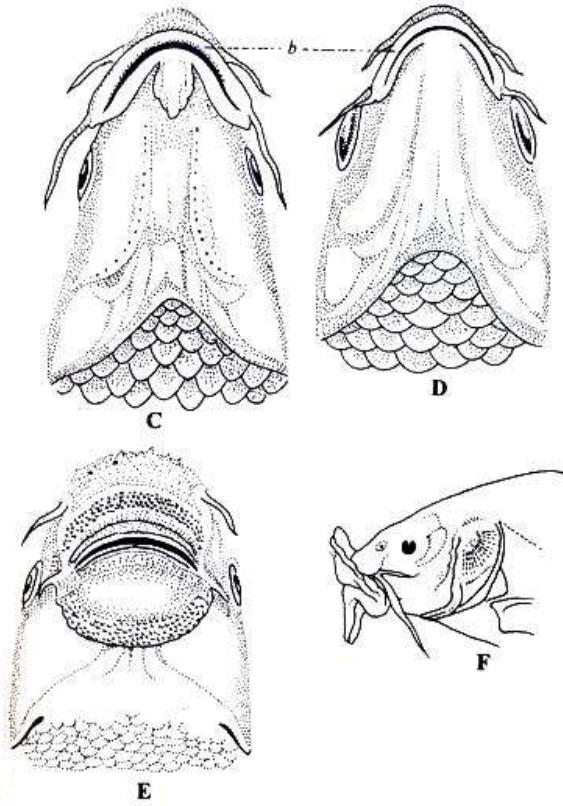


Fig. 13. Lip structure. A. *Labeo dero* with pores. B. *Labeo dyocheilus* with stripes. C. Labial fold continuous with metum. D. Labial fold interrupted. (b=Upper lip) E. With a suction disc on lower lip *Garra*. F. Upper lip with fan-shaped enlargement *Tor progenius*.

Mouth

Mouth is the chief organ for feeding of the fish and based on the type of food it takes, the shape, position, size and form vary. In most cases it is terminal or slightly below sub-terminal (Fig. 14B). Surface swimmers as *Danio*, *Puntius*, and *Rasbora* species have a terminal mouth (Fig. 14A). On the other hand hill stream fishes as ,) *Balitora*, *Bhavana*, *Garra* species have their mouth narrow and placed in the ventral side of the snout (Fig. 14 C) to suit their scratching of food from the rocks and boulders where they live without being washed away by the surging waters. Species of *Glyptothorax* have their mouth placed slightly inferior. In Belonidae (freshwater Gars) the mouth is superior (Fig. 14 D), wide and the cleft extends to the border of the eyes (orbit).

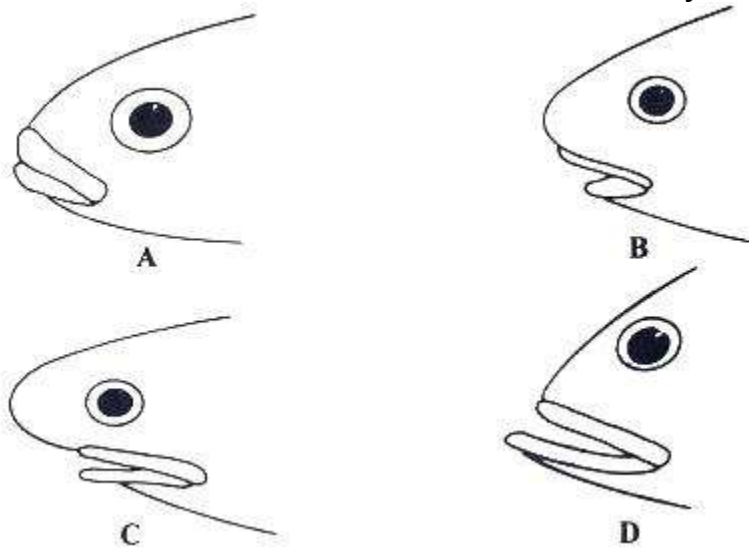


Fig.14. Shape of mouth. A. Terminal (*Danio*, *Rasbora*, *Putius*). B. Sub-terminal. C. Inferior (*Balitora*, *Garra*) D. Superior (Belontids).

Teeth

Teeth are borne on the jaws and palate. All fishes may not have teeth. Many as *Chanos chanos* (Milk fish), Cyprinids are without teeth (called edentate). Siluroids have sharp teeth. The teeth when present are mostly villiform (sharp) (Fig. 15 A), conical (Fig. 15 C), molariform (Fig. 15B Rita species), canine (*Pseud apocryptes* Goby). In Puffer fish (*Tetraodon* species) the teeth are formed like a beak-like dental plate. In most fishes the teeth on the lower jaw are in the form of a narrow or wide band, separated in the middle where as on the upper jaw it is uninterrupted and continuous. On the palate they may be in patches, discontinuous or continuous or as a single broad band. The band is nearly curved and may extend deep into the corner of the mouth. The teeth are essentially meant for crushing, scraping the food that the fish takes and accordingly they are modified.

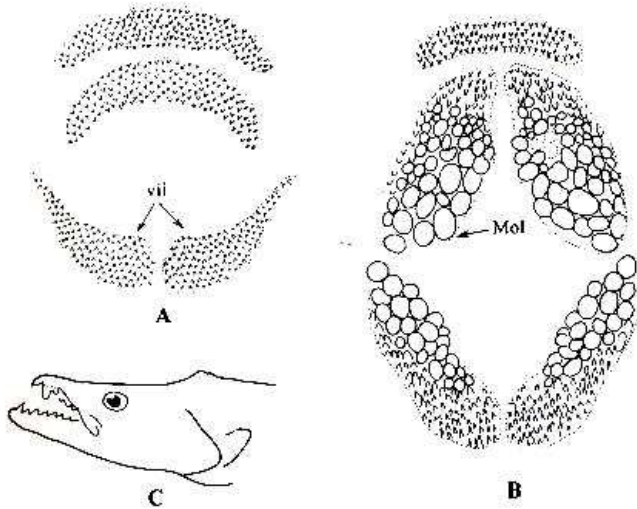


Fig. 15. Teeth. A. Villiform. B. Molariform (*Rita*). C. Conical (Gobies).

Jaws

As already stated the pre-maxillaries, maxillaries and mandible bones form the upper and lower jaws. They are united by a symphysis (joint) which enables them to open and close the mouth. The jaws bear the teeth described above and act as the frame for the shape of the mouth. The palate teeth are borne by the vomer bone, which is not a part of the jaw. The jaws are essentially meant to capture, hold and swallow the prey and the teeth help in munching, grinding and making it fit for passage through the gullet. In most fishes the jaws are more or less of equal length, but in some the upper jaw is longer than the lower (Fig. 16 A). In Clupeidae the lower jaw is longer than the upper (Fig. 16 B). In Engraulidae the upper jaw is projecting. In Ctenops species both the jaws are elongated to form a somewhat pipe-shaped mouth. In *Hyporhamphus* species (Hemiramphidae) the lower jaw in the adult is elongated as a long beak (Fig. 16 C). In Pipefishes (*Ichthyocampus* species) both the jaws are produced as a beak. In puffer fishes both jaws are divided by a median suture with a cutting edge and covered by ivory like substance. In some the lower jaw may be having a horny covering as in *Labeo fisheri* (Fig. 16 D).

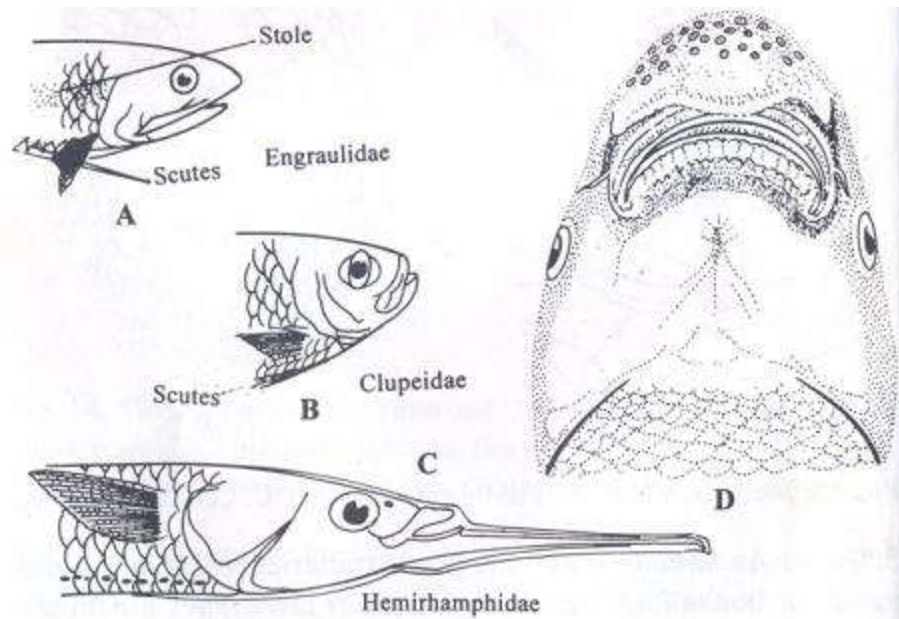


Fig.16. Jaws. A. Upper jaw longer than lower jaw (Engraulidae). B. Lower jaw longer than upper jaw (Clupeidae). C. Lower jaw elongated (Hemiramphidae). D. Jaw ridge horny (*Labeo fisheri*).

Barbels

Barbels are flexible tactile filaments under the chin surrounding the mouth, on the snout, on the sides, on the ventral side and in between the nostrils. In catfishes they play a very important role in identifying the food objects, locating the extent of the width in crevices and also as a defense organ. *Mystus bleekeri*, the fiddler fish of Mysore, erects its barbells in a threatening manner when disturbed. In the Ariid genus *Osteogeniosus* the only pair of maxillary barbels are thick and semi-osseous (Fig. 17 B). Most siluroids carry four pairs of barbels (Fig. 17 A), but it is not constant; it may be one, two or three. The Cyprinids also have barbels but not as long as in the catfishes. In *Nemacheilus* the barbells may be well developed and they are used as a sensory organ only (Fig. 17 C).

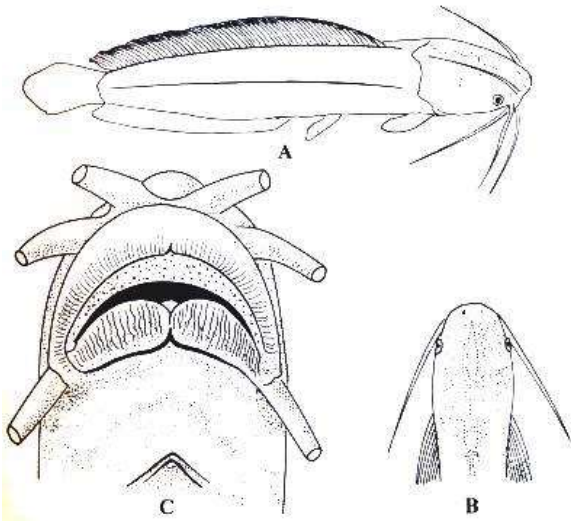
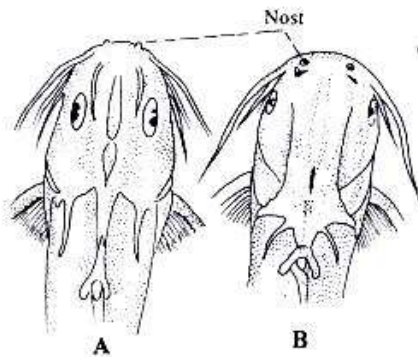


Fig. Barbels. A. Soft and muscular *Clarias batrachus*. B. Stiff and osseous *Osteogeniosus militaris*. C. Simple hollow short tubes. *Noemacheilus labeosus*.

Nostrils

Nostrils are a pair of apertures or slits on the snout which are the openings for the smell organs leading to the nasal canal on the skull. They are mostly small to medium and are sunk in the snout, often covered by mucous especially in catfishes. A pair of nasal barbels is often seen, which may be long, short or rudimentary and borne on the posterior one. They are generally well separated (Fig. 18A) but in Sisoridae the nasal barbels are closely placed one behind the other, slit-like but separated (Fig. 18 B). In Heteropneustidae the anterior nostril is placed /' on the tip of the snout and produced as short tube. In Ariidae they are closely placed and separated by a valve like structure (Fig. 18C). In some Nemacheilines a flap separates them. In *Oreonectes* the anterior nostril is prolonged as a long nasal barbel (Fig. 18 D). Whatever variations are seen the nostrils are a vital part of the fish and useful in classification.



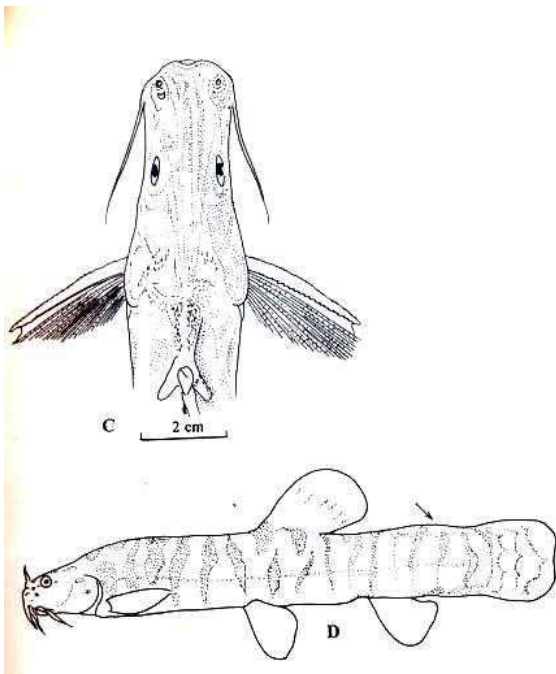


Fig 18. Nostrils. A. Placed wide apart Bagridae. B. Close together Sisoridae. C. Separated by a valve Ariidae. D. With a barbel in-between *Oreonectes* (*Oreonectes*) *evezardi*.

Eyes

Eyes mainly used for seeing food, enemies and predators are placed in most fishes dorso-laterally (at the sides) along a mid-axis line of the body. However this position may vary depending upon the habitat of the fish. It may be superior or inferior. Many gobioid fishes have the eyes placed on the top of the head. Species of *Oxyurichthys*, *Bathygobius*, *Boleophthalmus* have the eyes placed on top of the head. *Mugil corsula* has protruding eyes on the top (Fig. 19 A). In such cases the distance between the eyes becomes short. Puffer fishes, gouramies also have such an arrangement. The eyes in these cases are large. In some catfishes the eyes are placed low so that they are visible from below the ventral surface. *Chandramara chandramara* (Fig. 19 B), *Horabagrus brachysoma*, *Ompok* and *Ailia* species show this kind of placement. The catfishes browse at the bottom and hence the eyes are situated at this level. The eyes are generally large in size or moderate, but in the eels and hill-stream fishes they are, small; the latter being denizens of fast flowing shallow streams, with too much light penetrating, large eyes would be a disadvantage. In *Brachyamblyopui burmanicus* (eel like goby) the eyes are minute and hidden (Fig. 19 C) they are minute and hidden. The eyes are subcutaneous and they may be circular, oval in shape. Some cave dwelling fishes are totally blind.

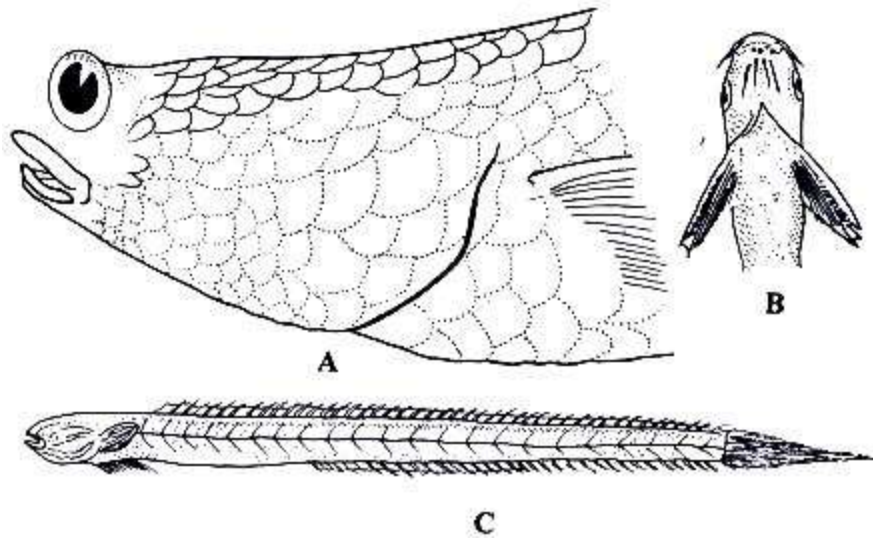
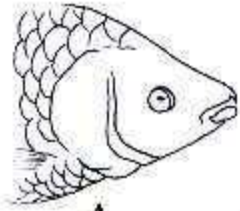


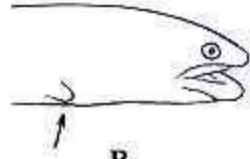
Fig. 19. Eyes. A. Superior *Mugil corsula*. B. Inferior visible from below ventral surface *Chandramara chandramara*. C. Minute reduced, hidden *Brachyamblyopus burmanicus*.

Operculum and Gills

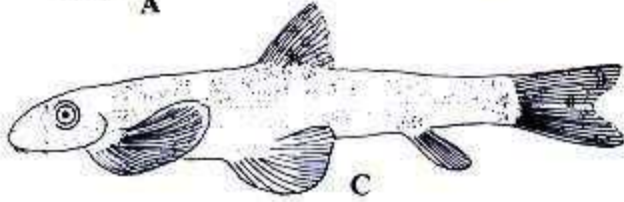
Operculum and gills form part of the branchial apparatus. On either side of the fish the gill slits are situated which may be wide (Fig. 20 A), narrow or even in the form of a small aperture as in the case of the eels. In the snake eels (Ophichthyidae) the gill openings are in the pharynx as wide slits (Fig. 20 B). On the other hand in Moray eels (Muraenidae) they are small, round openings only (Fig. 20 D). In hill stream fishes they are greatly restricted to the ventral side (*Bhavana australis*, Fig. 20 C). Where the openings are wide they are covered by a group of flat thin opercular bones joined together by the skin which covers the gills inside. On the ventral side of the head numerous tiny thin bones are arranged fanwise from the lower side of the opercle. These are branchiostegal rays (Fig. 20 F) covered by a thin membrane. Comb-like plates, red on colour are seen on either side, which are the gills. The concave pharyngeal margins of the branchial arches are fringed with a double series of either cartilaginous or bony tubercles or filaments called the gill rakers. The anterior row of gill rakers on each arch usually interdigitate with those of the posterior row on the preceding arch and in this way the two rows form a sieve like mechanism to prevent any solid particles entering the pharynx with the respiratory current of water and from passing into the gill clefts and clogging it. The gill arches carry the gill lamellae and gill rakers or branchiospines. The first branchial arch (the anterior-most one) (Fig. 20E) carry rakers on the upper limb and filaments on the lower limb. Five gill arches are placed on either side of the head region (Fig. 20 G). The rakers on the upper and lower limb of the first arch are counted separately Usually the first gill arch alone is taken for counts.



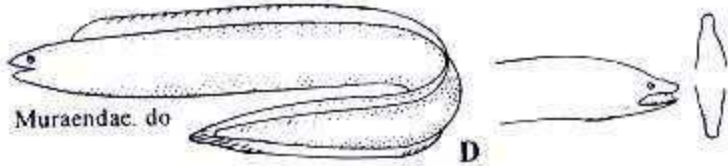
A



B

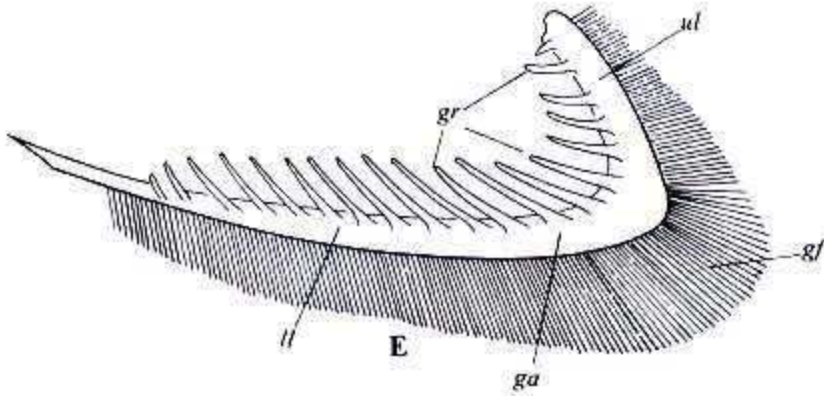


C



Muraenidae

D



E

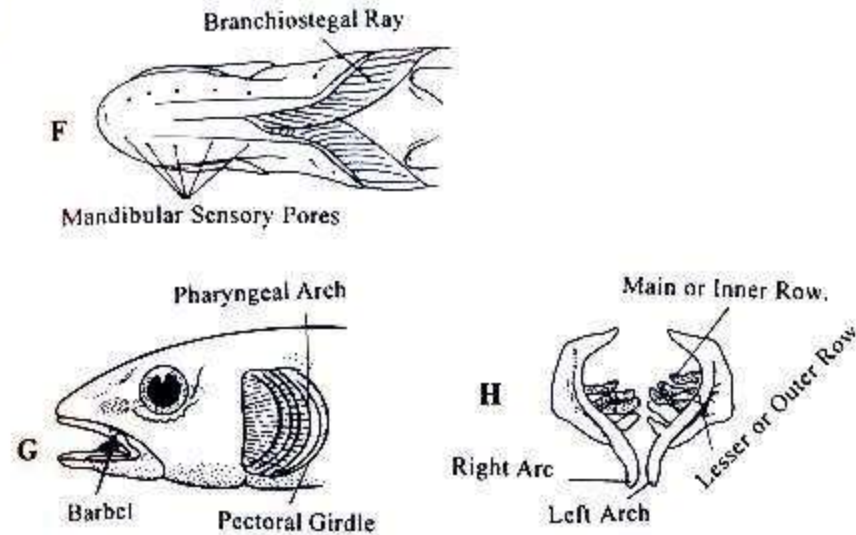


Fig. 20. Operculum and gills. a. Normal. B. Eel as a moderate slit in pharynx near base of pectoral fin. C. Greatly restricted above base of pectoral fins *Bhavana australis*. D. Round and lateral in pharynx Mureanidae. E. Structure of a gill. (*u.l*) Upper limb. (*gf*) Gill filament. (*ga*) Gill arch. (*ll*). Lower limb. (*gr*) Gill rakers.

2.1.5.10 Median groove

Median longitudinal groove or fontanel are two longitudinal-externally visible long depressions on the head and covered by skin in catfishes. They may be single or double and are in the center of the head extending from near the snout to the base of the occipital process. When single (Fig.21 A) it is a continuous depression without a break. When double it is interrupted (Fig. 21 B) in the middle by a short bone. These represent the passage for the cranial nerves in the skull. When covered with thick skin its extent can be found by inserting a needle and dragging (Fig. 21 C).

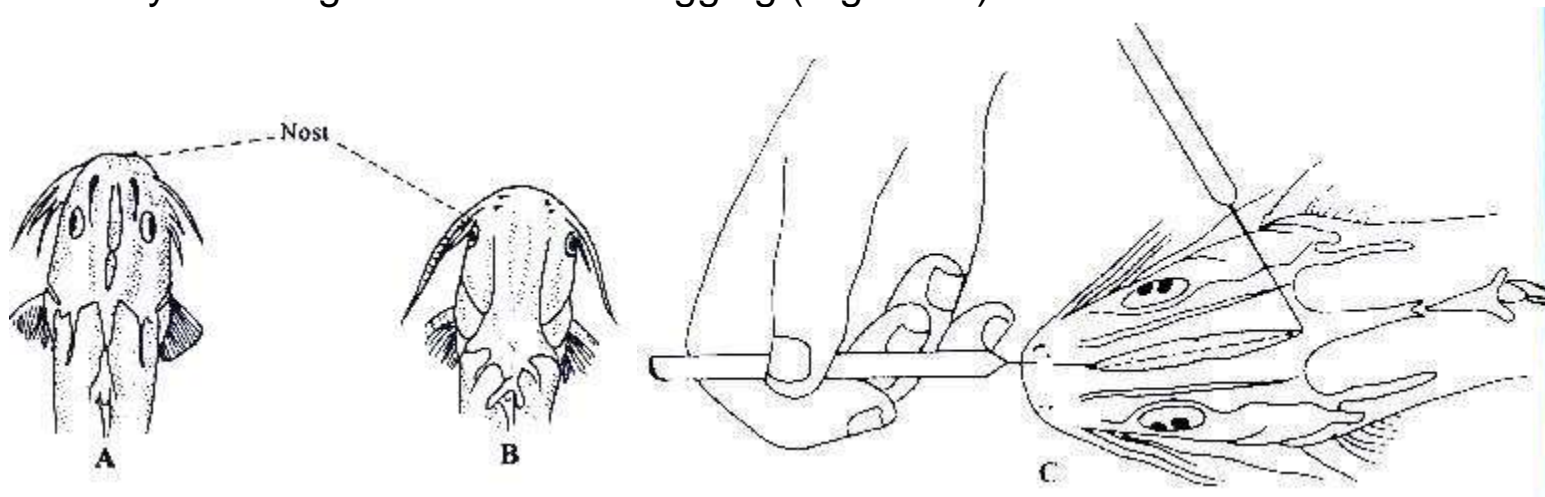


Fig. 21 Median groove. A. Continuous. B. Interrupted as two fontanel. C. Extent and identification of fontanel.

Pectoral girdle

These are paired bony structures on either side of the fish in the head region inserted laterally in most cases. They bear the pectoral fin and pectoral spine in catfishes. These articulate and are attached to the 'post-temporal bone of the cranium. Besides the spine an elongated cleithral process (Fig. 22 A) is visible above the pectoral fin at the side in catfishes. This may be rugose and prominent in some genera. The pectoral spines are mostly stout, strong, serrated along the outer edge or smooth, but in most Cases they are strong, with anteriorly directed (antrorse) serrations; in some both the inner and outer edges are serrated, where the direction of the serrations are towards the posterior end it is called retrorse. (Fig. 22 A) In *Erethistes pussilus* the spine serrations are different; they are divergent (Fig. 22 B). Some fishes exhibit a long filament from the tip of the pectoral spine.

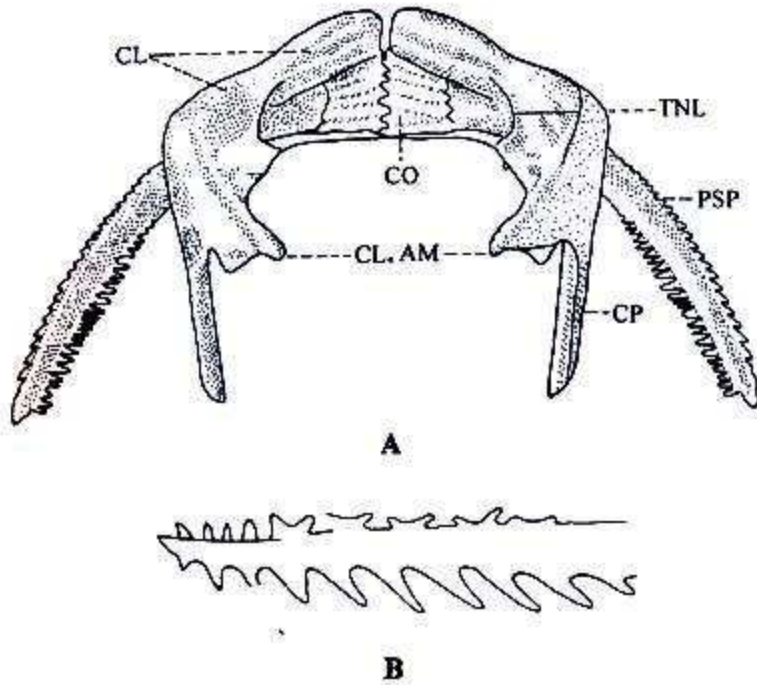


Fig. 22. Pectoral girdle of *Rita rita*. A. Showing (PSP) pectoral spine with antrose teeth on inner edge and retrorse teeth on outer edge. CL = Cleithrum. CLAM. = Upward directed short narrow arm of Cleithrum. CP = Cleithral process. O = Coracoid bone. TNL = Tunnel. B. Divergent serrations along outer edge in *Erethistes pussilus*.

Occipital process

An arrow like conical bone with a broad base extending from the supra-occipital bone to the basal bone of the dorsal fin (Fig. 23A) in catfishes. The junction with the basal bone of the dorsal fin may be Interrupted (Fig. 23 B) by a short or long space which is helpful on separating group of fishes. The bone may be interrupted by an inter-neural shield (Fig. 23 C) as in *Aorichthys aor* and *seenghala*.

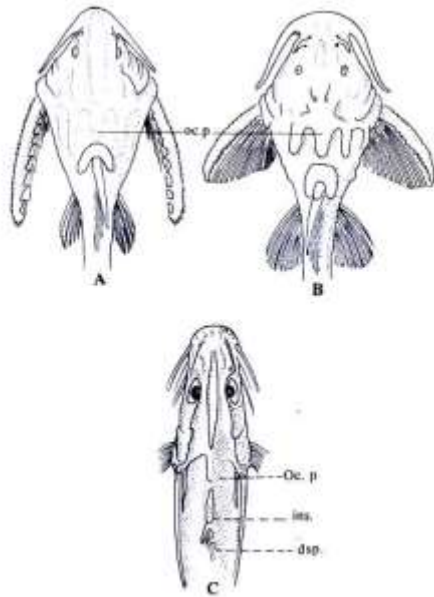


Fig. 23. Occipital process. *Hara hara*. A. Reaching basal bone of dorsal fin. B. Not reaching. C. Inter neural shield.

Body

The Body of the fish carries the paired and unpaired fins, scales, lateral line and internal organs as already started. The main features are 1. Paired fins. 2. Unpaired fins. 3. Lateral line. 4. Scales.

Paired fins

The pectoral, pelvic fins are the paired fins since they are two in numbers placed side by side. The pectoral fins- are inserted in most cases laterally but in some may be horizontally (Psilorhynchidae, some Homalopterids) or even above the ventral profile (perches, gobies) (Fig. 24 C). They bear the fin rays, simple and branched and in catfishes the pectoral spine. In some cases the fin rays may be elongated as long filaments (Fig. 24 D *Ctenops nobilis*). The shape of the pectoral fins vary differently. The pelvic fins (some times called ventral fins), are inserted in most cases ventrally and are placed with a distance in between them (Fig. 25 A), but in Gobiidae they are united. In *Sicyopterus* they are united in the form of a cup (Fig. 25 B) shaped disc. The fins bear the simple and branched rays. In Syngnathids they are much reduced. The fins are absent in some (eels, Mastacembelidae, Puffer fishes). In perches the fins when present may be thoracic (Fig. 24 A) or jugular (Fig. 24 B) in position and bear spines.

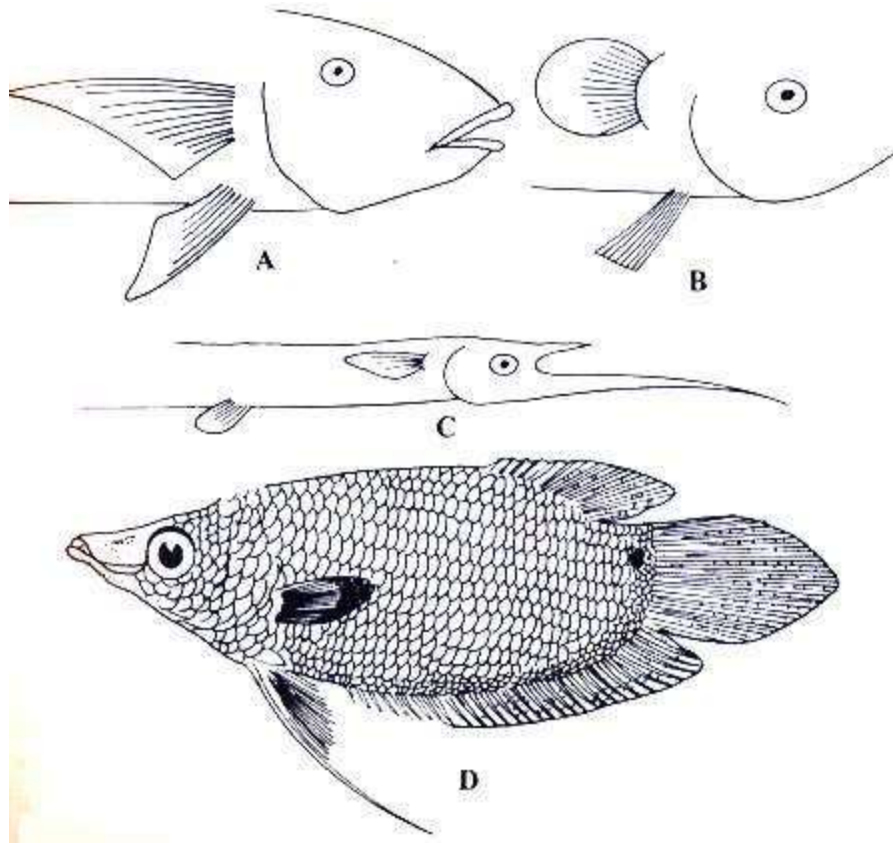


Fig. 24. Pectoral fin insertion. A. Thoracic. B. Jugular. C. Abdominal. D. with filaments *Ctenops nobilis*.

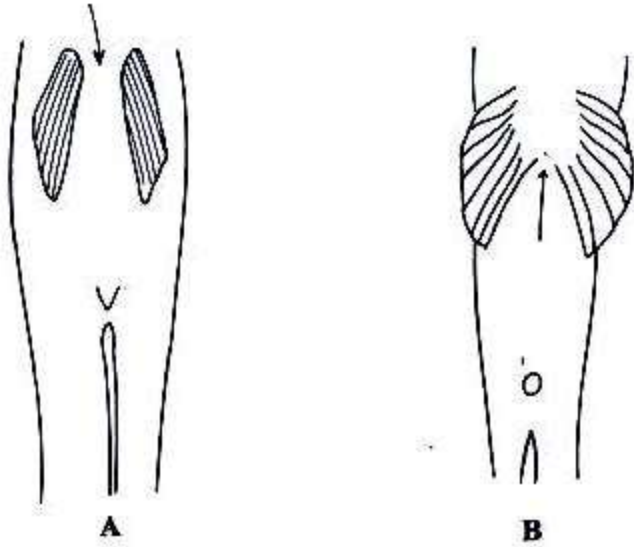


Fig. 25. Pelvic fins: A. Free. B. United as a cup (Gobioids).

Unpaired fins

The dorsal, anal and caudal fins are unpaired in the sense that they are single and not in pairs as the above. The [dorsal fin](#) in most fishes is single, concave in shape (Fig. 26 A) with smooth or serrated spine (Fig. 26 B), with simple (Fig. 26 D), and branched rays (Fig. 26 F). The principal ray may be thickened (Fig. 26 E). There may be a procumbent spine in some (Fig. 26 G *Mystacoleucus*). In *Megalops cyprinoides* the last ray is prolonged as a filament (Fig. 26 H). In Perches there are [two dorsal fins](#) one after the other with the first one separated either by a short or long gap from the second fin (Fig. 27 B) or may even be united (Fig. 27 A); both may bear spines and also soft and branched rays. Generally the first fin is shorter than the second one but this may not always be true. In mugils the first fin is with spines only, separated from the second one by a distance. In Synbranchids (Swamp eels) the dorsal fin is vestigial in the form of ridges only. In Mastacembelus the fin is in two parts; the first one with 32 to 40 short depressible spines and 46 to 90 rays. In *Sillaginopsis* the second dorsal spine is prolonged as a long filament (Fig. 26 C). The fin may be in different positions on the dorsal profile, mostly at the center, but in many may be far posterior above the anal fin. The fin may be free or even confluent with the caudal fin.

Fig 26 & 27 Added

An [adipose dorsal fin](#) is present in siluroids and salmons; it is generally smooth, free (Fig. 28A) and not united with the rayed dorsal fin though the interspace between the two may be long or short. In *Sisor rhabdophorus* the adipose fin is reduced in the form of a spine (Fig. 28 C). In *Chaca chaca* and some other fishes it is confluent with the caudal fin (Fig. 28 B).

Figure 28 Added

The anal fin is inserted on the ventral side and is with simple and branched rays. Generally the fin is free (Fig. 29 A), short, but exceptions are there as in the case of *Horabagrus*, *Clarias*, *Heteropneustes*, Schilbeids, Pangasids. Plotosids. In the latter the fin is confluent with the caudal fin. (Fig. 29 B); whereas in Claridae and Heteropneustidae though long, it is separated from the fin by a short distance. In *Horaichthys* the fin is modified into two parts; the first six rays are separated as an independent gonopodium. In *Garnbusiaan* intromittant organ is present (Fig. 29 D). In both cases Only the males show this adaptation. The perches (Fig. 29 C *Dahlioides quadrifasciatus*) may have spines in the anal fin.

Fig 29 Added

The caudal fin or the tail fin is the propeller for the fish and acts as a rudder. It is the posterior most part of the fish body. It is of varying shapes and is always a single fin, rounded. with or without margins (Fig. 30 C), truncate (Fig. 30 F), furcate or slightly emarginate (Fig. 30 A), forked (Fig. 30 B), lunate or lanceolate (Fig. 30 H), wedge or paddle shaped (Fig. 30 D), notched (Fig. 30 E), rounded (Fig. 30 G) or ovate (Fig. 30 J) etc. In most cases it is forked to varying degrees. The lobes may be equal or unequal (Fig. 30 K) and sometimes filamentous extensions are also present (Sisor, Bagarius).

Fig 30 Added

Lateral line

The Lateral line is the sensory line formed along each side consisting of sensory pores to tiny tubes in scales or skin. Most fishes have the lateral line, but in some it is absent (Mugilidae) (Fig. 31 D). It is generally continuous (Fig. 31 A), but in some Cyprinids and Perches it may be discontinuous (Fig. 31 B) or in two levels (Fig. 31 C). Generally it stops at the base of the caudal fin but in *Lates calcarifer* it extends beyond into the caudal fin (Fig. 31 E). In *Toxotes chatareus* it is interrupted (see Fig. 10).

Scales

Scales are thin bony plates covering the whole or part of the body of the fish. They can be microscopic as in the cobitids, small as in *Chela*, large as in *Labeo* and big as in Mahseers. Their edges may be spinous (ctenoid Fig. 32 A, B *Butis butis*, *Ophiocara* species of Eleotridae), or looth (cycloid Fig. 32 C, D). Most fishes have the latter variety. The numbers vary according to the size; it may even exceed 100 (*Securicula*), limited to 87 or even less than 20 (*Puntius titeya*). Most are deciduous in that they fall off easily. In some fishes the scales are in the form of bony plates (Puffer fishes).

The variations in the different body parts of the fish have been outlined mainly to indicate that these are very helpful and often used in separating taxa.

Fig 32 Added

Abdomen

The Abdomen of a fish is mostly rounded except in flat fishes, hill stream fishes and deep sea fishes where they are flat. In most Cyprinids the abdomen may be keeled with no barbels (Fig. 33 A) or rounded with barbels (Fig. 33 B).

In Clupeids the ventral profile may be with serrations (Fig. 33 C). In the Sisorid fish *Glyptothorax* an adhesive apparatus is developed (Fig. 33 D) in which the paired fins, pectoral and pelvics, may be plaited (Fig. 33E).