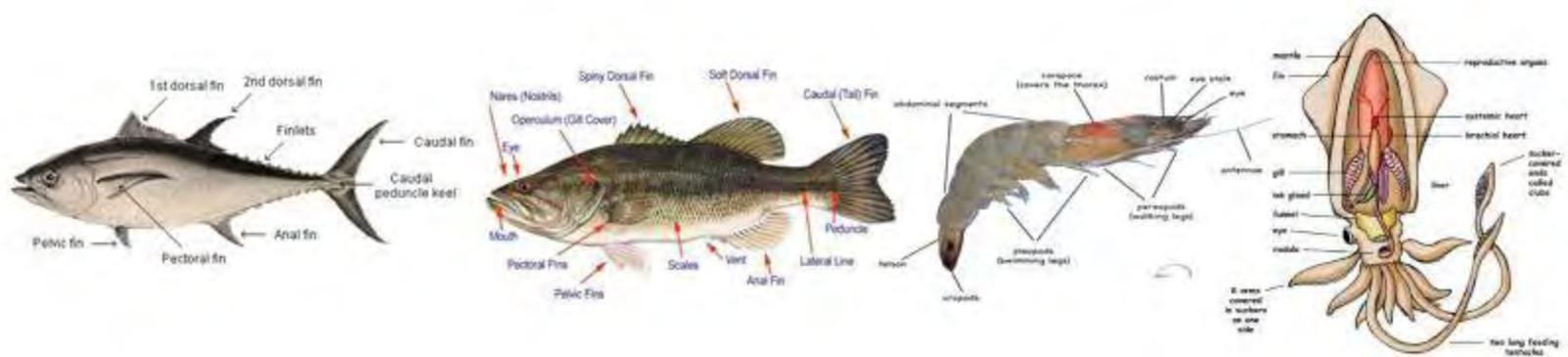


SPECIES IDENTIFICATION



FIMSUL-II
(Component – III)
Estimation of Marine Fish Landings
in Tamil Nadu with Enhanced
Sampling Coverage

FISHERY RESOURCES ASSESSMENT DIVISION



ICAR – Central Marine Fisheries Research Institute
Kochi | Kerala | India

Training Manual

SPECIES IDENTIFICATION

FISHERY RESOURCES ASSESSMENT DIVISION

ICAR-Central Marine Fisheries Research Institute
(Department of Agricultural Research and Education, Government of India)
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Basic Finfish Features

Vivekanand Bharti

Fishery Resources Assessment Division

Taxonomy is the practice of identifying different organisms, classifying them into categories and naming them. The whole life (living or extinct) of the world are classified into distinct groups with other similar organisms and given a scientific name. The classification of organisms has various hierarchical categories. Categories gradually shift from being very broad and includes many different organisms to very specific and identifying single species.

The most common system of classification in use today is the Five Kingdom Classification, proposed by R.H Whittaker in 1969. Five kingdom classification of living organisms is as follows:

1. Kingdom: Monera

It consists of primitive organisms. The organisms are very small and single celled. It includes species like the Bacteria, Archae bacteria, Cyanobacteria and Mycoplasma.

2. Kingdom: Protista

It is single-celled eukaryotes and mainly belongs to aquatic. It includes diatoms, euglena and protozoans like Amoeba, Paramecium, Plasmodium, etc.

3. Kingdom: Fungi

Kingdom Fungi is also called Kingdom Mycota and consists of network of thread-like structures called as mycelium. The bodies consist of long, thread-like structures which is called hyphae. These organisms are mostly saprophytes or parasites and also symbionts. This kingdom of fungi also includes Lichens, Mycorrhiza, etc. Example: Aspergillus.

4. Kingdom Plantae

Kingdom Plantae is also known as Kingdom Metaphyta. It is eukaryotic, multicellular plants. This kingdom includes all types of plants like herbs, shrubs, trees, flowering and non-flowering plants. Example: Rose plant, Mango tree, etc.

4. Kingdom Animalia

Kingdom Animalia is also called Kingdom Metazoa. It is heterotrophic, eukaryotic, multicellular organisms. They lack cell wall. This kingdom includes all types of animals. Example: Fish, Shrimp, Crab, Lobster, Chank, etc.

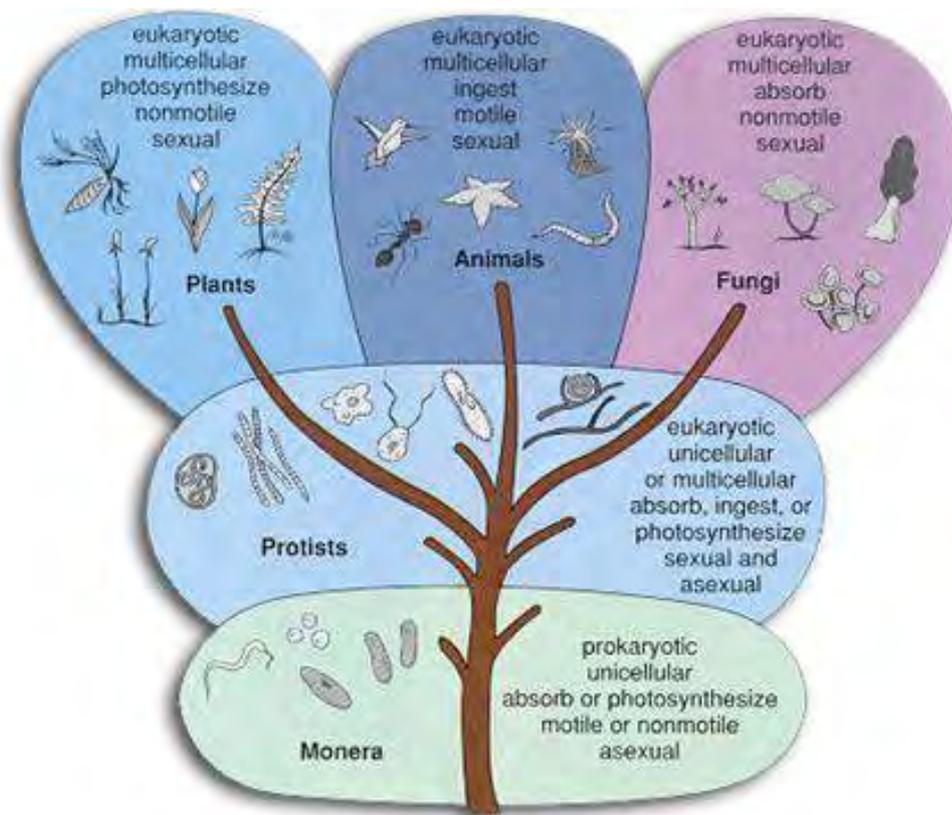


Figure 1. Five Kingdom Classification

Taxonomic hierarchy

Taxonomic hierarchy is the arrangement of various categories in successive levels of the biological classification. Each of this level or hierarchy is called as the taxonomic category or rank. Every organism can be classified at 7 different levels - kingdom, phylum, class, order, family, genus and species. Each level contains organisms with similar characteristics. The kingdom is the largest group and very broad. Each successive group contains fewer organisms, but the organisms are more similar. The species is the smallest group and is very narrow.

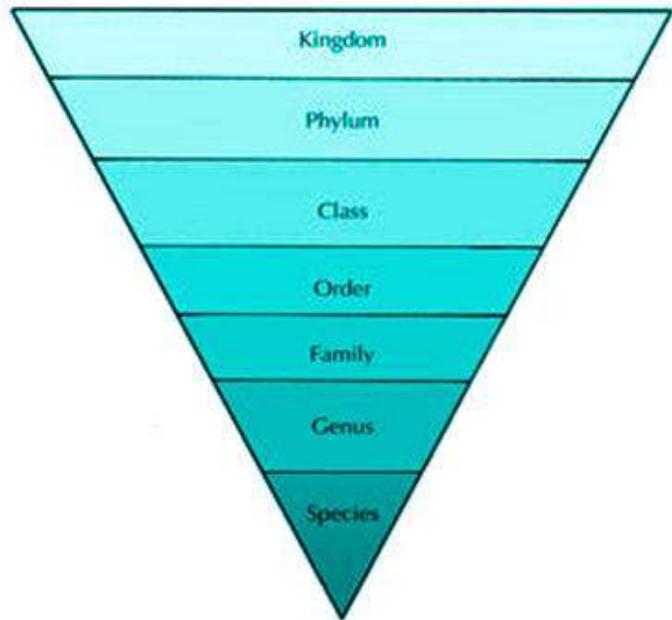


Figure 2. Taxonomic hierarchy

Species

An individual belonging to a group of organisms that are very similar to each other and are having common characteristics and are capable of mating with one another to produce fertile offspring. The species is the fundamental category of taxonomic classification, ranking below a genus or subgenus.

Biological Nomenclature

Biological nomenclature is a language that we use to communicate ideas and information about the diversity of life. It is an information retrieval system conveying information about diversity and relationships. It was introduced by Carl Linnaeus.

Common Vs Scientific Names

Common names for species are words in the language of the layperson. These names can often be misleading.

Disadvantages

1. They are not useful to people with a different language or dialect
2. Some species have several common names
3. Some species share the same common name
4. Some species may not have a common name

General rules

The scientific name of each species is formed by the combination of two words - as signified equally by "binomial," "binominal," and "binary - and the two words are in a modern form of Latin.

1. Latin language
2. Consists of a genus and species name
3. Generic names always begin with a capital letter
4. Species names always begin with lower-case letter

Example: - *Sardinella longiceps*, *Rastrelliger kanagurta*, *Thunnus albacares*, etc.

Finfish

Finfish can be defined as cold-blooded aquatic craniate vertebrate with fins for locomotion and gill for respiration. About 33,218 species of finfish has been identified in the world at present time. It may live in freshwater, brackish water and marine water. The skeleton of finfish is made up of either bone (called bony finfish) or cartilaginous (called cartilaginous finfish).

Identification

The external morphological characters of finfish are used for identification of species. There are two main features - morphometric characters and meristic characters. Morphometric characters include body shape/parts, mouth location and size, tail shape and colour. Meristic characters are the counting of spine, ray, etc in fin or other part of body. External part of finfish is commonly divided in two parts, 1) Head consist of Snout, Lips, Mouth, Jaws, Teeth, Barbels, Nostril, Eyes, Operculum and Gills; 2) Body incudes Fins, Lateral Line, Skin and Scales.

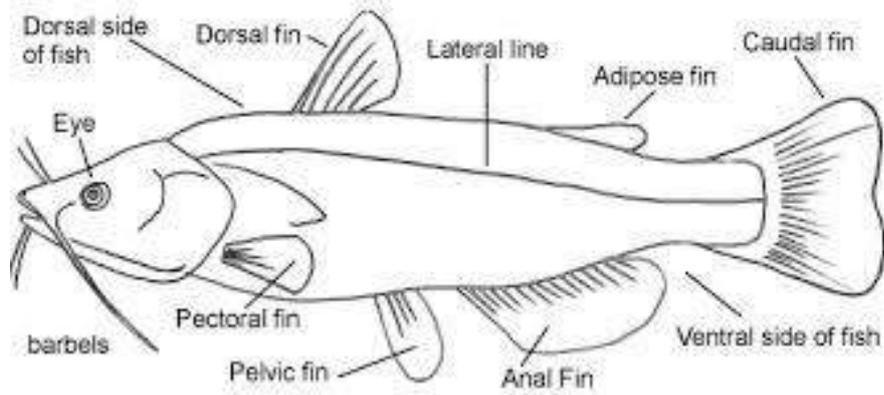


Figure 3. Finfish external features

Section of finfish

Finfish may be dissected into dorsal side, ventral side, anterior end and posterior end.

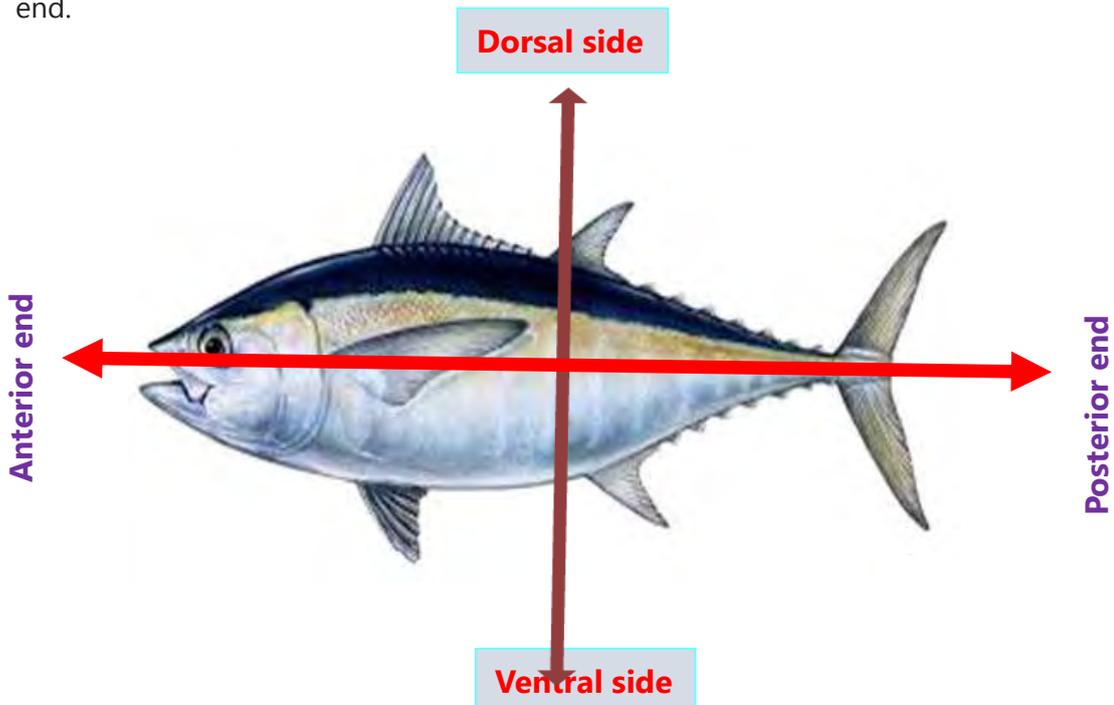


Figure 4. Section of finfish

Snout

Snout is the anterior most part of the fish (forward end of head). It is rounded or obtuse in most cases. There can be many variations to the shape of snout.

1. Pointed and sharp (Eels)
2. Tubular with jaws at tip
3. Smooth in most cases

Lips

The bone of the upper and lower jaw is covered by lips. Mostly they are thin smooth membranes but in some cases they may have pores, stripes or modified to form a sucker like disc in *Garra* species.

Mouth

Mouth is the main organ which fish use while feeding. The position and shape of the mouth depends on the type of food a fish eats and the level at which it swims. The mouth shapes can be

1. **Terminal Mouth:** - Terminal mouth is found in those fish, which feed from water column on other fish or zooplankton. Terminal mouths are located in the middle of the head and point straight forward; both jaws are of the same length. Example Danios, Rasbora, Putnius, etc.
2. **Superior Mouth:** - The superior mouth is oriented upwards and the lower jaw is longer than the upper jaw. Usually, fish with this type of mouth feed at the surface. They lay in wait for prey to appear above them, then strike suddenly from below. Many species of fish with a superior mouth feed largely on insects, however, some may feed on other fish that swim near the surface.
3. **Sub-terminal Mouth:** - It is also called an inferior or ventral mouth. The inferior mouth is turned downward. The lower jaw is shorter than the upper jaw. Fish with inferior mouths are bottom feeders and often possess barbels that assist in locating food particles.
4. **Protrusible Mouth:** - Often fish will have a protrusible mouth feature, which allows them to extend their reach when attempting to snatch prey or food particles.

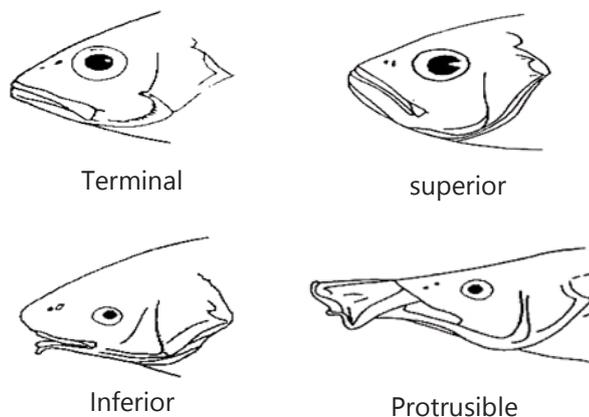


Figure 5. Type of mouth

Jaws

The jaw consists of the upper jaw and lower jaw. The upper jaw consists of bones called pre-maxillaries and maxillaries, while the lower jaw consists of mandible bones. These are connected by a joint which enables the fish to open and close the mouth. Jaws contain teeth and frame the shape of the mouth.

Teeth

Most fish have teeth on jaws and palate. In addition to these teeth some fish have pharyngeal teeth also. However not all fish have teeth like cyprinids. There are many types of teeth :-

1. **Canine:** - It is large conical teeth frequently located at the corners of the mouth, for example, snappers.
2. **Viliform:** - Villiform teeth is small and fine teeth.
3. **Molar form:** - Molariform teeth is molar like broad and rounded. It is used for crushing molluscs and crustaceans.
4. **Cardiform:** - It is fine, pointed teeth arranged as in a wool card; for example, the pharyngeal teeth in pickerels (*Esox*).
5. **Incisor:** - Large teeth with flattened cutting surfaces adapted for feeding on molluscs and crustaceans; for example, chimaeras (*Holocephali*).

Barbels

Barbels are slender, whisker like tactile organs near the mouth. They are found in fish like catfish, carps etc, they house the taste buds used by fish to find food.

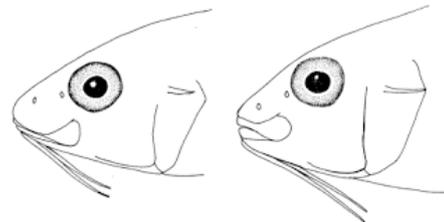


Figure 6. Barbels in finfish

Nostrils

Nostrils are pair of apertures or slits on the snout of the fish. They are openings for the smell organs leading to the nasal canal on the skull. They are small to medium and are sunk in snout, in some fish like catfish they are covered with mucus. Position and type of nostrils is often used for identifying a fish.

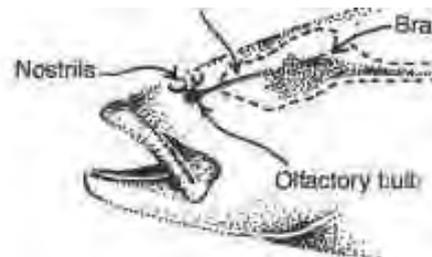


Figure 7. Nostrils in finfish

Eyes

Eyes are mainly used by fish for seeing, food, enemies and predators. They are placed dorso-laterally (upper part- on the side) in most fish. However, the placement depends upon the habitat of fish. They can be placed at the top or bottom of the skull. Deepwater swimming fish have large eyes as they receive less light at that depth, on the other hand eyes of hill stream fish are small as they live near the surface and receive a large amount of light.



Figure 8. Eye in finfish

Operculum and gills

Operculum along with gills form breathing apparatus for the fish. On each side of fish there are slits called gills. The gills are composed of comb-like filaments, the gill lamellae, which help increase their surface area for oxygen exchange. In bony fish, the gills lie in a branchial chamber covered by a bony operculum. A fish breathes by taking in water through its mouth and forcing it out from gills. There are tissue linings in the gills which absorb oxygen, CO₂ is also expelled from the gills. The majority of bony fishes have 5 pairs of gills. In cartilaginous fish, gill slits are not covered and lie in a row behind the head. In general, there are five pairs in cartilaginous fish, but a few species have 6 or 7 pairs.

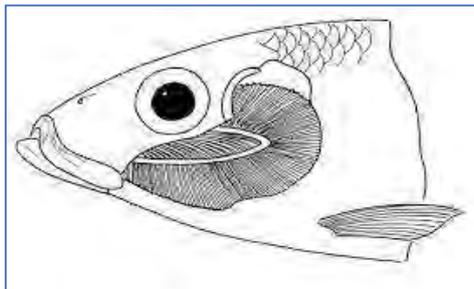


Figure 9. Gill slit in bony finfish

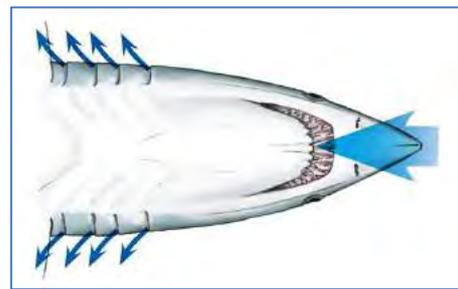


Figure 10. Gill slit in shark

Fins

Fins are thin appendages on the body of fish. They are made of bony spines protruding from the body of fish with skin covering them and joining them together in case of bony fish or Osteichthyes. In case of cartilaginous fish, fins are present as flippers. They are foil shaped and are primary means of locomotion for the fish. Some generate thrust when moved, others are used for stabilizing and steering. In bony fish (Osteichthyes), most fins may have spines or rays. A fin may contain only

spiny rays, only soft rays, or a combination of both. If both are present, the spiny rays are always anterior. Spines are generally stiff and sharp. Rays are generally soft, flexible, segmented, and may be branched. This segmentation of rays is the main difference that separates them from spines; spines may be flexible in certain species, but they will never be segmented. Fins occur in both pairs and single, they may be covered with scales or without scales.

1. Pectoral Fins

The pectoral fins occur in pair and are located on each side, usually just behind the operculum (gill cover), and are homologous to the forelimbs of tetrapods. There are many adaptations to these fins in some cases they create a dynamic lifting force that assists some fish, such as sharks, in maintaining depth and also enables the "flight" for flying fish. In many fish, the pectoral fins aid in walking, especially in the lobe-like fins of some anglerfish and in the mudskipper.

2. Pelvic Fins

Pelvic fins occur in pairs and are found on the ventral (lower) side of the fish below the pectoral fins. They assist the fish in going up and down in water, turning and stopping. In some fish like gobies they are joined into a single sucker like disc which is used to attach to objects.

3. Dorsal Fin

Dorsal fin is a single fin present on the dorsal side of body. The dorsal fin serves to protect the fish against rolling, and assists in sudden turns and stops. When the top of rays is connected with membrane they are called soft, else they are called hard spines. In many fish it is single and concave in shape with first spine being largest and last spine shortest. In perches there are two dorsal fins, one after another. The first fin is separated by either a short or long gap, or it may be combined.

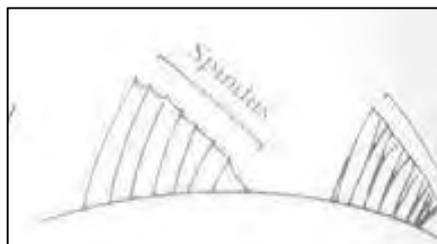


Figure 11. Separate Dorsal fin

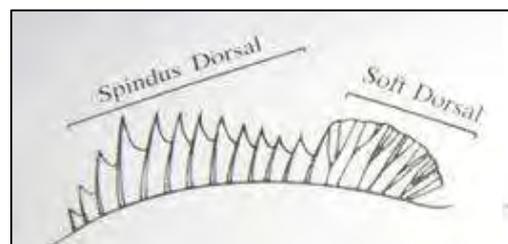


Figure 12. Combined Dorsal fin

Caudal Fin

Caudal or tail fin is located at the end caudal peduncle of the fish. The caudal peduncle is the narrow part of the fish's body to which the caudal or tail fin is attached. It is always a single fin and acts as rudder for the fish. On the basis of external and internal structure, caudal fins are Protocercal, Heterocercal, Diphyrcercal, Hypocercal, Homocercal, Isocercal and Gephyrocercal.

The posterior end of the vertebral column is bent upward and continues upto the end of the caudal fin in the case of Heterocercal Caudal fin. Heterocercal caudal fin is found in elasmobranch (shark) and primitive fish such as Acipenser.

Homocercal caudal fin looks externally symmetrical with equal epi- and hypochordal lobes, but internally hind end of the vertebral column is tucked upward and shortened. Thus, Homocercal caudal fin is internally asymmetrical. It is found in higher teleost.

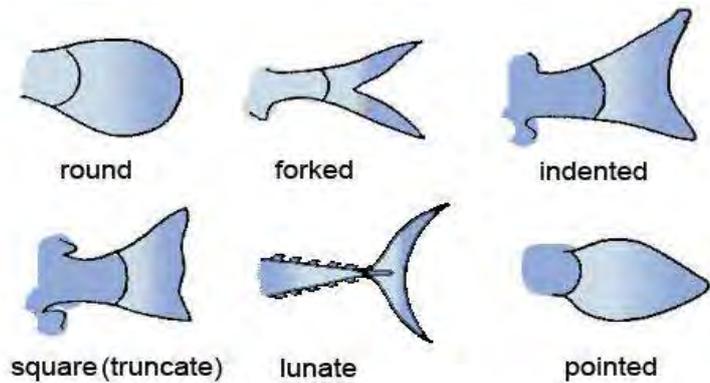


Figure 13. Caudal fin bony finfish

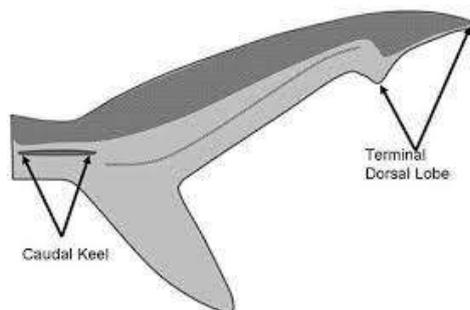


Figure 14. Heterocercal caudal fin

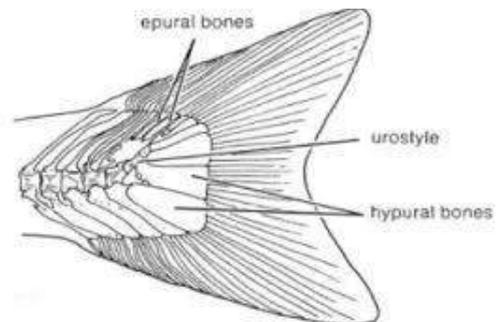


Figure 15. Homocercal caudal fin

Adipose Fins

The adipose fin is a soft, fleshy fin found on the back behind the dorsal fin and just forward of the caudal fin. It is absent in many fish families, but is found in Salmonidae, characins and catfishes.

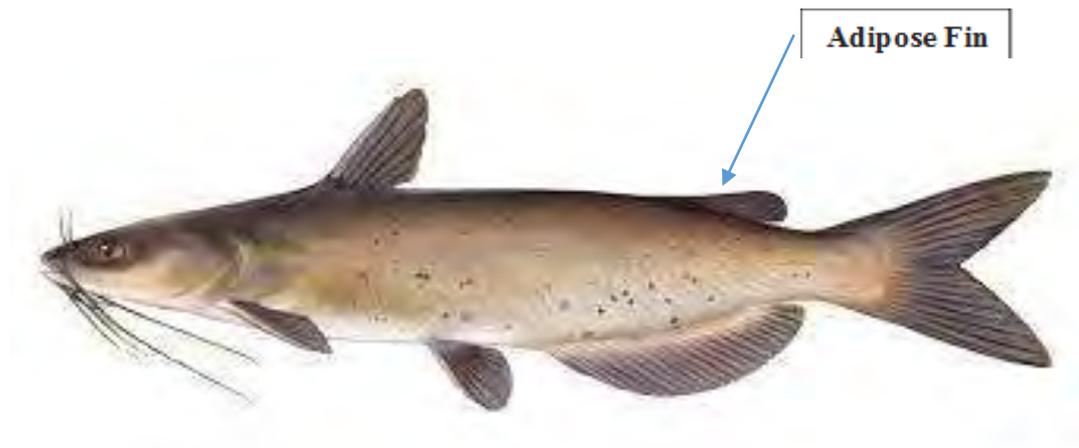


Figure 16. Adipose fin

Caudal Keel

Many fast swimming fish have a horizontal keel just in front of tail fin. It is present as ridge in caudal peduncle. It provides stability and support to the tail fin. They are always present as either a single pair or double pair, one of each side.

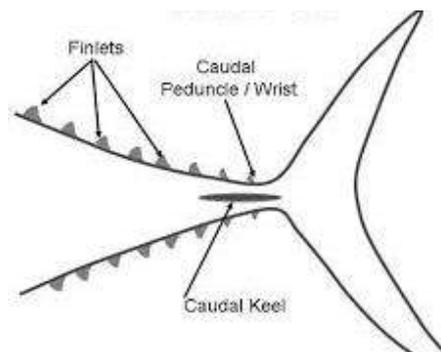


Figure 17. Caudal Keel

Fin lets

Fin lets are small fins, generally behind the dorsal and anal fins. Example, Tuna.



Figure 18. Fin lets

Skin

The skin of fish consists of live cells, there is very superficial amount of keratin in outermost layer. It is generally permeable. Fish typically have numerous individual mucus-secreting skin cells that aid in insulation and protection, but may also have poison glands, photospheres, or cells that produce a more watery, serous fluid. The colour in skin is mostly provided by melanin, however often the skin is colourless. The colour is provided by largely due to chromatophores in the dermis, which, in addition to melanin, may contain guanine or carotenoid pigments.

Scale

The outer body of many fish is covered with scales. Some fishes have a type of scale known as the scute, which is an external shield-like bony plate, or a modified, thickened scale that often is keeled or spiny. eg. clupeids and carangids.

There are four principal types of fish scales, which are following:

1. Placoid Scales

Placoid scales also called dermal denticles, are similar to teeth in that they are made of dentin covered by enamel. They are typically found in sharks and rays.

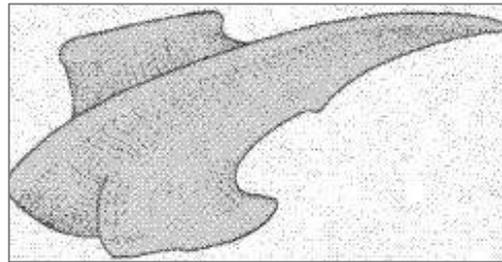


Figure 19. Placoid Scales

2. Ganoid scales

Ganoid scales are flat, basal-looking scales that cover a fish body with little overlapping. They are typical of gar and bichirs.

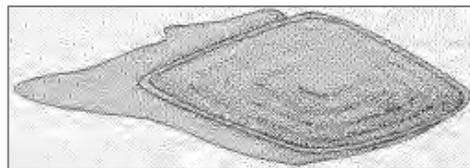


Figure 20. Ganoid scales

3. Cycloid scales

Cycloid scales are small oval-shaped scales with growth rings. They are found in many teleosts.

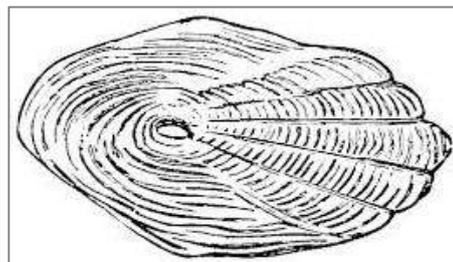


Figure 21. Cycloid scales

4. Ctenoid scales

Ctenoid scales are similar to the cycloid scales, with growth rings. They are distinguished by spines that cover one edge.

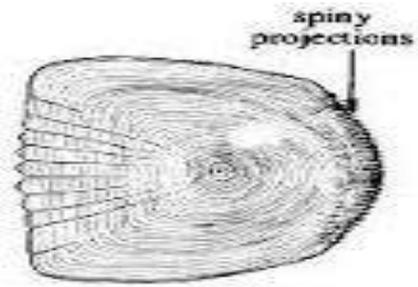


Figure 22. Ctenoid scales

Lateral Line

The lateral line is a sense organ used to detect movement and vibration in the surrounding water. In most species, it consists of a line of receptors running along each side of the fish. It can be complete (eg. Pomfrets, Sciaenids), incomplete (eg. Pomacentridae) and interrupted (eg. Serranids, Cichlids).

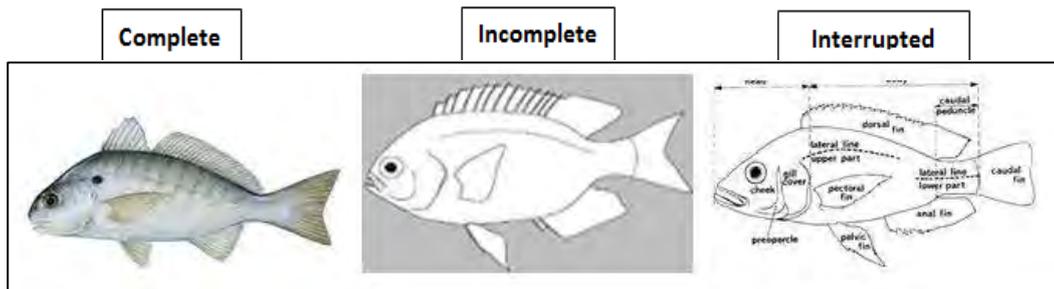


Figure 23. Lateral line

Body shapes

Anguilliform: Greatly elongated snake like fish with an almost circular cross section

eg. Eel

Taeniform : Body is laterally compressed and greatly elongated bodies. eg. Gunnels

Ovate or Truncated: eg. File fish and pomfrets

Depressiform: Dorsoventrally compressed and bottom oriented fish. eg. skate, rays, toad fish

2

Common Pelagic Finfish Families and their Identification

E. M. Abdussamad

Pelagic Fisheries Division

Bony fishes are distinguished by the presence of bony endoskeleton. Their second noteworthy character is the presence of a swim bladder or lungs, which helps the fish to maintain its body density equivalent to that of its surrounding medium. The skin of bony fish is normally covered with overlapping scale, which are either cycloid or ctenoid. In some it become obsolete and in others it is modified by calcification to an ossified dermal covering in complete bony coating.

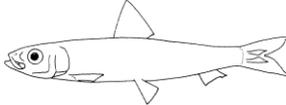
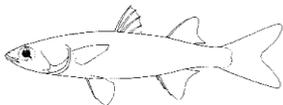
They are also provided with well developed fins which aid in propulsion and or balancing. Fins generally consist of widely spaced mobile rays joined only by externally thin webs of tissue, enabling them to fold or unfold like a fan depending on the situation. Body of most of the teleost fishes taper to a slender caudal peduncle just anterior to caudal fin. Size vary from few millimeter to several meters.

Classification

Fishes are classified mainly based on external characters. The important taxonomic tools employed are morphometric and meristic characters. The former deals with external shape and appearance and the latter relies on the count of structures like scales, scutes, fin rays & spines etc.

They belong to the Class: Teleostomii, Subclass: Actinopterygii and Super order: Teleostii. They are further categorized as *lower teleost* and *higher teleost*.

Key characters

Key character	<i>lower teleost</i>	<i>higher teleost</i>
1. Nature of fin especially spines	 lack spines	 well-developed spines
2. Number of dorsal fin	one (+some have an adipose fin)	2 - 1 st spinous, second soft (total absence of adipose fin)
3. Nature of scales	cycloid scale	ctenoid rarely cycloid
4. Position of pelvic fin	abdominal	thoracic
5. Pelvic fin rays	6 or more soft rays	1 Spine and 5 or less soft rays
6. Pectoral fin base	Horizontal in orientation	vertical in orientation
7. Nature at upper jaw	by both premaxilla and maxilla	boarded by premaxilla alone
8. Nature of swim bladder	characteristics by a duct	total absence of duct
9. Caudal fin rays	more than 18-20	less than 17 in most, in few-10-15
10. Intra muscular bones	present	absent

Lower teleost

Order

Clupeiformes

Bathyclupeiformes

Cypriniformes

Myctophiformes

Beloniformes

Alopeiformes, *etc.*

Higher teleost

Perciformes

Order: Clupeiformes

Lower forms having primitive characteristics; possess single dorsal fin. This is the most populous group among the fishery resource distributed in fresh, brackish and marine environment. The important characters of this group are- dorsal & anal fin without spine; scales cycloid & well developed, pelvic very small or absent in some cases and placed mainly abdominal and horizontal and with 6 or more soft rays; upper jaw bordered by both pre-maxilla and maxilla; lateral line absent in most cases and scales cycloid and in most cases deciduous.

Living representatives are split into 14 suborder and further into super families and families.

Family: Elopidae (Giant herring)

Body elongate, sub-cylindrical covered with thin/small deciduous scales; scaly basal sheath for anal fin; lateral line present; pelvic with 17-18 rays. Represent one genera and single species.

Eg. *Elops* sp.

Family: Megalopidae (Tarpon)

Elongate laterally compressed body, large prominent scales, head scale-less; no scaly basal sheath for anal fin; lateral line present; last ray of dorsal elongate and filamentous. Represent by one genera and single species.

Eg. *Megalops* sp.

Family: Albulidae (Lady fish)

Elongate body, bluntly conical (pointed) snout projecting beyond mouth, lateral line present; inferior mouth, head scale less - anal very small. Represent by one genera and single species.

Eg. *Albulus* sp.



Family: Notopteridae (Feather back)

Represent fresh/brackish water fishes; tail tapering, prolonged and confluent with the caudal; dorsal, pectoral and pelvic rudimentary or absent; pre-pelvic portion of abdomen serrate; body with small cycloid scales; lateral line present, sub opercle absent.

Eg. *Notopterus* sp.

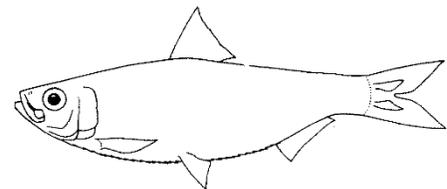
Family: Chanidae (Milkfish)

Accessory respiratory organs present, and are placed in a risses (cavity) behind the region at gill cavity, abdomens rounded, pelvic opposite to the dorsal. Scales are minute and grooved in the centre. Head without scales, Pectorals and pelvics have auxiliary scales above and below, lateral line present; Represent by one genera and single species.

Eg. *Chanos chanos*

Family: Clupeidae (Sardines & Shads)

Represent typical pelagic fishes. Elongate laterally compressed body; belly in most cases with keeled scutes; Lateral line absent, body covered with thin deciduous cycloid scales; dorsal placed mid-way between head and caudal; mouth terminal; supramaxilla broad.



Eg. *Sardinella* spp. (Sardine), *Esculosa* sp. (Kowala) (White sardine), *Pellona* sp. (Shad), *Euplatygaster* sp. (Indian shad), *Opisthopterus* sp. (Long timed herrings)

Family: Dussumieridae (Rainbow sardines & Sprats)

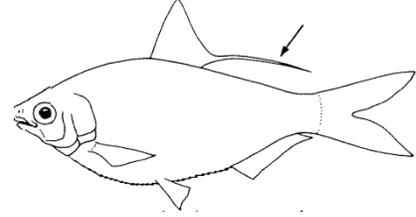
Fishes with elongated bodies and rounded bellies; body covered with thin deciduous cycloid scales; no lateral line, dorsal placed nearer to caudal; mouth terminal; supra maxilla narrow; fins small.

Eg. *Dussumieria* sp., *Spratallodes* sp., *Ehirava* sp.

Family: Dorosomidae (Gizzard shad)

Oval deep laterally compressed body; abdomen sharp ventrally and with scutes; head naked; dorsal placed behind pelvic in some species last ray prolonged, stomach gizzard like, lateral line absent

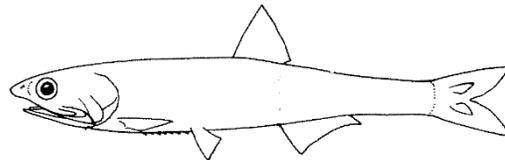
Eg. *Nematulosa* sp. (Long rayed bream), *Anodontosoma* sp. (Short nosed gizzard shad), *Gonialosa* sp. (Ganges gizzard shad)



Family: Engraulidae (White baits and Anchovies)

Elongate compressed body, snout bluntly rounded; mouth inferior, maxilla in most cases very long extended even beyond the operculum; belly with keeled scute; translucent body with silver streaks on sides in most

Eg. *Stolephorus* sp., *Thryssa* sp., *Thrysoacles* sp., *Coilia* sp.



Species under the genus *Stolephorus* are called as whitebaits and those under *Thryssa*, *Thrysoacles* and *Coilia*– Anchovies

Family: Chirocentridae (Wolf herrings)

Elongate laterally compressed body; ventral edge sharp without scutes; dorsal fin far back on the body opposite to anal; upturned mouth with sharp canine teeth; scales thin and deciduous, no lateral line, air bladder is partly osseous and cellular.

Eg. *Chirocentrus* spp.

Order: Bathyclupeiformes

Represent deepsea forms. Exhibit large similarity with Clupeiformes. Single dorsal fin with a single spine, body covered with very large deciduous cycloid scale. Pelvic fin small, thoracic in position. Anal long, almost reaching middle of the abdomen, in Family Bathyclupeidae.

Eg. *Bathyclupea* sp.

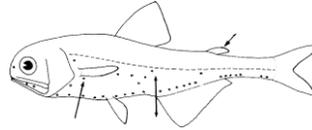
Order: Myctophiformes (Lantern fishes)

Mesopelagic fishes; possesses large mouth with very feeble teeth; dorsal placed at about

middle of the body, dorsal adipose fin present-small and placed opposite to the end of the anal; photophores present on the body.

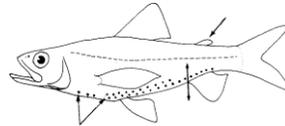
Two families

Family Myctophidae



&

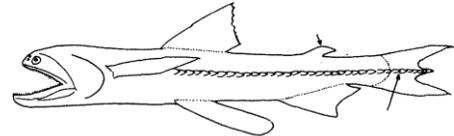
Family Neoscopilidae



Eg. *Diaphus* sp., *Benthoosema* sp., *Neoscopelus* sp.

Order: Aulopeformes (Scopeliformes) (Bombay duck and lizard fishes)

Possesses large mouth; dorsal adipose fin present-small and placed opposite to the end of the anal; No photophores.



Family: Harpodontidae (Bombay duck)

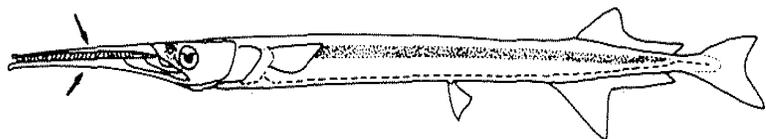
Elongate laterally compressed translucent body; abdomen rounded and not keeled; cleft of the mouth oblique, wide and extending up to operculum; teeth prominent; maxilla narrow extending to gill opening; lower jaw longer than upper; caudal tri-lobed, pectoral long; pelvic origin opposite to dorsal. Eg. *Harpodon* sp.

Order: Beloniformes (Flying fishes/half & fullbeaks)

Fishes with single dorsal fin, placed close to the caudal fin almost opposite to anal; pectoral fin above the middle line, *i.e.* in the upper half of the body; pelvic almost abdominal; lateral line close to lower margin of the body; caudal with lower lobe longer than upper; scale cycloid and deciduous.

Family: Belonidae (Garfishes/fullbeaks)

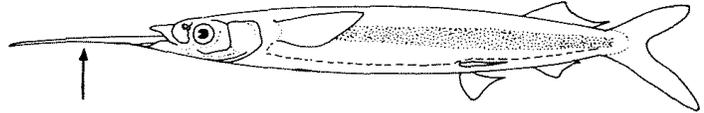
Slender elongate body; both jaws produced; teeth enlarged and needle like; no gillrakers. Eg. *Ablennes* sp., *Tylosaurus* sp.



Family: Hemiramphidae (halfbeaks)

Body cylindrical; lower jaws produced with a sensitive tinge; upper jaw in a small triangular flap; teeth enlarged and cardiform.

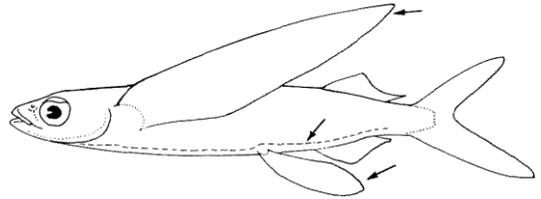
Eg. *Zenarchopterus* sp.,
Hemiramphus sp.



Family: Exocoetidae (Flying fishes)

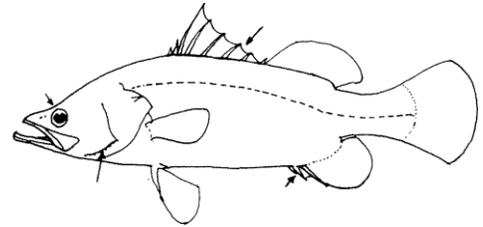
Jaws normal-not produced; teeth very minute; pectoral fin enlarged into wing like structures.

Eg. *Exocoetus* sp., *Cypselurus* sp.



Order: Perciformes (Perch like fishes)

Perch like or bony in appearance with two dorsal fins, 1st spinous and 2nd soft with fin rays; pelvic fin always thoracic; placed somewhat vertical; total absence of adipose fin; upper jaw bordered by pre-maxilla alone.



Pelagic groups

Family: Carangidae (Jacks, scads, trevallies, horse mackerel, queenfish, darts, etc.)

Body greatly compressed varying in shape from deep rhomboid to slender and elongate; caudal peduncle slender; dorsal completely separated with a procumbent spine; soft dorsal long based. The family specific characters are either anal fin with two detached spine and or straight part of lateral line with scutes and or caudal peduncle with dorsal and ventral groove and or lateral fleshy keel.

Represented by 20 Genera and more than 60 species in Indian waters.

Eg. *Alectis* sp.; *Alepes* sp.; *Atule* spp.; *Carangoides* spp.; *Caranx* sp.; *Decapterus* sp.; *Gnathanodon* sp.; *Megalaspis* sp.; *Naucrates* sp.; *Selar* spp.; *Selaroides* sp.; *Seriola* sp.; *Seriolina* sp.; *Trachinotus* sp.; *Ulua* sp.; *Uraspis* sp.

Family: Coryphaenidae (Dolphin fish)

Body greatly compressed varying in shape from deep rhomboid to slender and elongate; caudal peduncle slender; dorsal and anal fin very long, continuing almost to caudal fin, fins without sharp spines and finlets, dorsal origin on nape, caudal deeply forked, adult male with bony crust in front of the head.

Eg. *Coryphaena* spp.

Family: Caesionidae (Fusiliers)

Body moderately deep, slender and fusiform, horizontal axis from tip of snout to middle of caudal fin cutting through the middle of the eye, single long based dorsal, first half spinous (10-15 spines) and posterior half with soft rays; mouth small, protractile and terminal; anal with 3 spines.

Eg. *Caesio* sp., *Gymnocaesio* sp., *Pterocaesio* sp.

Family: Mugilidae (Mulletts)

Body elongate; head broad and flattened, mouth terminal & small, pectoral high (in the upper half) on body; two dorsal fins, first dorsal with 4 spines, and second dorsal with one spine, anal with 3 spines; sides silvery; no lateral line axillary scales at pectoral and pelvic bases.

Eg. *Mugil* sp., *Liza* sp., *Valamugil* sp.

Family: Sphyraenidae (Barracudas)

Body elongate; sides silvery; head large, snout very long pointed; mouth terminal; lower jaw projecting beyond upper; teeth strong; pectoral in the lower half of the body; two dorsal fins-widely separated; first dorsal, with 5 spines, second dorsal one spine, anal with 2 spines; lateral line present.

Eg. *Sphyraena* sp., *Lates* sp.

Family: Trichiuridae (Ribbonfishes)

Body elongate, compressed and ribbon like; teeth strong and fang like and tapered to a pointed caudal fin absent, body without scales; dorsal & anal fin long; dorsal start shortly

behind head and reaches up to caudal tip; anterior portion with spines; pelvic fin absent or reduced to a scale or scale like spine.

Eg. *Trichiurus* sp., *Lepturocanthus* sp., *Euplerogrammus* sp.

Family: Rachycentridae (Cobias)

Body elongate, subcylindrical; head broad and depressed; snout pointed; mouth terminal with lower jaw projected; first dorsal modified in to 7 to 9 short spines; anal with two spines; caudal lunate in adult with upper lobe longer than lower. Represented by single genera and single species.

Eg. *Rachycentron* sp.

Family: Scomberidae (Mackerel, tuna, seerfishes)

Body elongate, sub-cylindrical to compressed, snout pointed; mouth terminal; 5 or more finlets followed by second dorsal and anal fins; pelvic fin with one spine and 5 rays, placed thoracic or jugular.

i. Mackerel

Body fusiform; scales moderately large covering the whole body, size of the scale comparatively large on cheek and below pectoral fin origin; 5-6 detached finlets after second dorsal and anal fin eyes covered with anterior and posterior eyelids; gillrakers elongate and visible when mouth is open.

Eg. *Rastrelliger* sp.

ii. Tunas

Body elongate, round to torpedo shaped; mouth large; scales restricted to pectoral region forming corselet (bony armor), scales apparently absent towards posterior part 6-9 detached finlets after second dorsal and anal fin; caudal peduncle slender and possess a median and two lateral keels caudal fin typically forked.

Eg. *Auxis* sp., *Euthynnus* sp., *Thunnus* sp., *Katsuwonus* sp., *Sarda* sp., *Gymnosarda* sp.

iii. Seerfish/Spanish mackerel & Wahoo

Body elongate, slightly compressed (cigar shaped) and apparently naked (uniformly covered with very minute scales); jaws with large flattened and sharp teeth, gill rakers poorly developed; caudal peduncle with a prominent median keel and two ridges above and below; 7-10 detached finlets after second dorsal and anal fin.

Eg. *Scomberomorus* sp., *Acanthocybium* sp.

Family: Xiphidae (Swordfishes)

Body elongate and robust, snout (pre-maxilla and nasal bone) produced into a spear; which is dorso-ventrally flat in cross section; body naked without scale, pelvic fin absent; two dorsal fins, first short based and not sail like, second one small and backwardly placed; caudal peduncle with single median keel.

Eg. *Xiphias* sp.

Family: Istiophoridae (Billfishes, Marlin, Sailfishes)

Body elongate and robust, snout produced into a spear; which is round in cross section; body completely covered with lancet like scales; pelvic fin present and spear like; two dorsal fins, first long based and sail like in appearance, second one small and backwardly placed; two anal fins; caudal peduncle with two keels.

Eg. *Istiophorus* sp., *Makaira* sp., *Tetrapturus* sp.

Family: Ambassidae (Glossy perchlets)

Body glass like; oblong, snout pointed; a notch above the eye; mouth oblique; lower jaw prominent; two separate dorsal fins; procumbent spine present, scale sheath present at dorsal and anal fin bases; pre-opercle with double serrated edge.

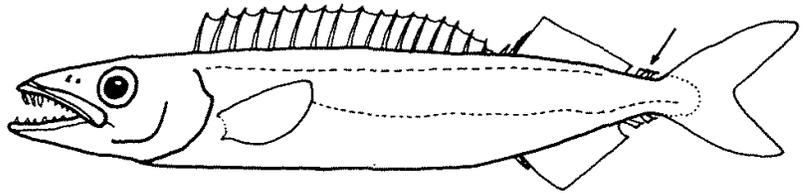
Eg. *Ambassis* sp.

Family: Latidae

Body opaque, 3rd dorsal spine elongated, opercle with a backwardly directed spine, pre-opercle serrated (single), caudal fin rounded.

Family: Gempylidae (Snake mackerel, Barracudas, Oilfishes)

Body elongate, compressed, snout pointed; mouth terminal, not protractile; teeth strong; those at front of upper jaw often fang like, two dorsal, second shorter than the first; 5 or more finlets followed by second dorsal and anal fins; pelvic fin thoracic or jugular; often reduced to a single spine with few or no soft rays.



Eg. *Neopinnula* sp., *Thyrsitoides* sp., *Thyrsites* sp., *Gempylus* sp., *Rexea* sp., *Promethychthys* sp.

3

Field Identification of Tunas from Indian Waters

Subal Kumar Roul and Retheesh T. B.
Pelagic Fisheries Division

The Family Scombridae is one of the largest and most economically important fish family which comprises of most advanced scombroid fishes such as mackerels, tunas and bonitos with 54 valid species in 15 genera (Collette *et al.*, 2001). Among them, tunas are one of the important food fishes exploited all over the world. Altogether 9 species in 6 genera are contributing to the Indian tuna fisheries. Indian tunas are classified into two categories such as (i) Coastal tuna and (ii) Oceanic tuna. *Euthynnus affinis*, *Auxis thazard*, *A. rochei*, and *Sarda orientalis* are considered as coastal tuna where as *Thunnus albacares*, *T. obesus*, *T. tonggol*, *Katsuwonus pelamis*, and *Gymnosarda unicolor* are mostly oceanic in nature. Among all tuna species, yellow fin and big eye tunas are growing into bigger size and having high export demand due to the superior meat quality. Identification of these tuna species are relatively easier for freshly caught specimens. The iced or frozen fishes are very difficult to identify as a result of discolouration, fin damage, skin damage, change in body shape due to handling and storage process.

In such condition the internal characteristics such as air bladder length, striation on liver and shape would be the better option to identify both the species, but it causes several practical difficulties for surface fisheries. Even though yellow fin and big eye tunas are easiest to identify in fresh condition, misidentification of both the species occurs in several cases mostly in case of juveniles and spoiled one as two species are morphologically very similar, especially < 40 cm FL. Hence, correct identification of both the species is highly essential in order to estimate the catch statistics accurately for both tuna species separately along the Indian coast.

Family: Scombridae (Tunas, Bonitos, Mackerels, Seerfishes, and Wahoo)

Diagnostic characters: Scombroid fishes having elongate and fusiform body with pointed snout. Adipose eyelid is present in some genera (*Rastrelliger* & *Scomber*). Double dorsal fin, the first dorsal is generally short and separated from second dorsal fin. Finlets are present behind both dorsal and anal fins. Caudal fin is deeply forked with minimum 2 small keels on each side of caudal peduncle, a larger keel in between two small keels in several species (e.g. tuna, bonito, seerfish and wahoo). Inter-pelvic process is either single or double (tuna). Body either entirely covered with small to moderate sized scales (*Rastrelliger*, *Scomber*, *Scomberomorus*) or with a well-developed corselet i.e. the area behind head and around pectoral fins usually covered with moderately large and thick scales, rest of the body scale less (e.g. *Auxis*, *Euthynnus*, *Katsuwonus*) or covered with small scales (e.g. *Thunnus*).

Colour and body pattern: *Rastrelliger* species having one or two horizontal rows of spots on each side of back where as *Scomber* species having wavy bands on upper sides. *Scomberomorus* and *Acanthocybium* are blue-grey above and silvery below with dark vertical bars or spots on sides. *Sarda* has 5 to 11

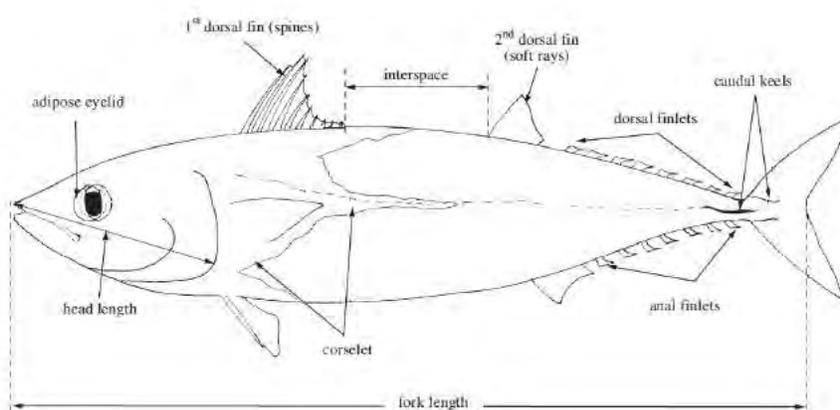


Fig.1 General features of a typical scombroid fish species

dark oblique stripes on back and *Euthynnus* has a striped pattern on back and several dark spots between pectoral and pelvic fins. *Katsuwonus* has 4 to 6 conspicuous

longitudinal stripes on belly. Most species of *Thunnus* have bright yellow finlets with black borders.

Key to the species of tuna occurring in the area

A simple identification key for the Indian tuna species based on the field observation and the keys given by Collette (2001) and Itano (2005).

- 1. Two small keels and a large median keel between them on either side of caudal peduncle (Fig. 2); 7 to 10 dorsal and 7 to 10 anal finlets; adipose eyelids absent; teeth in jaws slender, conical, hardly compressed; corselet of scales well developed

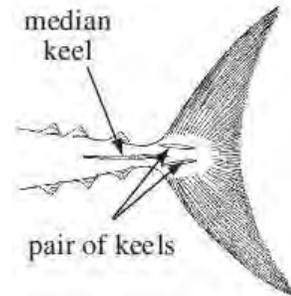


Fig.2 caudal keel

- 2a. Upper surface of tongue without cartilaginous ridges (Fig.3a)3
- 2b. Upper surface of tongue with cartilaginous ridges (Fig.3b)4

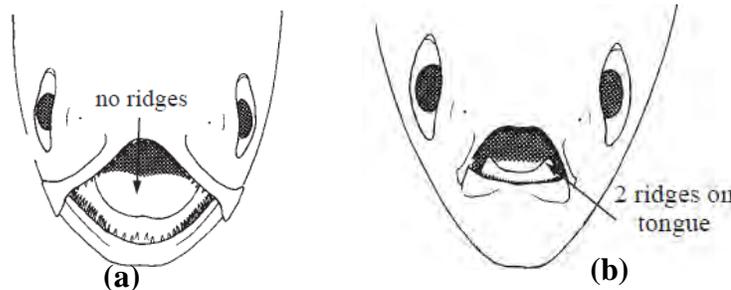


Fig.3 Anterior view of head

- 3a. Five to eleven narrow, dark longitudinal stripes on upper part of the body (Fig. 4), no teeth on tongue*Sarda orientalis*



Fig.4 *Sarda orientalis*

- 3b. Body without stripes or dark spots above lateral line (Fig.5).....
*Gymnosarda unicolor*



Fig.5 *Gymnosarda unicolor*

- 4a. First and second dorsal fins are widely separated (Fig. 6a), first dorsal fin spine X to XII; interpelvic process single and large (Fig. 6b)(*Auxis*)
5

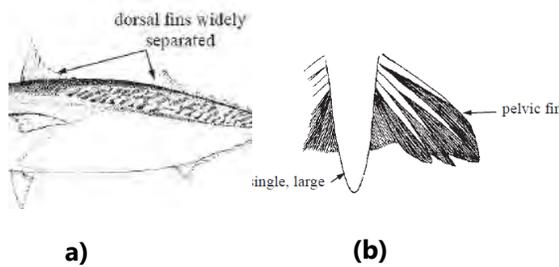


Fig. 6

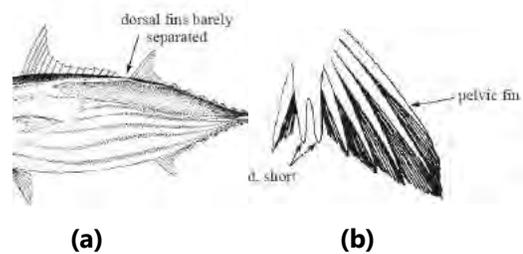


Fig. 7

- 4b First and second dorsal fin base not separated (Fig. 7a), first dorsal fin spine first dorsal fin spine XII to XVI; interpelvic process bifid and short (Fig. 7b)*Katsuwonus, Euthynnus, Thunnus*.....6

- 5a. Body slightly compressed laterally; Posterior extension of corselet narrow; dorsal naked area extends anterior to tips of pectoral fins; gill rakers 36 to 42 on first gill arch; 15 or more nearly horizontal oblique dark comparatively narrow wavy lines in scale less area (Fig. 8)*Auxis thazard*



Fig. 8 *Auxis thazard*

- 5b. Body rounded; Posterior extension of corselet wide; dorsal naked area does not extend anterior to tips of pectoral fins; gill rakers 43 to 48 on first gill arch; 15 or more nearly vertical dark bar in scale less area (Fig. 9)*Auxis rochei*



Fig. 9 *Auxis rochei*

- 6a. Four to six dark longitudinal stripes on belly (Fig. 10); gill rakers on first gill arch 53-63.....*Katsuwonus pelamis*



Fig. 10 *Katsuwonus pelamis*

- 6b. No dark longitudinal stripes on belly; gill rakers on first gill arch 19-45.....*Euthynnus, Thunnus*.....7

- 7a. Body naked behind corselet, several black blotches present between pectoral and pelvic fin base fin base (Fig. 11); a number of blue-black broken wavy lines directed backwards and upwards behind the corselet; pectoral fin rays 25-29*Euthynnus affinis*



Fig. 11 *Euthynnus affinis*

- 7b. Body covered with small scales behind the corselet, no black blotches on body (Fig. 12), pectoral rays 30-36.....
 (*Thunnus*)..... 8

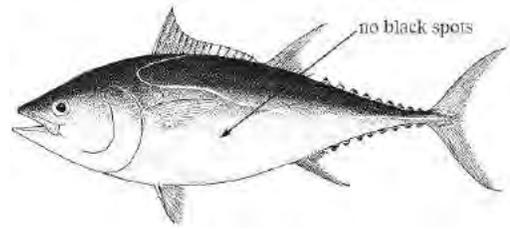


Fig. 12 *Thunnus*

- 8a. Belly silvery white with rows of oval shaped pale spots/streaks arranged horizontally; finlets yellow with grey margin (Fig. 13); Second dorsal and anal fins never greatly elongate, less than 20% of fork length at all sizes; caudal region comparatively long and slender*Thunnus tonggol*



Fig. 13 *Thunnus tonggol*

- 8b. Body with vertical lines or marks; finlets yellow with black margin in fresh condition (Fig. 14)9

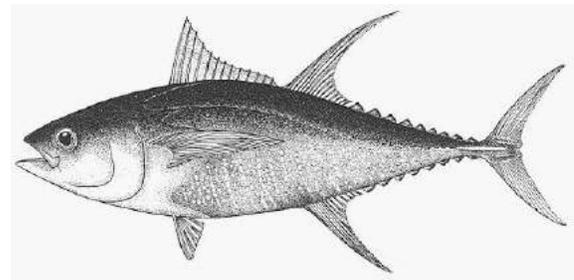


Fig. 14

- 9a. Three rounded lobes of equal size and ventral surface striated; swim bladder large, occupies entire body cavity; widely spaced white lines or marks in fresh condition; finlets with thick black margin; large head and eye as compared to yellowfin tuna of same FL; Second dorsal and anal fin short in adult; central portion of fork region forms a flat or slightly crescent shaped area (Fig. 15).....*Thunnus obesus*

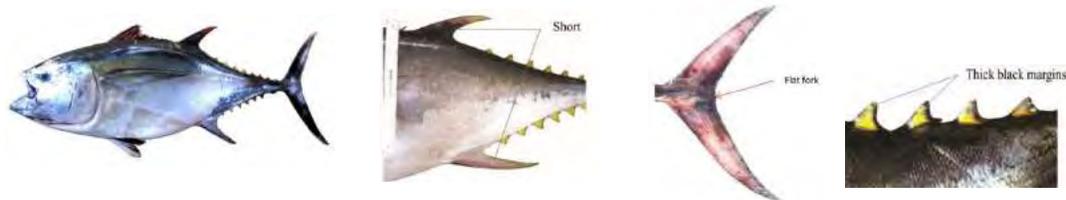


Fig. 15 *Thunnus obesus*

9b. Right lobe longer and thinner than the rounded medial and left lobes, lobe without striations; swim bladder small and occupies only anterior half of body cavity; closely spaced silvery lines; finlets with very thin or no black margin; small head and eye as compared to bigeye tuna of same FL; second dorsal and anal fin greatly elongated in adults; central portion of fork region forms "V" or "M" notch distinct notch in adult (Fig. 16).....*Thunnus albacares*



Fig. 16 *Thunnus albacares*

4

Taxonomy of Exploited Demersal Finfishes of India: Lizardfishes, Pigface breams, Eels, Guitar fishes and Pomfrets

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Demersal Fisheries Division

Demersal fishes are those fishes which live and feed on or near the bottom of seas. They occupy the sea floors, which usually consist of mud, sand, gravel or rocks. In coastal waters they are found on or near the continental shelf, and in deep waters they are found on or near the continental slope or along the continental rise. In India, demersal finfishes contribute about 26% to the total marine fish landings of the country, which is dominated by perches, croakers, catfishes, silverbellies, elasmobranchs, lizardfishes, flat fishes, pomfrets, etc., in order of abundance. Most of the demersal finfishes in India are exploited by mechanised trawlers.

Taxonomic research on fishes in general and other taxa of the animal kingdom was conducted extensively in the earlier periods by various research and survey organisation of the country. The Central Marine Fisheries Research Institute (CMFRI), which is primarily concerned with research and development of marine organisms, from the production point of view, made several taxonomic contributions on marine

invertebrates, fishes, reptiles and mammals, mostly in the decade of 60s and 70s. However, the taxonomic research in general in the country appears neglected and it is imperative to bring back the subject in order to conserve and rational utilisation of exploited marine fishery resource of the country. In the following sections, the classification of some of the demersal finfish resources such as pigface breams, lizardfishes and eels exploited along the coastal waters of India are described.

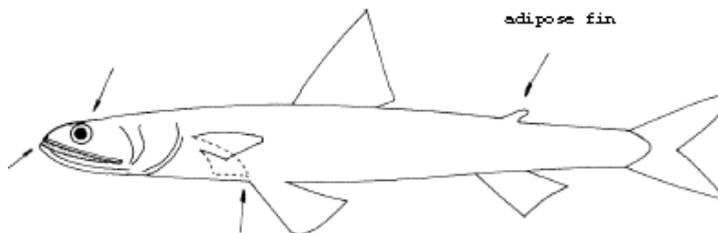
Lizardfishes

Lizardfishes, belonging to the family Synodontidae, is an important demersal fishery resource in the world over. This resource is distributed in the Indo-West Pacific; Red Sea and further east to Southeast Asia and Australia, Persian Gulf, East Africa to Japan and the Great Barrier Reef. Lizardfishes are found in the sublittoral zones above 100 m depth inhabiting muddy bottom and reef areas.

Studies on the systematics of lizardfishes dates back to early 20th century included them under the family Synodontidae of the order Iniomi. Later the classification was revised and included lizardfishes under the family Synodidae (Synodontidae, Sauridae) under the order Scopeliformes. Family Synodontidae includes Bombayduck (Harpadon sp.) and lizardfishes. Of these, lizardfishes are included under four genera namely Synodus, Saurida, Trachinocephalus and Xystodus. While Xystodus is known only from Australian waters, the other three genera occur in the Atlantic, the Pacific and the Indian Ocean.

Major characteristics

- Body elongate, usually cylindrical with adipose fin
- Head lizard-like
- Mouth large and terminal, with rows of numerous small, slender teeth
- Teeth also on palate and tongue, those on palate in 1 or 2 bands



The systematic position of the Family Synodontidae (Berg, 1940)	
Phylum	Vertebrata
Sub Phylum	Craniata
Superclass	Gnathostomata
Series	Pisces
Class	Teleostomi
Sub Class	Actinopterygii
Order	Scopeliformes
Family	Synodontidae

Genus: *Saurida* Valenciennes, 1849

Body elongate, snout obtusely pointed, short. Eyes with adipose lids. Head depressed. Cheeks and opercular bones scaled. Teeth in jaws in several rows. Teeth on palate in double bands on each side, vomerine teeth sometimes present, teeth present on tongue. 13-16 branchiostegal rays, gill rakers rudimentary. Dorsal fin with 10–13 rays, adipose fin small above the anal; anal with 9 – 13 rays its origin nearer to caudal base than to ventral base. Pectoral with 11–16 rays, pelvic 9 rayed, the inner not much longer than the outer. Caudal forked.

The following species were recorded under the genus *Saurida*:

1. *Saurida tumbil* (Bloch 1795)
2. *S. undosquamis* (Richardson1848)
3. *S. micropectoralis* Shindo & Yamada 1972
4. *S. longimanus* Norman, 1939
5. *S. nebulosa* Valenciennes in Cuv. & Val., 1849
6. *S. isarankurai* Shindo & Yamada, 1972
7. *S. pseudotumbil* Dutt & Vidyasagar, 1981.

Genus. *Synodus* Gronow, 1763

Body more or less depressed, covered by cycloid scales. Head depressed, with a flat triangular snout. Eyes of moderate size, anterior with adipose eyelid. Teeth in 2 or 3 rows in the jaws, single band of teeth in the palate. Teeth present on the tongue.

Dorsal nearly in the middle of the body, with an adipose fin, which is opposite the short anal. Anal fin base shorter than dorsal base. Ventral 8 rayed; the longer inner rays much longer than outer rays. Branchiostegal rays 12-16.

The following four species were obtained under the genus *Synodus* from the west and east coasts of India.

1. *Synodus indicus* (Day 1873)
2. *S. binotatus* Schultz 1953
3. *S. jaculum* Russell & Cressey, 1979
4. *S. variegatus* (Lacepede 1803)

Genus. *Trachinocephalus* Gill, 1862

Body moderately compressed; snout short, eyes forward in the head, with rudimentary adipose eyelid. Snout obtuse and short. Mouth large, oblique with lower jaw slightly projecting. Teeth in 2-3 series on the jaws, a narrow band of 2 series of equal teeth on each side of the palate. Tongue toothed. Origin of dorsal nearer to snout than the small adipose fin, which is opposite to hinder half of anal. Pectoral reaching to about 10th scale of lateral line. Origin of ventral before the tip of pectoral and reaching beyond the base of dorsal fin. Anal fin base longer than dorsal fin base. Silvery yellow below, dark above with longitudinal stripes along the body. A black blotch at the upper end of the operculum.

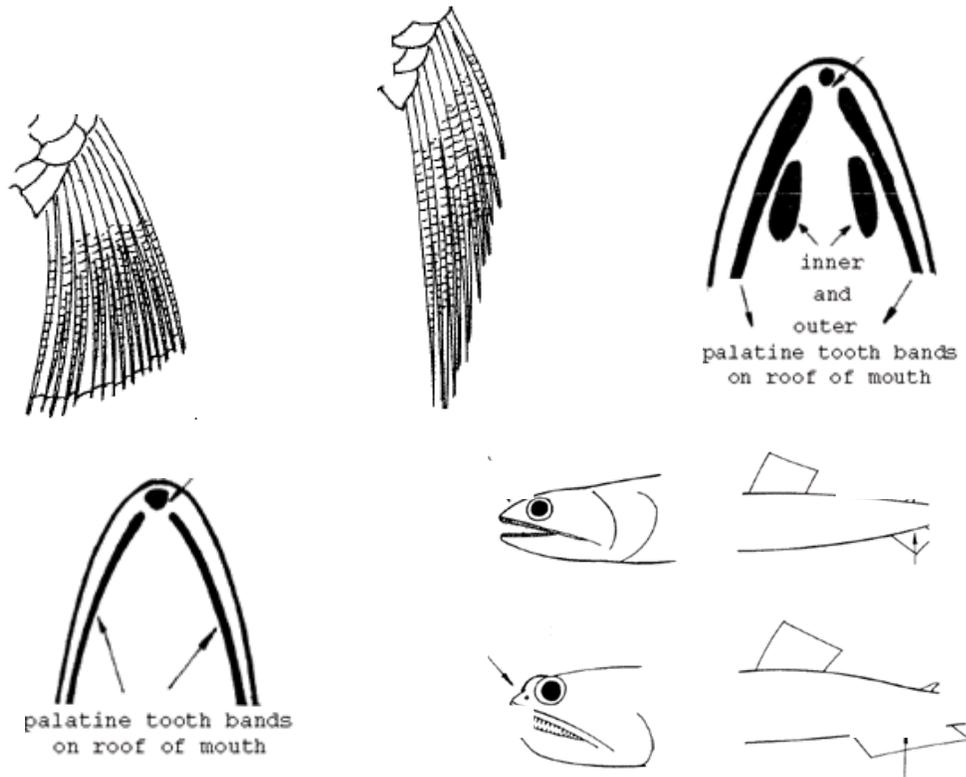
Trachinocephalus myops, the snakefish or bluntnose lizardfish, has long been regarded as the sole species in the genus, comprising one of the last vestiges of shore species with nearly circumtropical distributions. A second species, *Saurus trachinus* Temminck & Schlegel 1846, was described from Japan, but has been considered a junior synonym of *T. myops* by recent authors. Despite multiple citations of *T. myops* in the literature and checklists, the species has never been the subject of a taxonomic revision. However, the examination of specimens of *T. myops* from around the world, revealed three morphologically distinct but closely related species, one of which was new from the Marquesas Islands. The Genus *Trachinocephalus* is represented by a single species *T. myops* (Forster, 1801) which is distributed all along the Indian coast.

Key to identification of major Genus

1a. Nine pelvic fin rays, inner barely longer than outer; palatine teeth in 2 pairs of bands.**Saurida**

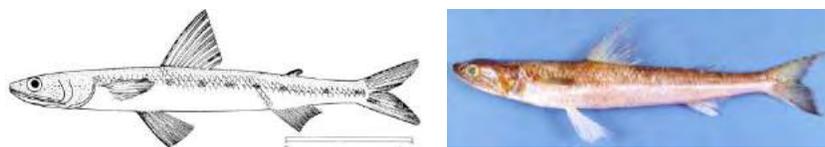
1b. Eight pelvic fin rays, inner much longer than outer palatine teeth in 1 pair of bands

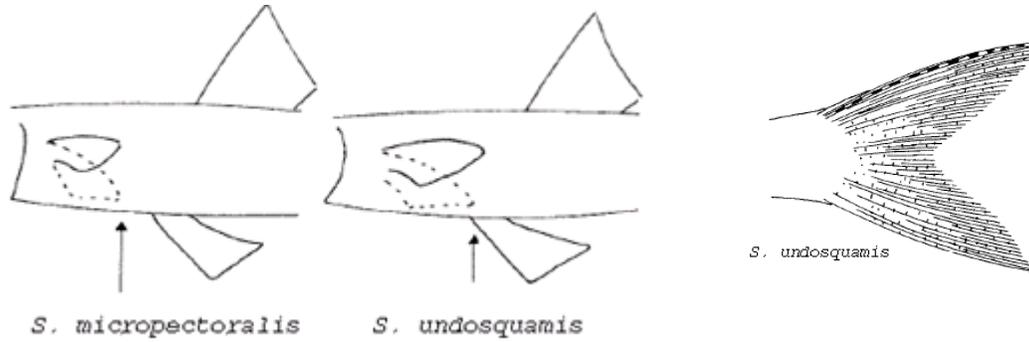
- 2a. Eye opposite about mid-point of upper jaw; head depressed; anal fin base shorter than dorsal fin base..... **Synodus**
- 2b. Eye nearer to anterior end of upper jaw; head not depressed; anal fin base longer than dorsal fin base..... **Trachinocephalus**



Saurida undosquamis

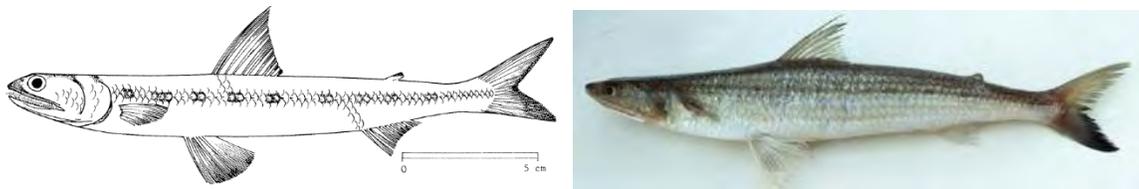
2 rows of teeth on anterior part of outer palatine tooth bands. Pectoral fins moderately long, reaching to level of pelvic fin base; 4 to 7 dark dots on upper edge of caudal fin;





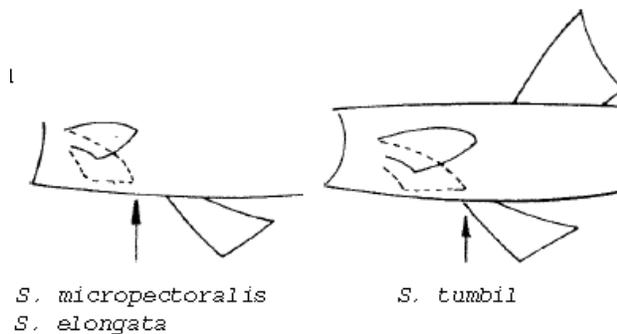
Saurida micropectoralis

3 or more rows of teeth on anterior part of outer palatine tooth band. Pectoral fins short, their tips not reaching to level of pelvic fin origin; pelvic fin rays almost equal in length.



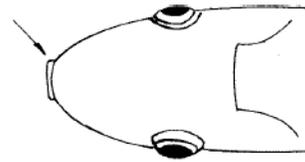
Saurida tumbil

3 or more rows of teeth on anterior part of outer palatine tooth bands. Pectoral fins just reaching to level of pelvic fin base; pelvic fin rays almost equal in length.



Saurida isarankurai

Lower jaw clearly projecting beyond tip of snout; also, lower caudal fin lobe smaller than upper.



head viewed from above
S. isarankurai

Saurida gracilis

Cross-bars or a series of dark patches present on all fins.

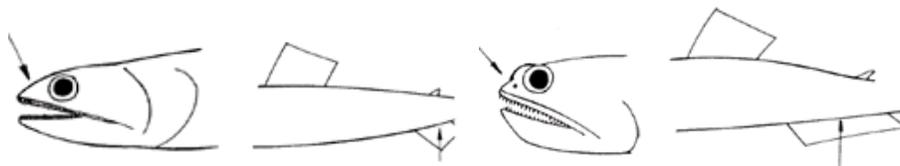
Saurida longimanus

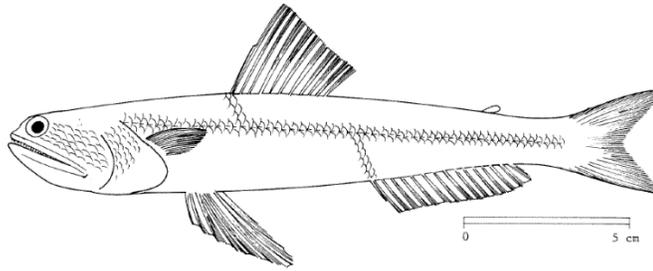
Very long pectoral fins (reaching far beyond level of first dorsal fin ray).

Synodus and Trachinocephalus species: inner pelvic fin rays much longer than outer ones (3 times longer; equal in *Saurida*).

Trachinocephalus myops

Eyes placed near to tip of snout (snout shorter than eye diameter); mouth large, with small, close-set teeth; palatine teeth in a single band on each side. Inner pectoral fin rays about 3 times longer than outer ones; anal fin base distinctly longer than dorsal fin base.





Genus *Synodus*

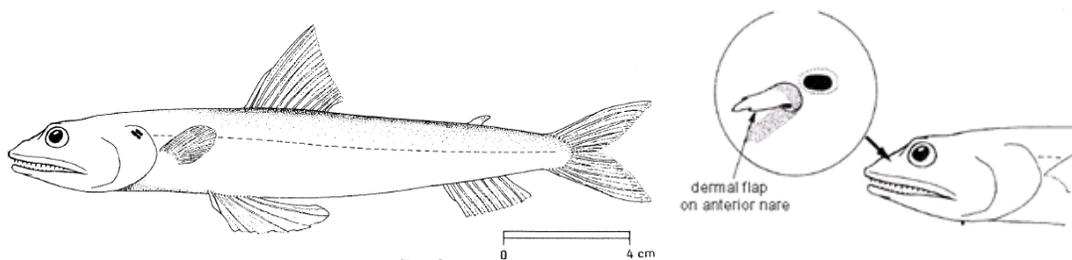
Eight pelvic fin rays, inner much longer than outer; palatine teeth in 1 pair of bands

2a. Eye opposite about midpoint of upper jaw; head depressed; anal fin base shorter than dorsal fin base..... ***Synodus***

Synodus indicus

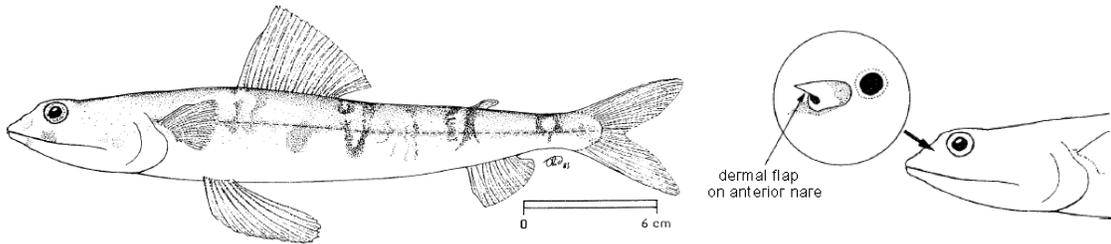
Dermal flap on anterior nares long, triangular, often notched distally. Dorsal fin rays 11 to 13 (average 11.9); anal fin rays 8 to 11 (average 9.4).

2 small pigment spots at upper distal corner of operculum.



Synodus englemani (S. variegatus)

Anterior palatine teeth long and forming a discrete group; dermal flap on anterior nares short, tubular. Dorsal fin rays 12 or 13 (average 12.7); anal fin rays 8 to 10.



Pigface breams

Pigface breams or the emperor breams belong to the family Lethrinidae. They are tropical marine perciforms found entirely in the Indo-Pacific, except one species that occurs only in the eastern Atlantic. They belong to the suborder Percoidei, a diverse group containing many families whose relationships are poorly understood. Within this suborder, lethrinids are included under the superfamily Sparoidea which also contains the families Sparidae (porgies), Centracanthidae and Nemipteridae (threadfin bream). Among percoids, sparoids appear most closely related to the Lutjanidae (includes the snappers or Lutjanidae and, fusiliers or Caesionidae) and the Haemulidae (includes the grunts or Haemulidae and Inermiidae). There has been much confusion concerning the familial allocation of the genera and species amongst these groups.

Lethrinids are mostly reef fishes but their preferred habitat is sandy or rubble substrate. The reefs which they frequent can be shallow, coralline reefs or deep, rocky reefs. One species frequents the outer edges of the continental shelf and



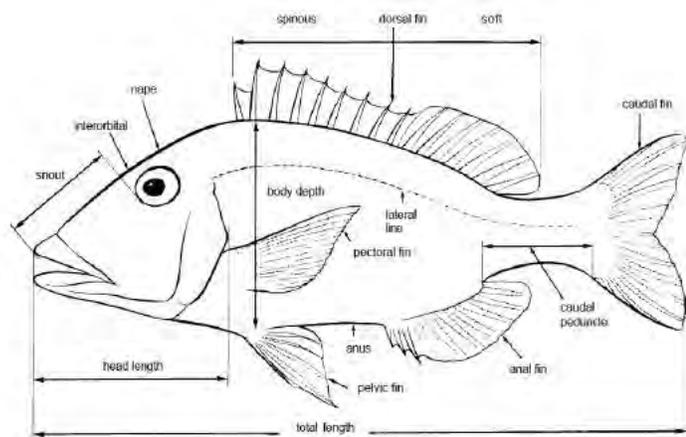
is caught to depths of 180 m. Lethrinids can be solitary or schooling and do not appear to be territorial. They often form large aggregations while spawning.

Lethrinids are bottom-feeding, carnivorous, coastal fishes, ranging primarily on or near reefs. They generally possess large, strong jaws and food preference is correlated with the type of lateral jaw teeth and to a certain extent, the length and angle of the snout found in a particular species. For example, the humpnose big-eye bream, *Monotaxis grandoculis*, has large, well-developed molars, and a short, blunt snout. It consumes molluscs, sea urchins and other hard-shell invertebrates. At the other extreme, the longface emperor, *Lethrinus olivaceus*, has conical lateral teeth, and an elongate, gradually sloping snout. It feeds mainly on fishes and crustaceans. Between these extremes, species exhibit many intermediate lateral teeth types, from molar through rounded to conical, and snout shape also varies widely. Diet concomitantly varies between the extremes from primarily hard-shell invertebrates, to soft-shell invertebrates, to fishes, with combinations of these food items found in many species. There is also a great deal of selectivity for particular food items. *Lethrinus nebulosus*, a commonly occurring species of pigface breams in India.

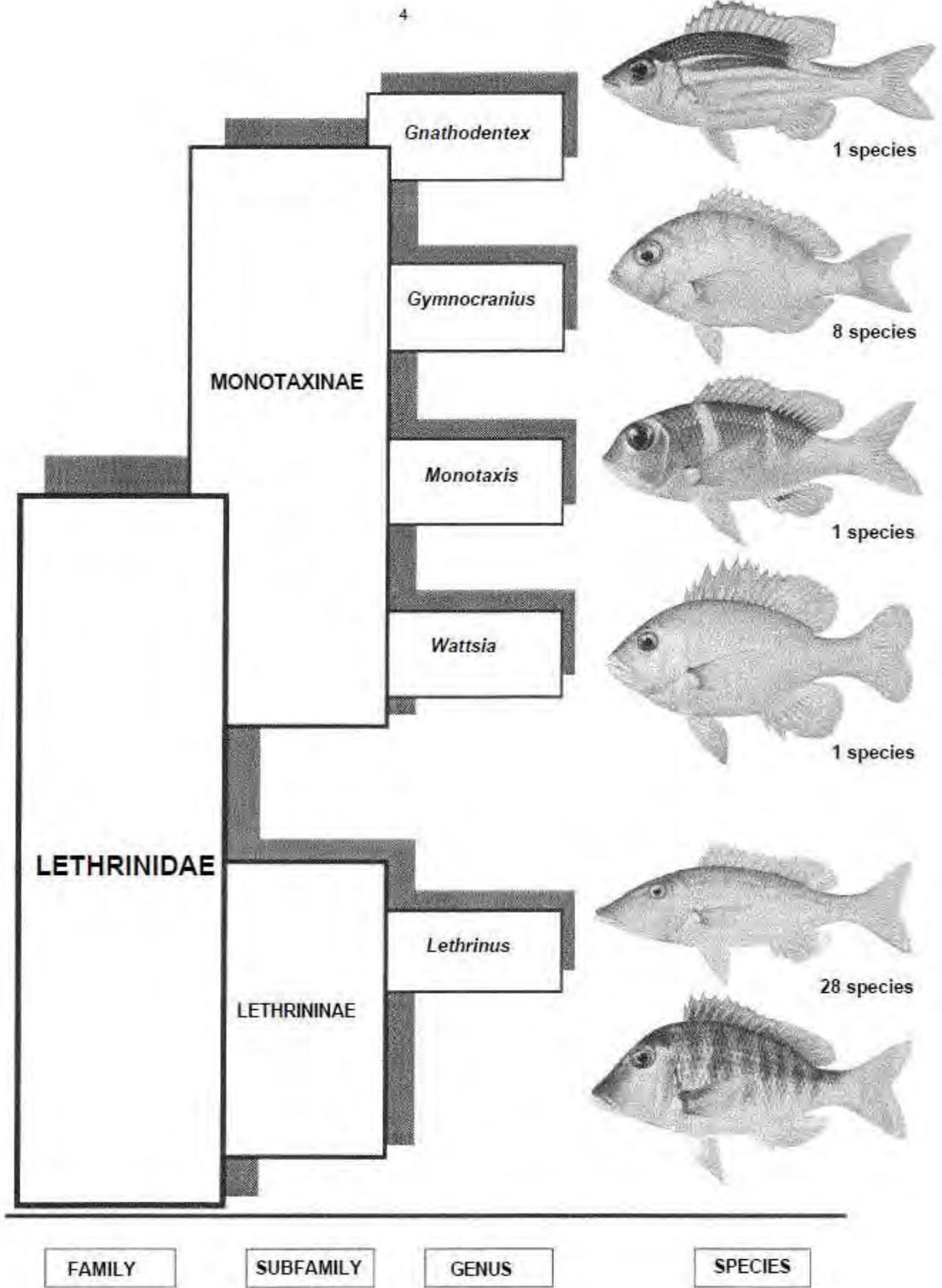
Problems previously encountered in identification of lethrinids are primarily due to the

fact that many of the characters traditionally used to differentiate fishes are relatively constant among certain species of lethrinids. When they are live or still fresh, colour can be very helpful for species determination. Body colours and markings also add to the confusion because they can change substantially according to the time of day, the

emotional state of the fish, geographic locality, and state of freshness. Despite these problems, previous researchers have contributed to our understanding of the systematics of lethrinids and have revealed a number of characters that help to differentiate species. For example, the pattern of dark pigment cells, or melanophores, on the membranes of the pelvic fin, help differentiate some species which were previously difficult to separate.



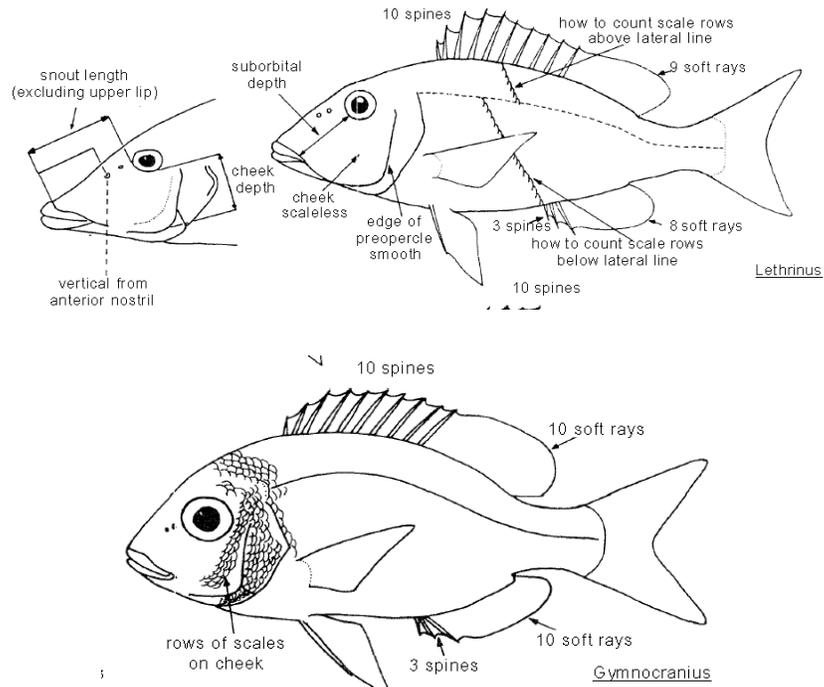
External morphology measurements of Lethrinids



A provisional classification of the subfamilies and genera of the family Lethrinidae

General characteristics of Lethrinidae

- Perch-like fishes with a large head: lips often thick and fleshy; maxilla concealed, without supplementary bone, mostly slipping below infraorbital bones, but overlapping the premaxilla anteriorly
- A single, continuous dorsal fin with 10 spines and 9 or 10 branched (soft) rays
- Cheeks, upper surface of head and preorbital area scaleless in *Lethrinus*, but scales present on cheek in the other genera



Similar families existing in the area

Lutjanidae (Lutianus)

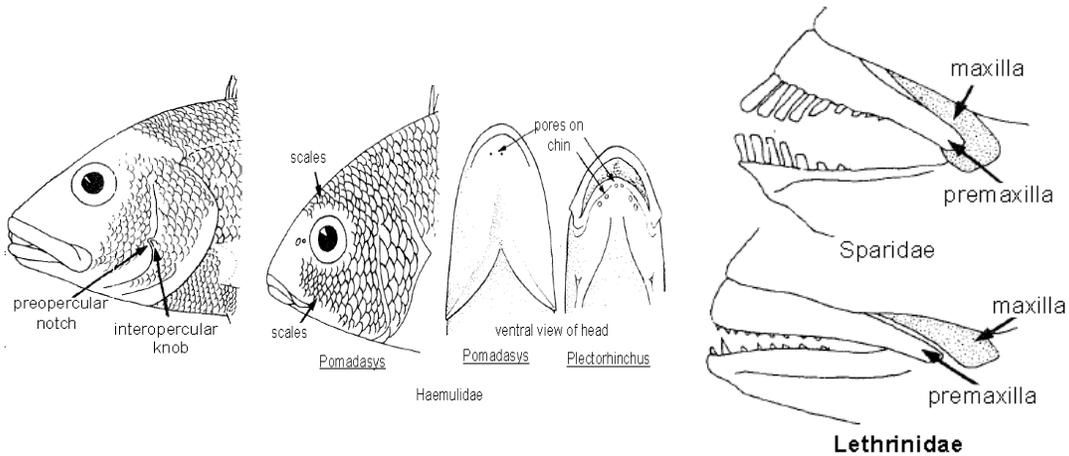
- Cheek always scaled (naked in Lethrinus)
- A preopercular notch and an interopercular knob often present

Haemulidae

- Scales always present between eye
- Mouth (absent in that area in Lethrinidae); 2 or more pores present on chin

Sparidae

Posterior tip of premaxilla overlapping maxilla at hind end of mouth (maxilla overlapping premaxilla in Lethrinidae); usually more than 10 dorsal fin spines.



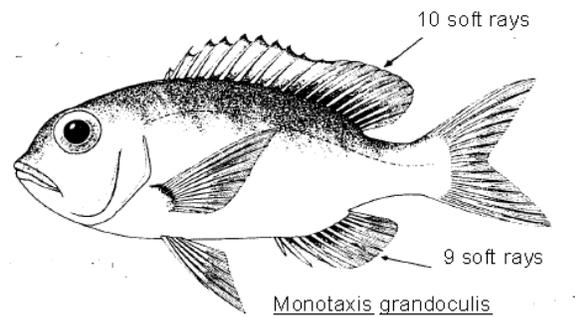
Key to the identification of major species of Lethrinidae

1a. Cheek with 4 to 6 vertical rows of scales; 10 soft rays in dorsal fin; 9 or 10 soft rays in anal fin

2a. Nine soft rays in anal fin

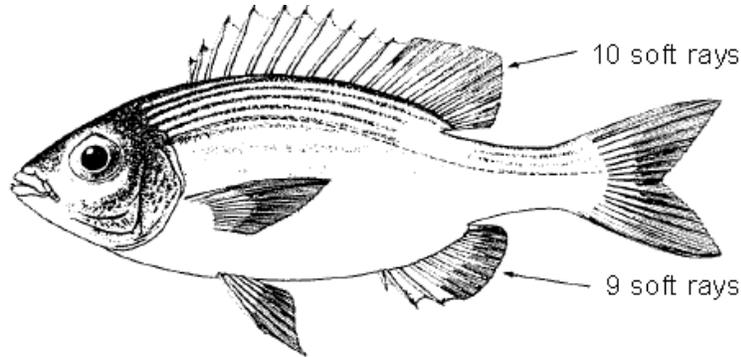
Profile of head in front of eye strongly convex; pectoral fin with 14 soft rays, inner surface of pectoral fin base scaled. No longitudinal stripes on body -----

Monotaxis grandoculis

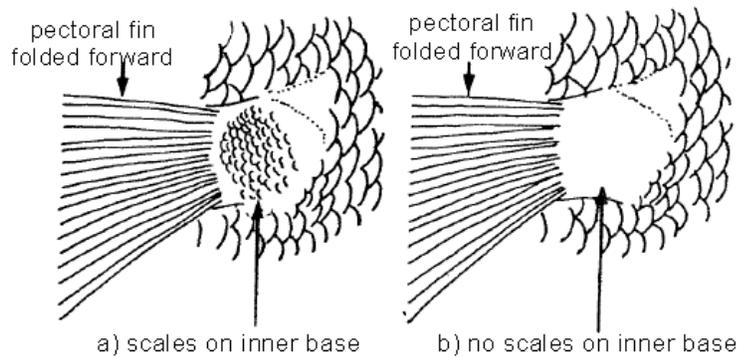


Profile of head in front of eye slightly convex or straight; pectoral fin with 15 soft rays; inner surface of pectoral fin base scaleless yellow longitudinal stripes on body -----

----- ***Gnathodentex aurolineatus***

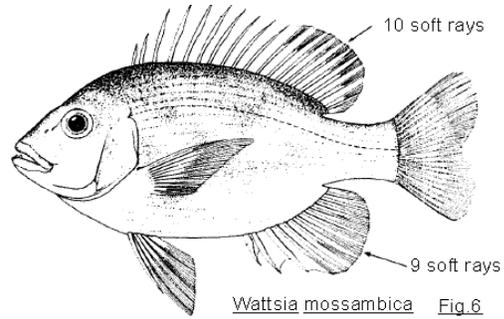


Gnathodentex aurolineatus Fig.4



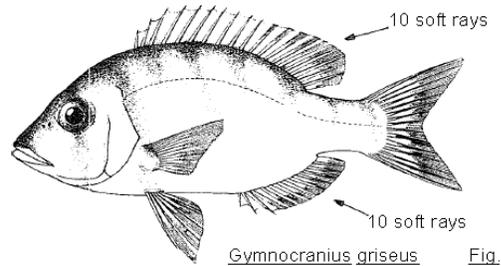
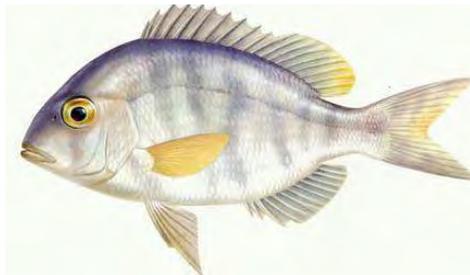
2b. Ten soft rays in anal fin

4a. Maxilla with a strong denticulated longitudinal ridge. caudal fin lobes rounded; body 2.2 times or less in standard length ***Wattsia mossambica***



4b. Maxilla surface smooth; caudal fin lobes pointed; body not as deep, 2.3 to 2.8 times in standard length (adults). Anal-fin base 2.1 to 2.5 times longer than longest soft anal-fin ray; no wavy blue lines on cheek, snout or opercle.....

Gymnocranius griseus



1b. Cheek naked; 9 soft rays in dorsal fin; 8 soft rays in anal fin

6a. Snout and head elongate; body depth less than head length, inner surface of pectoral finbase scaleless,

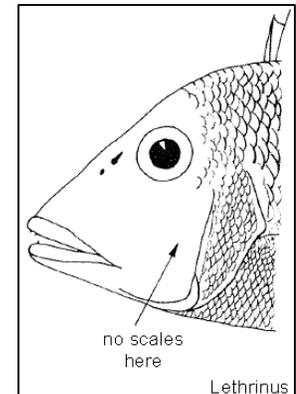
7a. Upper margin of eye almost on dorsal profile; interorbital space concave, flat or only slightly convex

8a. No red coloration to opercle or pectoral fin base

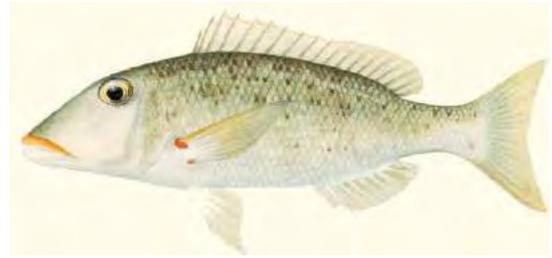
9a. Posterior nostrils much closer to anterior nostril than to anterior margins of eye ***Lethrinus variegatus***

9b. Posterior nostril about halfway between anterior nostril and anterior margin of eye..... ***Lethrinus semicinctus***

8b. Bright red coloration to opercle and/or pectoral fin base



10a. One or 2 red spots on pectoral fin base; opercular margin red ***Lethrinus xanthochilus***



10b. No red spot on pectoral fin base; a conspicuous red spot on opercular edge.....***Lethrinus rubrioperculatus***

7b. Upper margin of eye well separated from dorsal profile; interorbital space moderately to strongly convex



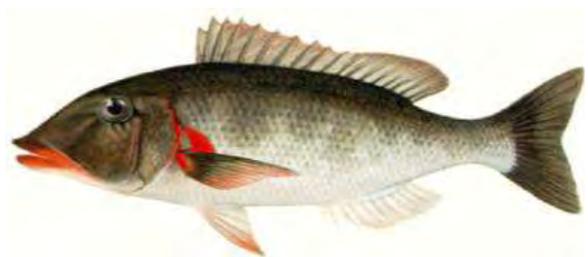
11a. No red coloration present; oblique bluish lines from eye to snout tip, and a few broken streaks connecting eyes on top of head ***Lethrinus microdon (L. elongatus)***

11b. Red coloration present on lips, pectoral fin base or opercular edge

12a. A single, bright red blotch above pectoral fin base; opercular edge and pectoral fin, base also red; lips large and bright red; profile of snout concave, snout bulbous.....***Lethrinus conchiliatus***



12b. No red coloration on and above pectoral fins base or opercular edge; a red line sometimes present above and below lips; often 2 or 3 blackish streaks radiating from eye; profile of snout straight.....***Lethrinus elongatus (L. microdon)***



Redaxil emperor

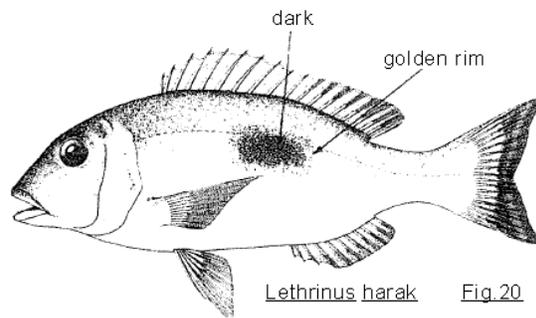
6b. Snout not elongate; body depth greater than head length

13a. A characteristic series of bright blue lines radiating across cheek from eye; centres of scales with white spots; often longitudinal yellowish streaks on body.....***Lethrinus nebulosus***

13b. No blue radiating lines on head 14a. A persistent, oblong blotch present on sides, usually encircled with a golden rim



Spangled emperor



Thumbprint emperor

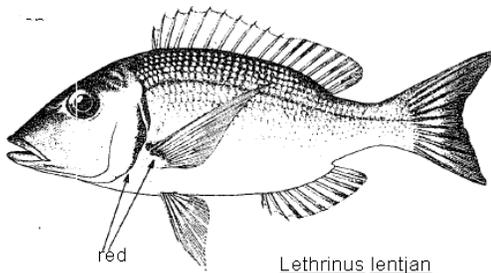
14b. No obvious large dark blotch present on sides of body

15a. Small orange spots on sides of head.....***Lethrinus kallopterus***
(*Lethrinus erythracanthus*)



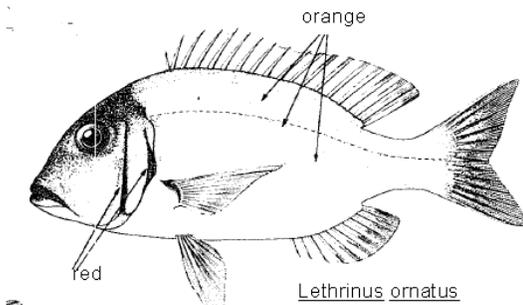
Orange-spotted emperor

15b. No orange spots on head red spot on opercular margin and on pectoral fin base; no conspicuous yellow stripes on body..... ***Lethrinus lentjan***



17b. Snout length (excluding upper lip) equal to, or less than cheek depth

19a. Several prominent bright orange stripes present on body; opercular and preopercular margins bright red) ***Lethrinus ornatus***



Ornate emperor

19b. No bright orange stripes on body; no red colour on preopercle

20a. Six scale rows between lateral line and median dorsal fin spines..... ***Lethrinus mahsenoides (L. lentjan)***

20b. Less than 6 scale rows between lateral line and median dorsal fin spines; opercular margin not red

21a. Four scale rows between lateral line and median dorsal fin, spines (excluding the very small scales at base of dorsal fin) ***Lethrinus mahsena***

21b. Five scale rows between lateral line and median dorsal fin spires (excluding the very small scales at base of dorsal fin)..... ***Lethrinus crocineus***



Sky emperor



Yellowtail emperor

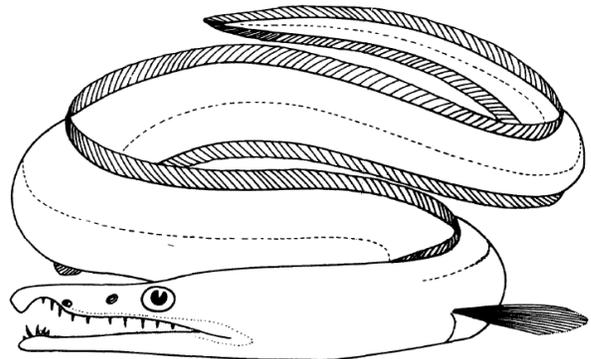
Eels

The Muraenesocidae, or pike congers, are a small family of marine eels found worldwide in tropical and subtropical seas. Some species are known to enter brackish water. Pike congers have cylindrical bodies, scaleless skin, narrow heads with large eyes, and strong teeth. Their dorsal fins start above the well-developed pectoral fins. These rather aggressive fish range from 60 to 250 cm (2.0 to 8.2 ft) in length.

Members of the family Muraenesocidae are taxonomically nested within the monophyletic order Anguilliformes. This order comprises all "true eels" that share the synapomorphy of a particular larval form called a leptocephalus. Muraenesox eels of the Bombay-Saurashtra waters are known as "Wam" the most abundant and economically important being *Muraenesox talabonoides* (Bleeker), which occurs in both inshore and offshore catches landed at Sassoon Dock, Bombay. In India, the swim bladders of eels (*Muraenesox talabonoides* Bleeker), are of best quality and fetch very high market price owing to the huge export demand. Eel air bladder is mainly used for making Isinglass. Silver conger eel *Muraenesox cinereus* is locally called as "Vilangu meen" and kadal bamboo and its air bladder is called as "netti". *M. cinereus* is the only species of Muraenesocidae family, observed in the landings at Chennai Fisheries Harbour. *M. cinereus* are mainly landed by multiday trawlers. The species is available throughout the year. Along the southwest coast of India, both *M. cinerius* and *M. bagio* are landed in mechanised trawlers throughout the year.

Family: Muraenesocidae (Pike-congers)

Eel-like fishes, cylindrical in front, compressed towards tail. Large mouth with upper jaw extending well behind eye. Fangs (large canine teeth) on vomer (a median tooth-bearing bone on roof of mouth) and at front of lower jaw; tongue not free from floor of mouth. Gill openings large, separate and placed low on body. Pectoral fins present; dorsal and anal fins long, continuous with caudal fin; pelvic fins absent. Anus well behind pectoral fin and somewhat before midpoint of body. No scales.



Colour: grey, yellow or white, sometimes almost black on back.

Key to Genera

1 a. Distinct bulge at bases of canine teeth on middle part of vomer

Muraenesox

1 b. Canine teeth on vomer conical, or if flattened, then not bulging at bases

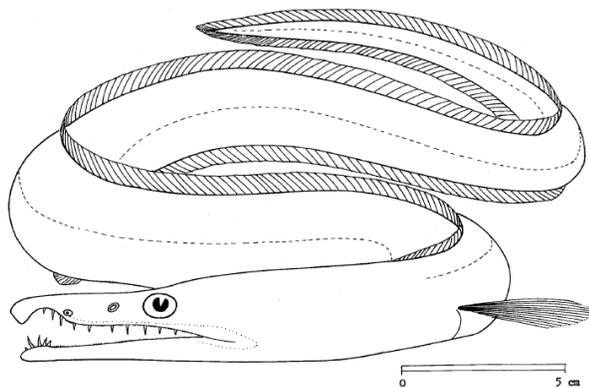
Congresox

***Congresox talabon* (Cuvier, 1829)**

English name - Yellow pike-conger

Distinctive characters:

Eel-shaped fish without scales. Mouth large, upper jaw ending well behind eye. Outer tooth row in lower jaw leaning outward; middle canines on vomer (roof of mouth) conical (needle-like, not blade-shaped). Dorsal and anal fins joined to caudal fin; pectoral fins well developed, their length about 3 times in length of head.



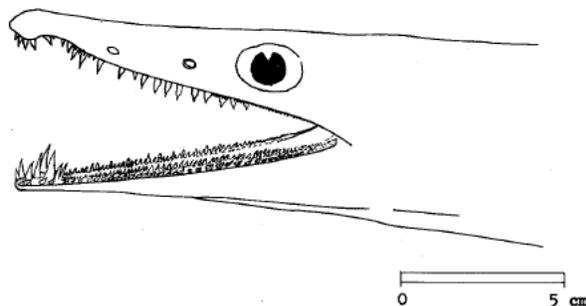
Colour: Head and body yellow.

***Congresox talabonoides* (Bleeker, 1853)**

English name - Indian pike-conger

Distinctive characters:

Eel-shaped fish without scales. Outer tooth row in lower jaw leaning outward; middle canines on vomer conical (needle-like, not blade-shaped). Dorsal and anal fins joined to caudal fin; pectoral fins well developed, their length at least 4 times in length of head.



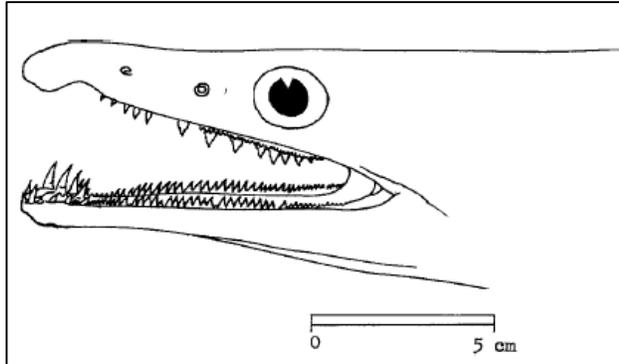
Colour: head and body yellow. size: Maximum: 200 cm; common: 150 cm.

***Muraenesox bagio* (Hamilton-Buchanan, 1822)**

English name - Common pike-conger

Distinctive characters:

Eel-shaped fish without scales. Posterior nostril only a little closer to eye than to anterior nostril; snout long; eye 3 times in length of snout. Mouth large, maxillary ending well behind eye; outer tooth row in lower jaw pointing straight upward; middle canines on vomer with distinct basal lobes, their bases sometimes in contact. Dorsal and anal fins joined to caudal fin; pectoral fins well developed; 35 to 38 pores in lateral line from head to above anus



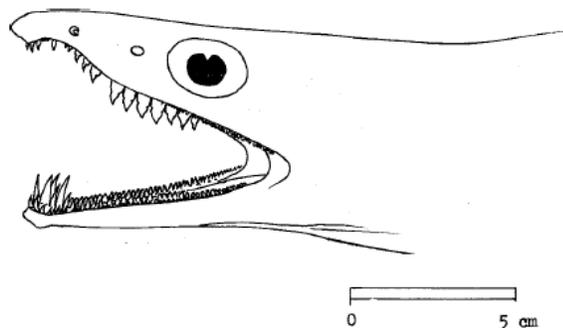
Colour: Head and body greyish

***Muraenesox cinereus* (Forsska, 1775)**

English name - Daggertooth pike-Conger

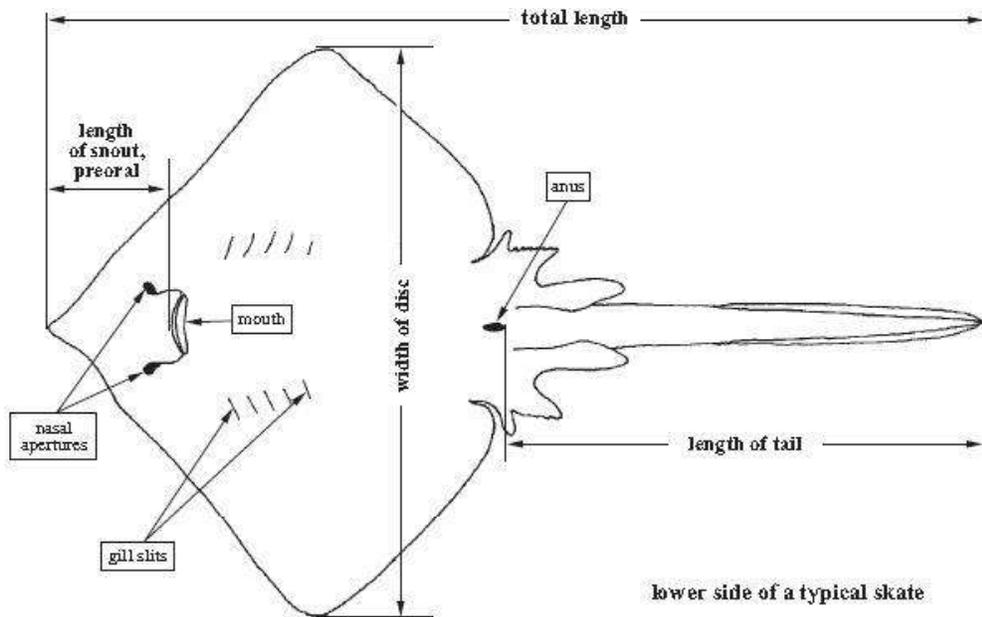
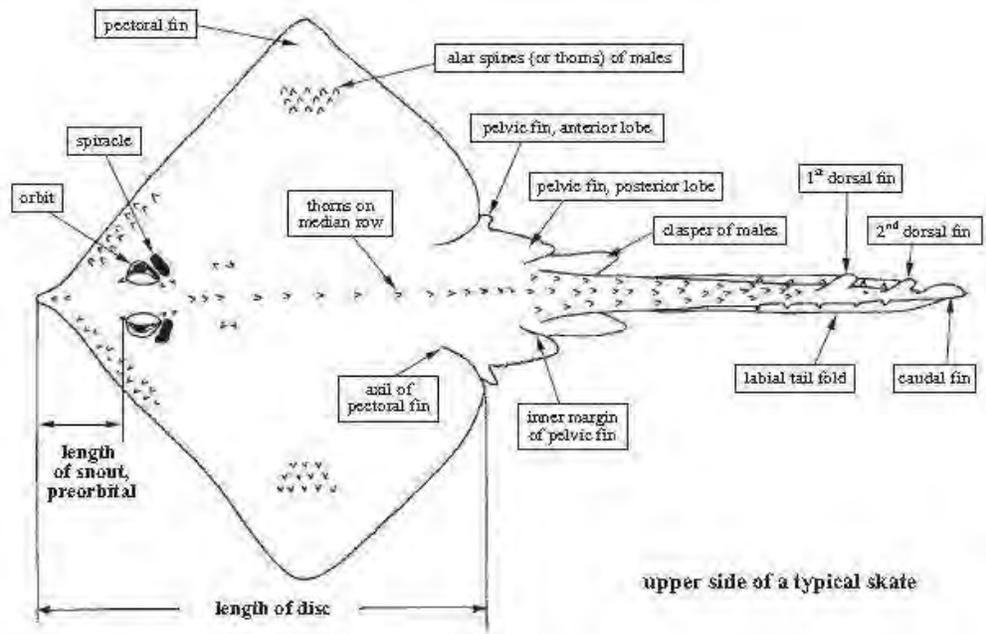
Distinctive characters:

Eel-shaped fish without scales. Posterior nostril much nearer to eye than to anterior nostril. Snout short; eye 2.0 to 2.5 times in length of snout. Mouth large, upper jaw ending well behind eye. Outer tooth row in lower jaw pointing straight upward; middle canines on vomer (roof of mouth) with distinct basal lobes, their bases more or less in contact. Dorsal and anal fins joined to caudal fin; pectoral fins well developed; 39 to 47 pores in lateral line from head to above anus.



Colour: Head and body normally quite dark to grey/black.

Batoid fishes
Rays, Skates, Guitarfishes and Mantas



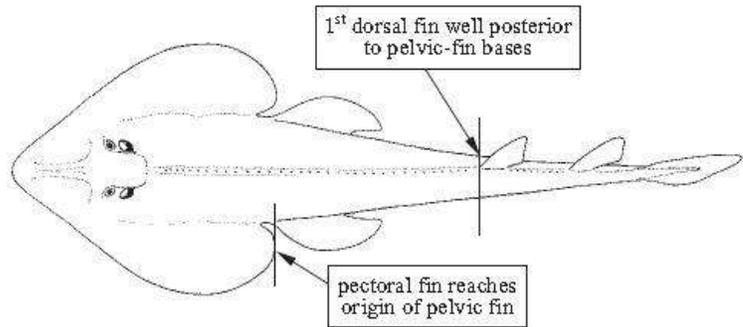
Technical terms and measurements of batoid fishes

Order Rhinobatiformes – Guitarfishes, wedgefishes and shark-rays

Body elongated and shark-like with pectoral fins expanded and fused with head and trunk; two subequal and well separated dorsal fins; no saw-like snout.

Rhinobatidae - Guitarfishes

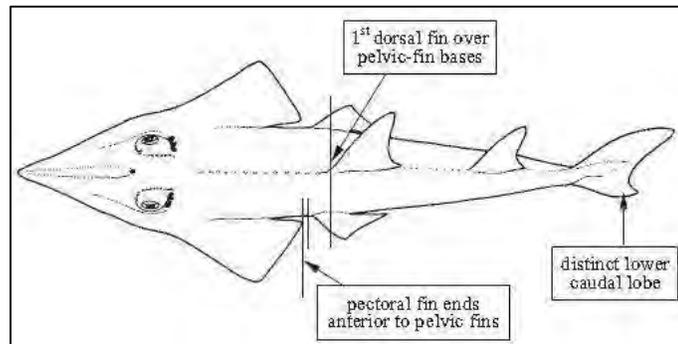
Demersal fishes, reaches upto 3 m total length, also found in inshore waters and sometimes in deeper waters of the upper slope; off sandy beaches, muddy bays, estuaries, and off river mouths. From the intertidal down to 366 m depth. Possibly 6 species in the region.



Guitar fishes

Rhynchobatidae - Wedgefishes and shark-rays

Demersal fishes, reaches upto 3 m total length, also found in inshore waters, muddy bays, estuaries and river mouths, and coral reefs; from the intertidal to at least 64 m. Possibly two species in the area.



wedge fishes and shark-rays

Rhynchobatidae

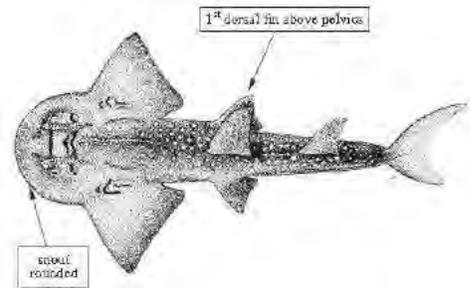
***Rhina ancylostoma* Bloch and Schneider, 1801**

FAO name: - Bowmouth guitarfish

Size: Reported to reach 2.7 m total length.

Habitat and biology: A bottom living species that occurs close inshore and on offshore reefs, from depths of 3 to 90 m. Feeds on crabs and shellfish.

Distribution: Confined to the Indian and western Pacific oceans. From north of South Africa to the Red Sea and eastward to Japan, New Guinea and Australia.



Rhina ancylostoma

***Rhynchobatus djiddensis* (Forsskal, 1775)**

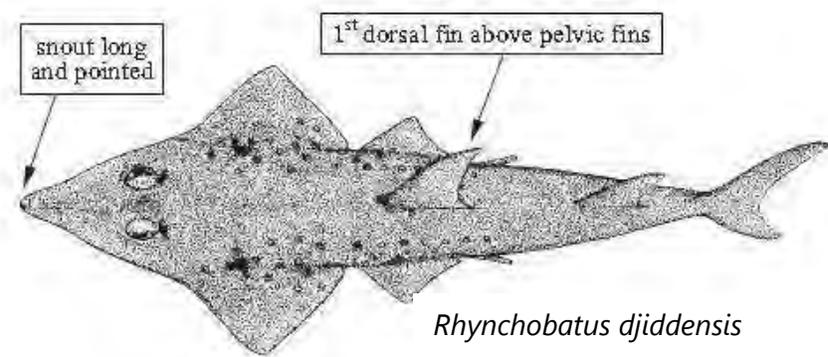
FAO names: - Giant guitarfish

Size: To at least 3 m total length.

Habitat and biology: Occurs in shallow inshore waters, on sandy bottoms, from depths of 2 to 50 m. Feeds on benthic invertebrates.

Distribution: Known from the western Indian Ocean including the Red Sea and Gulf of Aden. Possibly also in the eastern Indian and western Pacific Oceans but records need confirmation.

Remarks: Another species of *Rhynchobatus* is reported from the area. Similar or identical to *R. australiae* Whitley, 1939, its status and distribution needs further study. The species identical to *R. australiae* are frequently collected along the southwest coast of India. However, the taxonomic status of the species is yet to be confirmed.



Rhynchobatus djiddensis

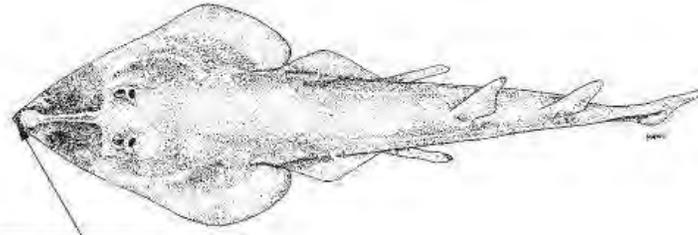
***Rhinobatos halavi* (Forsskal, 1775)**

FAO names: - Halavi guitarfish

Size: To 150 cm total length

Habitat and biology: An inshore species of sandy bottoms. Up to 10 young per litter. Feeds on prawns and other crustaceans.

Distribution: Occurs in the Indo-West Pacific from the Red Sea to the Gulf of Oman. Possibly east to the Persian Gulf, India, Myanmar, the Philippines, Vietnam and China.



snout moderately long and broad, sides nearly straight

Rhinobatos halavi

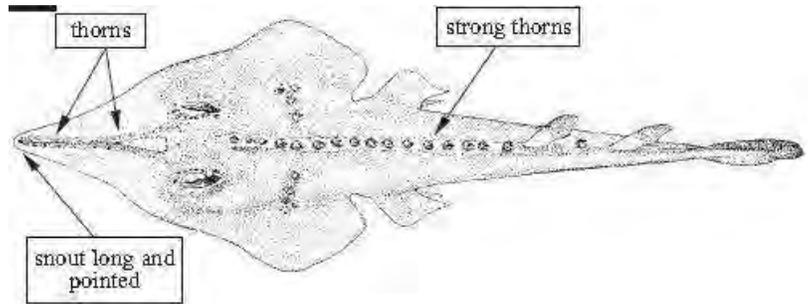
Rhinobatos granulatus
Cuvier, 1829

FAO names: - Sharpnose guitarfish

Size: To at least 1.8 m total length, possibly to 2.15 m.

Habitat and biology: Found inshore and offshore from the intertidal to the outer continental shelves down to 119 m. Biology is little known.

Distribution: Occurs in the Indo-West Pacific from the Persian Gulf and off India east to Viet Nam and New Guinea. Presence in the region needs to be confirmed.



thorns

strong thorns

snout long and pointed

Rhinobatos granulatus

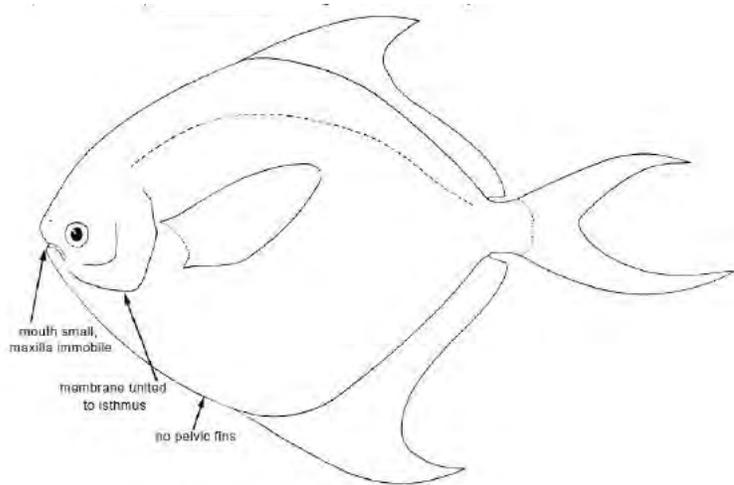
Pomfrets

Among the demersal fishes, pomfrets belonging to the family Stromateidae are found in the catches all along the coast of India, particularly in Maharashtra and Gujarat states. Pomfrets are one of the elite table fishes in coastal regions of India and has a high demand in international markets. The Pomfret fishery is mainly formed by three species i.e. Silver pomfret (*Pampus argenteus*), Black pomfret (*Parastromateus niger*) and Chinese pomfret (*Pampus chinensis*). The pomfrets constitutes about 1.62% of the total marine fish production in India. They are schooling, pelagic, medium-sized fishes (up to about 60 cm in length) inhabiting shallow waters, generally in coastal areas, sometimes entering estuaries. Soft-bodied coelenterates and pelagic crustaceans are important in their diet. They are usually captured by trawling, and are among the finest of food fishes, and one species in the family (*Pampus argenteus*) is of significant commercial importance in the area. The identification features of family, genus and species described by FAO are given below.

Family: Stromateidae (Butterfishes, Fiatolas, Silver pomfrets)

Body very deep and compressed, caudal peduncle short and compressed, with no keels or scutes. Head deep and broad, snout short and blunt; eyes small, centrally located and surrounded by adipose tissue which extends forward around the large nostrils; mouth sub-terminal, small and curved downward, the maxilla scarcely reaching to below eye, and the angle of gape located before eye; premaxilla not protractile; maxilla immobile, covered with skin and united to cheek; teeth minute, uniserial and flattened, with very small cusps; gill covers very thin, gill membranes broadly united to the isthmus in all Indian Ocean species, gill opening a straight slit. Single dorsal and anal fins, long-based and slightly to deeply falcate, preceded by none or 5 to 10 flat, blade-like spines, pointed on

both ends and resembling the ends of free interneurals; pectoral fins long and wing-like; no pelvic fins; caudal fin usually forked, in some species with very extended lobes. Lateral line single, high, following dorsal profile and extending onto caudal peduncle. Scales small, cycloid (smooth) very easily shed; head naked, with prominent canals visible under the thin skin.



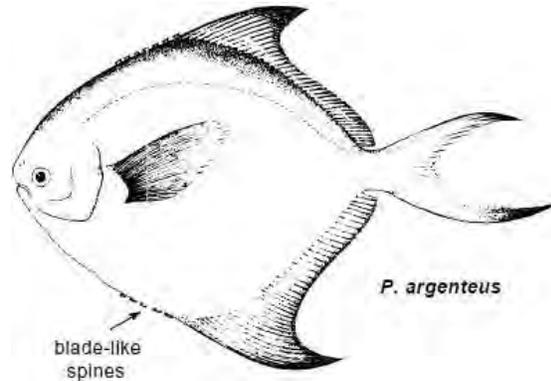
Colour: Conspicuously silvery with a bluish cast on back; gill membranes and inside of mouth dark.

***Pampus argenteus* (Euphrasen, 1788)**

FAO name : - Silver pomfret

Distinctive characters: Body very deep, compressed but fairly thick; caudal peduncle short, deep and compressed, without keels; musculature firm. Mouth small, subterminal and curved downward; maxilla immobile, covered with skin and united to cheek; jaw teeth minute, uniserial and flattened, with a large central cusp and 2 smaller cusps; palate toothless; gill membranes broadly united to isthmus; gill opening a

vertical slit covered with a flap of skin; gillrakers 2 to 3 + 8 to 10 on first arch. Dorsal and anal fins subequal in length, originating ahead of mid-body but behind pectoral fin base; preceded by 5 to 10 very low blade-like spines, pointed on both ends and resembling the ends of free interneurals; dorsal finrays 38 to 43, anal finrays 34 to 43; pectoral fins long and wing-like; pelvic fins absent; caudal fin stiff and forked, the lower lobe longer than the upper; anterior rays of median fins, especially the anal fin, and ventral lobe of caudal fin often greatly produced, decidedly falcate. Scales very small, cycloid (smooth), easily shed, and extending onto bases of all fins. Lateral line high, following dorsal profile and extending onto caudal peduncle. Skin thin, canal system clearly visible, particularly as a parallel network on the naked head and nape. Very numerous, small, slender pyloric caeca on the intestine.



Colour: Silvery white on the sides and blue to grey on the back. Body covered with small black dots, especially prominent on snout, lower jaw and cheek. Fins yellowish with dark edges. Young silvery. **Maximum Size:** about 60 cm; common to 30 cm.

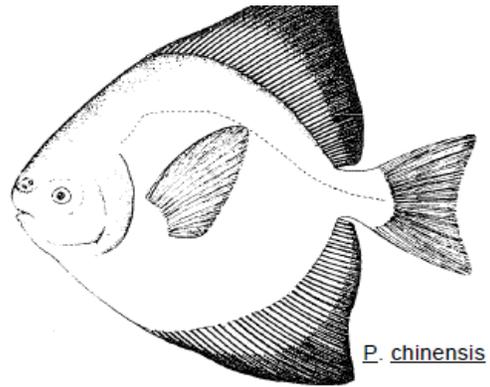
***Pampus chinensis* (Euphrasen, 1788)**

FAO Name: - Chinese silver pomfret

Distinctive characters: Body very deep, compressed; caudal peduncle very short, deep and compressed, without keels; musculature firm. Mouth small, curved downward; maxilla immobile covered with skin and united to cheek; jaw teeth minute, uniserial and flattened, with a large central cusp and 2 smaller cusps; palate toothless; snout obtuse; gill membranes broadly united to isthmus; gill opening a straight vertical slit covered with a flap of skin. Dorsal and anal fins subequal in length, originating at level of or behind pectoral fin bases, no spines ahead of fins; dorsal finrays 43 to 50, anal finrays 39 to 42; pectoral fins broad; pelvic fins absent; caudal fin broad and only slightly forked; rays of median fins increasing and then diminishing gradually in length to produce an approximately vertical margin at posterior border of the fins, never falcate. Scales small, cycloid (smooth), easily shed and extending onto bases of all fins.

Lateral line high, following dorsal profile and extending onto caudal peduncle. Skin thin.

Colour: Grey to brown on the back, silvery white on sides; small black dots cover entire body; fins yellowish to dusky.



P. chinensis

Field Identification of Groupers and Snappers

Rekha J. Nair

Demersal Fisheries Division

Family Serranidae - Sea basses

Sea basses are mostly marine in habitat with wide spread occurrence from tropical and temperate seas. Fishes are characterised by an opercle with three spines with the main spine in centre and one each above and below. Body scales are generally ctenoid with cycloid scales also reported. Lateral line is continuous, not extending onto caudal fin. Single continuous dorsal fin, in some with notches, 7- 13 spines. Anal fin with 3 spines; caudal fin usually rounded, truncate, or lunate. Tip of maxilla exposed, pelvic fin with one spine and five soft rays; seven branchiostegal rays usually present. Colour patterns are helpful for identification of species, but variations are common based on ground of capture. Colour changes have also been noticed when the fish are brought to the shore. Red List assessments show that 20 species (12%) risk extinction if current trends continue, and an additional 22 species (13%) are considered to be Near Threatened.

Three subfamilies Serraninae, Anthinae and Epinephelinae are recognized with about 64 genera and 529 species (Fraser and Pauly online).

Subfamily serraninae

Synchronous hermaphroditism, with both sexes functional at the same time in a single individual, is characteristic of most species in the Subfamily Serraninae. Although these synchronous hermaphrodites can fertilize their own eggs, they normally spawn in pairs and alternate the release of eggs or sperm in order to have their eggs fertilized by the other fish.

The subfamily includes 13 genera *Acanthistius*, *Bullisichthys*, *Centropristis*, *Chelidoperca*, *Cratinus*, *Diplectrum*, *Dules*, *Hypoplectrus*, *Paralabrax*, *Parasphyraenops*, *Schultzea*, *Serraniculus* and *Serranus* with 86 valid species.

Subfamily anthinae

Includes around 21 genera, *Acanthistius*, *Anthias*, *Caesioperca*, *Caprodon*, *Epinephelides*, *Gigantias*, *Hemanthias*, *Holanthias*, *Hypoplectrodes*, *Lepidoperca*, *Luzonichthys*, *Plectranthias*, *Pronotogrammus*, *Pseudanthias*, *Rabaulichthys*, *Sacura*, *Serranocirrhitus*, *Stigmatonotus*, *Tosana*, *Tosanoides*, and *Trachypoma*, with about 214 species and is mostly being Indo-West Pacific in distribution.

Subfamily epinephelinae

The tribe Epinephelini is one of the most speciose percoid assemblages, with hypothesized monophyly comprising 167 species.

The subfamily includes around 30 genera *Aethaloperca*, *Alphestes*, *Anyperodon*, *Cephalopholis*, *Cromileptes*, *Dermatolepis*, *Epinephelus*, *Gonioplectrus*, *Gracilia*, *Mycteroperca*, *Paranthias*, *Plectropomus*, *Saloptia*, *Triso*, *Variola*, *Aulacocephalus*, *Belonoperca*, *Diploprion*, *Bathyanthias*, *Liopropoma*, *Rainfordia*, *Aporops*, *Grammistops*, *Jeboehkia*, *Pogonoperca*, *Pseudogramma*, *Rypticus*, *Suttonia* and *Niphon*.

Key to the genera of Serranidae

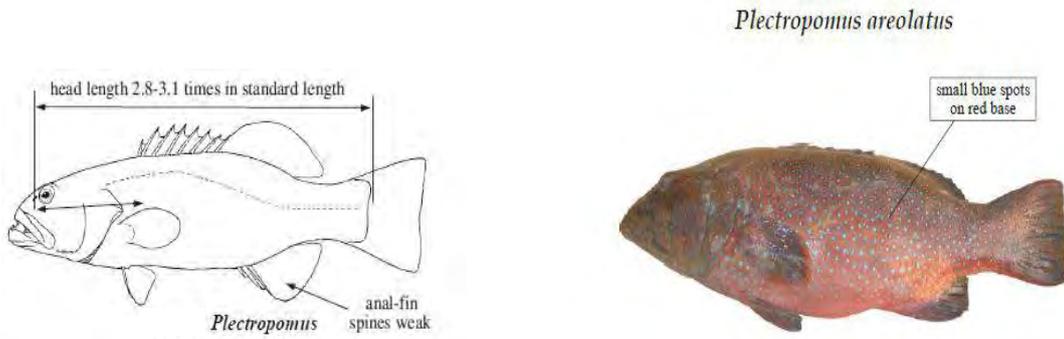
Less than 1/2 of upper border of opercle joined to body by skin; dorsal-fin spines VII to XI (tribe Epinephelini)- **1a**

1a. Dorsal-fin spines VII or VIII; lower edge of preopercle with 1 to 3 enlarged spines (usually hidden by skin, but these spines can be detected by running a finger or probe along preopercle edge).

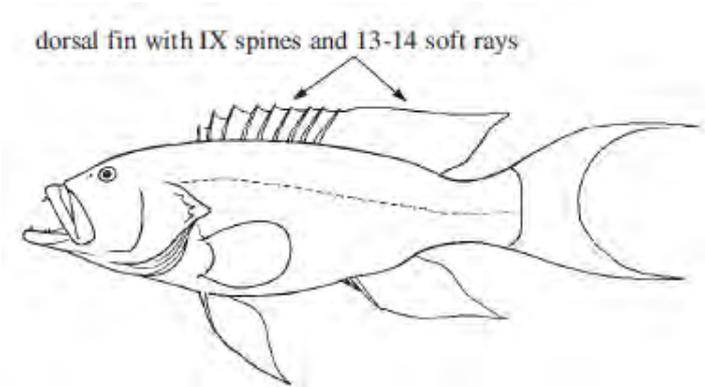
Anal-fin spines weak, the first and second covered by skin; preorbital depth 0.7 to 2 times eye diameter; head length 2.8 to 3.1 times in standard length

Plectropomus

- 1b. Dorsal-fin spines IX to XI; lower edge of preopercle smooth except for a few species of *Epinephelus* with 1 to 4 enlarged serrae **2**



- 2a. Caudal fin deeply lunate or forked; dorsal-fin spines IX. ***Variola***



- 2b. Caudal fin rounded, truncate, or concave; dorsal-fin spines 9-11.....**3**

- 3a. No teeth on palatines; body and head elongate and markedly compressed, the greatest body width 11 to 15% of standard length and more than 3 times in head length ***Anyperodon leucogrammicus***



- 3b. Palatines with teeth; body compressed in some species, but its width only 1.8 to 3 times in head length **4**

- 4a. Dorsal profile of head markedly concave; dorsal-fin spines X; rear nostrils of adults a long vertical slit ***Cromileptes altivelis***



- 4b. Dorsal profile of head straight, convex or slightly concave; dorsal-fin spines IX or XI. **5**

- 5a. Pectoral fins distinctly asymmetric, the fifth or sixth rays longest; dorsal fin with IX spines and 17 or 18 soft rays; caudal fin truncate ***Aethaloperca rogae***



- 5b. Pectoral fins symmetric or nearly so, the middle rays longest; dorsal fin with IX to XI spines and 12 to 21 soft rays; caudal fin rounded, truncate, or emarginate . . **18**

- 6a. Dorsal-fin spines 9 **19**

- 6b. Dorsal-fin spines 11 **20**

- 19a. Caudal fin rounded; dorsal-fin membranes distinctly incised between spines. ***Cephalopholis***

- 19b. Body depth 2.4 to 4.1 times in standard length, usually less than head length; dorsal fin with XI spines and 12 to 19 soft rays, the base of soft-rayed part shorter than or equal to that of spinous part. ***Epinephelus***

Key to the species of *Cephalopholis* occurring in the area

1. Caudal fin rounded; head length 2.2 to 2.7 times in standard length; colour pattern not of alternating stripes of blue and orange-yellow **2**

- 2a. Anal-fin rays usually 8; colour generally brown to dark brown **3**

- 2b. Anal-fin rays 9 (rarely 10); colour generally red, orange, or yellow **8**

- 3a. Small dark spots or dark-edged pale blue spots on head and/or body **4**

- 3b. No small dark spots or blue ocelli on head or body **5**

- 4a. Dorsal-fin rays 15 to 17; lateral scale series 92 to 106; pectoral-fin length 1.5 to 1.8 times in head length; blue ocelli on head, body, and basally on median fins; juveniles greenish grey, the median fins yellow ***Cephalopholis cyanostigma***
- 4b. Pectoral fins short, their length 1.5 to 1.8 times in head length; colour generally brown or yellowish brown, with dark blue lines on head, body, and fins; black spot between upper. 2 opercular spines ***Cephalopholis formosa***
- 5a. Body brown, with 7 to 8 more or less distinct dark bars; fins dark brown, with pale blue line caudal fin corner. ***Cephalopholis boenak***
- 5b. Dorsal-fin rays 15 to 17; lower limb of first gill arch with 17 to 19 gill rakers; colour dark brown, covered with small dark-edged blue ocelli; 6 pale bars often visible on rear half of body ***Cephalopholis argus***
6. Dorsal-fin rays usually 14 or 15; lower limb of first gill arch with 13 to 16 gill rakers; no auxiliary scales on body scales; colour not as above **7**
- 7a. Lateral-line scales 66 to 80 colour generally red to reddish brown with widely scattered whitish blotches (Indian Ocean) or generally brownish, covered with small dark red to reddish brown spots and irregular white blotches. ***Cephalopholis sonnerati***
- 7b. Lateral-line scales 45 to 68; colour not as above **8**
- 8a. Lateral-line scales 54 to 68; caudal fin blackish red, with red pectoral fins. ***Cephalopholis urodeta***
- 8b. Lateral-line scales 45 to 56; colour not as above **9**
- 9a. Lateral scale series 79 to 90; head length 2.2 to 2.4 times in standard length; dark brown saddle spot on caudal peduncle, followed by a smaller spot; submarginal dark streak at corners of caudal fin ***Cephalopholis leopardus***
- 11b. Lateral scale series 90 to 121; head length 2.3 to 2.6 times in standard length; colour not as above **12**
- 12a. Head, body, and fins covered with small blue ocelli **13**
- 12b. No blue spots on head, body, or fins **14**

13a. Body with 4 or 5 dark blotches along base of dorsal fin, a faint blotch on nape and 2 smaller ones on peduncle (blotches sometimes merging with or being replaced by dark red vertical bars); most specimens with dark-edged blue lines radiating from eyes ***Cephalopholis sexmaculata***

13b. No dark blotches on body or blue lines radiating from eyes ***Cephalopholis miniata***

14a. Edge of subopercle and interopercle distinctly serrate; pelvic fins usually reaching anus, their length 1.6 to 2 times in head length; colour generally orange-yellow to orange-red or golden, with red to orange dots on head and dorsally on body ***Cephalopholis aurantia***

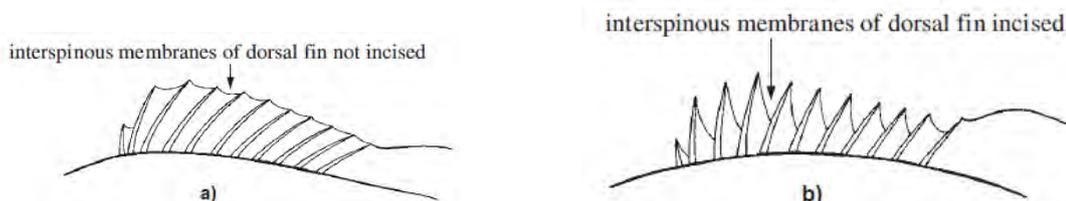
Key to the species of *Epinephelus* occurring in Indian waters

1a. Caudal fin of adults emarginate to truncate (slightly rounded on some *E. bleekeri* and juveniles, and convex if broadly spread in adults) **2**

1b. Caudal fin rounded (truncate on some *E. fasciatus* from Oceania) **12**

2a. Interspinous membranes of dorsal fin not incised. **3**

2b. Interspinous membranes of dorsal fin incised. **6**



3a. Gill rakers elongate, no rudiments, 20 to 23 rakers on lower limb of first gill arch; dorsal-fin rays 17 to 19; colour purplish to brownish grey with yellowish brown dots on head and longitudinal brown lines on dorsal part of body (lines usually lost on large adults) ***Epinephelus undulosus***

3b. Gill rakers not elongate and rudiments often present, 13 to 18 rakers on lower limb of first gill arch; dorsal-fin rays 15 to 17; colour not as above **4**

4a. Second dorsal-fin spine of adults elongated, its length 1.8 to 2.4 times in head length; total gill rakers on first gill arch 20 to 23; body depth 2.7 to 3.2 times in standard length; body reddish brown with a white dot on each scale; broad dark red margin on spinous portion of dorsal fin ***Epinephelus irroratus***

- 4b. Second dorsal-fin spine not elongate (third or fourth spines longest); total gill rakers on first gill arch 24 to 28; body depth 2.3 to 2.9 times in standard length **5**
- 5a. Body dark purplish grey with scattered irregular whitish blotches; body depth 2.6 to 2.9 times in standard length ***Epinephelus multinotatus***
- 5b. Head, body, and fins bluish grey with numerous blackish dots; large adults with scattered irregular blackish spots and blotches, most smaller than pupil; body depth 2.4 to 2.7 times in standard length ***Epinephelus cyanopodus***
- 6a. Lateral-line scales 48 to 54; head and at least front of body with small spots, either yellow (pale in preservative) or brown **7**
- 6b. Lateral-line scales 56 to 76; spots on head and body dark brown or absent . . . **10**
- 7a. Caudal fin truncate to slightly rounded; body depth 3.0 to 3.5 times in standard length; head, body, dorsal fin, and upper third of caudal fin with small orange-yellow spots, the lower two-thirds of caudal fin dark grey; anal and paired fins dusky, without spots ***Epinephelus bleekeri***
- 7b. Caudal fin slightly emarginate (truncate on some *E. chlorostigma*); body depth 2.7 to 3.4 times in standard length; spots on head, body, and fins yellow or yellowish brown to dark brown; anal fin with spots. **8**
- 8b. Head, body, and fins covered with small, close-set, yellowish brown to dark brown spots (dark in preservative) **9**
- 9a. Dorsal-fin rays 15 to 17; anal fin of adults rounded to slightly angular, the longest soft ray 2.0 to 2.6 times in head length; 14 to 16 gill rakers on lower limb of first gill arch; pyloric caeca 11 to 17; dark spots on body of adults about equal to pupil ***Epinephelus areolatus***
- 9b. Dorsal-fin rays 16 to 18; anal fin of adults angular or pointed, the longest soft ray 1.9 to 2.3 times in head length; 15 to 18 gill rakers on lower limb of first gill arch; pyloric caeca 26 to 52; dark spots on body of adults distinctly smaller than pupil ***Epinephelus chlorostigma***
- 12a. Anal-fin rays 9 (rarely 10); body with 5 dark bars below dorsal fin, the last 2 bars as broad as preceding bars; 2 pale interspaces below soft dorsal fin ***Epinephelus octofasciatus***

12b. Anal-fin rays 8 (rarely 7 or 9); colour not as above **13**

13. Lateral-line scales 56 to 65; lateral body scales smooth; rear nostrils and anterior nostrils subequal; juveniles with 2 broad, longitudinal, black-edged whitish bands that disappear in adults, the dark edges breaking into dashes and spots, which may be lost in large adults ***Epinephelus latifasciatus***

14. Lateral-line scales with branched tubules; eye small, its diameter about 1/8 head length for specimens of 20 cm length, about 1/9 head length at 35 cm, and 1/13 head length at 145 cm standard length; interorbital wide, the width more than 1/5 head length for specimens of 23 to 153 cm standard length; maximum length about 270 cm; juveniles yellow, with 3 broad black bars on body and irregular black bands on head ***Epinephelus lanceolatus***

Some common species

***Aethaloperca rogae* (Forsskal, 1775)**

Redmouth grouper

D IX, 17; A III, 8; P 17-18; V I, 5.

Body rounded its depth greater than head length; mouth slightly superior; dorsal profile of head steeply sloped; small hump on nape; pre-operculum finely



serrated; operculum with 3 undeveloped spines; pelvic fins equal to pectorals, reaching the level of anus or beyond; caudal fin truncate.

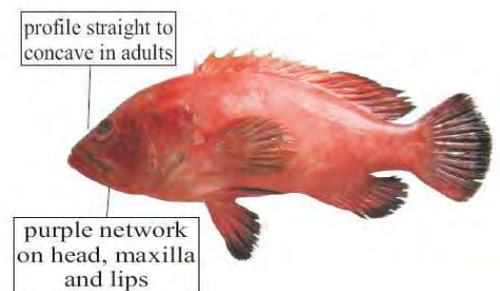
Body uniformly dark brown to black; reddish inside the mouth, gill cavity and upper jaw membrane; soft-rayed part of dorsal fin and caudal fin margin white white.

***Cephalopholis sonnerati* (Valenciennes, 1828)**

Tomato hind

D IX, 15; A III, 9; P 17-18; V I, 5; Gr 14 to 16.

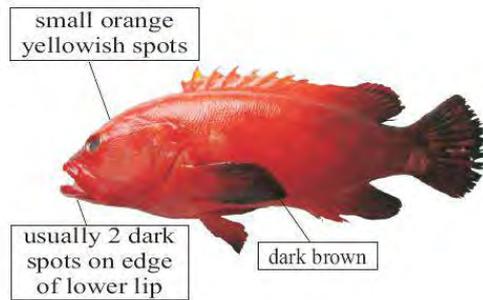
Body depth, greater than or equal to head length; dorsal profile of head near eye and nape strongly convex; mouth small, slightly superior; maxilla reaches posterior of eye; pre-operculum rounded; **operculum spines very small, poorly developed**; Body bright orange to red, with scattered bluish-white



spots; head purplish to red with numerous close-set orange-red spots; opercular flaps dark reddish; all fins reddish, the membranes of soft dorsal, caudal, anal, pectoral and pelvic fins dark red to dusky.

Cephalopholis urodeta

Similar to *C. sonnerati*, but differs in the absence of the reticulate pattern in *C. sonnerati*



***Epinephelus polyphkadion* (Bleeker 1849)**

Camouflage grouper

D XI, 15; A III, 8; P 16; V I, 5; LL 47 to 52; Gr (8-10) + (15-17).

Dorsal profile of head evenly convex; maxilla reaches rear edge of eye; pre operculum rounded, the serrae at corner slightly enlarged; two undeveloped spines in operculum; inter spinous membranes moderately incised; caudal fin rounded; body scales ctenoid.

Body pale brownish covered with numerous small dark brown spots; some irregular dark blotches



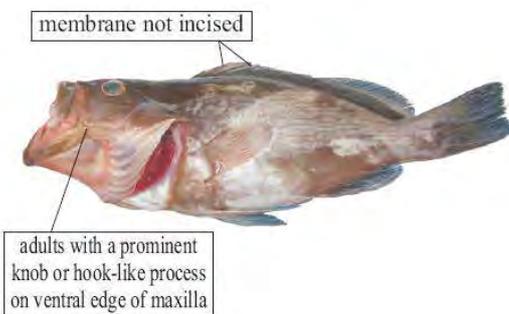
superimposed with the spots scattered in head and body; **a prominent black blotch on caudal peduncle**; dark spots extend all over head, including lower jaw, lips and inside of mouth; numerous small white spots on fins and a few on head and body.

***Epinephelus undulosus* (Quoy & Gaimard 1824)**

Wavy-lined grouper

D XI, 20; A III, 8; P 18; V I, 5; LL 70 to 75.

Eyes small; mouth superior to slightly protractile; pre-operculum highly serrated at the



angle; operculum notched with 2 undeveloped spines; **dorsal fin membrane not notched** between the spines; body scales ctenoid, except on belly; caudal fin truncate to slightly concave. Body generally brownish to purplish grey, usually with golden brown

to yellowish spots on head and upper body, which becomes wavy longitudinal lines in mid body; median fins and pelvic fin black to brown in base and bluish in the tip; preserved specimen becomes brownish with dark spots and lines.

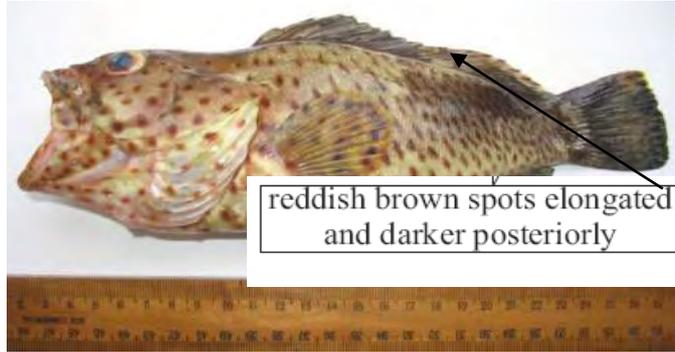
***Epinephelus longispinis* (Kner 1864)**

Longspine grouper

D XI, 16; A III, 8; P 18; V I, 5; LL 49 to 53; Gr (8 to 11) + (15 to 17).

Body deep, upper edge of operculum straight or slightly convex, with 3 undeveloped spines; the third or fourth spine longest, its length contained 2.1 to 2.6 times in head length; caudal fin rounded, convex.

Body pale to brownish and grey laterally; reddish to dark brown spots all over the body, which is round in head and slightly elongated in sides; some dark



spots or blotches at dorsal fin base; median and paired fins with dark brown spots; tip of the fins slightly yellowish; preserved specimen becomes brownish with dark spots.

***Plectropomus leopardus* (Lacepede 1802)**

Leopard coral grouper

D VII, 12; A III, 8; P 16; V I, 5; LL 89 to 99; Gr (1-3) + (6-10).

Body elongate, robust; Head comparatively small, 2.7 to 3.1 times in standard length; dorsal profile of the head slightly sloped, with a concave insertion near nape; eyes slightly prominent; mouth oblique, slightly superior; preoperculum rounded,



with 3 large, spines along lower half; operculum with 3 flat spines, the upper and lower spines covered by skin; pectoral fins subequal to pelvic fins; caudal peduncle broad; caudal fin emarginated.

Body brownish to orange-red, with numerous small dark-edged, blue spots on head and body (except ventrally) and fins; spots slightly elongated near mid body; pectoral fins reddish with darker rays; a indistinct dark band at rear margin of caudal fin.

***Variola albimarginata* (Baissac 1953)**

White-edged lyretail

D IX, 14; A III, 8; P 18; V I, 5; LL 120-130; Gr (7-9) + (13-16).

Body elongated, moderately deep; dorsal profile of head gently sloped; eyes small; mouth oblique, terminal; jaws with sharp canine teeth; maxilla reaches beyond the eye; pre-operculum finely serrate; operculum spines not well developed; soft rays tips of fins slightly elongated; caudal fin crescentic, the upper and lower rays elongate.



Brownish orange to reddish with numerous irregular, small whitish to pink or lavender spots to streaks; fins colour same as body except pectoral fin and caudal fin rear margin; rear margin of caudal fin dusky with a narrow white edge; pectorals yellowish; preserved specimens changes complete brownish white.

***Epinephelus coeruleopunctatus* (Bloch, 1790)**

White Spotted grouper

D XI, 15; A III, 8; P 18; V I, 5; LL 52-62; Gr 10+14-17.



Body moderately elongated; dorsal profile of the head nearly straight; head pointed; Body depth more or less equal to head length; pre-operculum rounded, serrated; eyes big, prominent; dorsal and anal fin soft rays, pectoral and caudal fins

rounded.

Body brownish gray to black with numerous large white spots including fins; dark blotches below dorsal fin and caudal peduncle; prominent black streak on maxillary groove.

***Cephalophalis miniata* (Forsskål, 1775)**

Coral hind

D XI, 14; A III, 8; P 17; V I, 5; LL 47-56; Gr 7-9+14-16.

Body moderately deep; dorsal profile of the head straight, with convex above eye; maxilla big, crossing the rear edge of eye; eyes small; pre-operculum rounded; soft rays of dorsal and anal fin, pectoral and caudal fins rounded.



Body orange to reddish brown, with small blue spots all over the body including fins; Margin of soft rays of dorsal and anal and caudal fins bluish.

***Anyperodon leucogrammicus* (Valenciennes, 1828)**

Slender grouper

D XI, 14; A III, 8; P 15; V I, 5; LL 61-72; Gr 7-9+14-17.

Body elongated, slightly compressed; head elongated, its length greater than body depth; dorsal profile of the head slightly sloped to straight; eyes moderate; mouth



large terminal; pre-operculum slightly serrated, rounded; interfin membrane of soft rays transparent; soft rays of dorsal and anal fin, pectoral and caudal fins rounded.

Body greenish brown to gray with numerous reddish spots including head and fins; spots in head small; 3 to 4 longitudinal white bands running from mouth to caudal peduncle.

***Cephalopholis argus* (Schneider, 1801)**

Peacock hind

D XI, 16; A III, 9; P 16; V I, 5; LL 46-51; Gr 9-11+17-19.

Body deep; head big, its length 2.4 to 2.7 times in standard length; eyes small; mouth big, terminal to slightly superior; maxilla extends beyond to the level of eye; pectoral fin fleshy; dorsal and anal fin soft rays, pectoral and caudal fins rounded.



Body dark brown with numerous blue to white spots with dark margin; 5 to 6 pale vertical bars on the rear part of body; dorsal fin spines with orange margin; posterior margin of median fins darker with a narrow white tip; pectoral fin with dark brownish to purplish red posterior edge.

***Cephalopholis formosa* (Shaw, 1812)**

Bluelined Hind

D IX, 18; A III, 8; P 15; V I, 5; LL 47-51; Gr 6+15.

Body moderately, deep; dorsal profile of the head sloped with convex inter-orbital; eyes small; maxilla ends at



posterior end of the eye; dorsal and anal fin soft rays, pectoral and caudal fins rounded; body scales ctenoid.

Body dark yellowish brown, fins darker; wavy longitudinal blue lines all over body including head and fins; blue spots on the snout, lower part of head and thorax.

***Epinephelus lanceolatus* (Bloch 1790)**

Giant grouper

D XI, 14; A III, 8; P 16; V I, 5; LL 46-51; Gr (9-11)+(17-19).

Body robust in adult and slightly deep in juveniles; dorsal profile of the head slightly convex; eyes small; mouth moderately big, terminal to superior; maxilla reaching rear edge of eye; pre-operculum finely serrated in edges; inter fin membrane of spines



notched; soft rays of dorsal and anal fin, pectoral and caudal fins rounded.

Body greyish yellow above, grayish white below and sides with numerous

uneven black blotches all over the body; head darker; fins yellowish with black blotches; juveniles with 3 irregular black bars in body, large adults dark brown to grey. This is a protected species under Wild Life (Protection) act, 1972 of India.

***Cephalopholis cyanostigma* (Valenciennes, 1828)**

Blue spotted hind

D IX, 15; A III, 8; P 15; V I, 5; LL 46 to 50; Gr 7-9+14-18

Body moderately compressed, deep; dorsal profile of head convex above eye; eyes small slightly projected; mouth large terminal to superior; maxilla vertically reaching the rear edge of the eye; pre-operculum rounded; body scales ctenoid; soft rays of the dorsal and anal fin, pectoral and caudal fin rounded.



Body brown to brownish red, head darker; with numerous black edged bluish spots all over the body

including fins; spots in head, chest and belly comparatively big with spots in fins and posterior body; sides with 4 to 5 dark chain like bars; median fins darker than body colour; pectoral fin darker or with black margin at the free tip.

***Epinephelus ongus* (Bloch, 1790)**

White streaked grouper

D XI, 14; A III, 8; P 15; V I, 5; LL 48 to 53; Gr 8-10+15-18.

Body comparatively deep; dorsal profile of head steeply sloped, slightly convex above eye; eyes big projected; mouth moderately small; maxilla vertically reaching middle of



the eye; head slightly pointed; pre operculum rounded; soft rays of dorsal and anal fins, pectoral and caudal fin rounded.

Body brownish with numerous small white spots all over the body which sometimes forms wavy lines; head

darker with less white spots; median fins with small white spots, posterior margin darker with white tip; paired fins greyish brown.

***Epinephelus merra* (Bloch, 1793)**

Honeycomb grouper

D XI, 17; A III, 8; P 17; V I, 5.

Body robust, slightly compressed, elongated; mouth superior, large, maxilla exposed, slightly protractile; small, slender teeth on jaws, vomer and palatine; some small canines on front; eyes prominent; dorsal profile of the head sloped; pre-operculum serrated; one flat spine on operculum; small ctenoid scales; pectoral fin like an hand fan; caudal fin rounded.



Body grey above and lighter below; brown to black spots all over the body, hexagonal anteriorly, rounded posterior; fins rays of dorsal and caudal fin yellowish; pectoral and pelvic fins dark brown to black.

***Epinephelus flavocaeruleus* (Lacepède, 1802)**

Blue-and-yellow grouper

D XI, 8; A III, 5; P 16; V I, 5; LL 61-74; GR (9-10) + (15-17)

Body deep; dorsal profile convex; eyes small, head length 2.5 in SL; BD 2.5 in SL; nostril top of the eye; mouth inferior;



teeth canine; operculum with undeveloped spines; pre-operculum serrated; interfin membrane of dorsal fin deeply notched; caudal fin truncate; caudal peduncle thick and short. In fresh condition body colour blackish with bright yellow dorsal, anal and caudal fins; outer tip of caudal blackish; in formalin preserved specimens fins are whitish; black tip of caudal fin is retained.

***Epinephelus spilotoceps* (Schultz, 1953)**

Four saddle grouper

D XI,17;A III,8;P 17;l,5;LL 60-69;GR (7-8)+(15-18)

Body elongated; pre dorsal profile is slightly convex; eyes small; head length 2.5 in SL; BD 2.5 in SL; mouth inferior; maxillary ends at the middle of the eye; teeth canine;



operculum with one developed spine; pre-operculum serrated; pectoral fin origin in front of the pelvic fins; dorsal fin spinous interfin membrane deeply notched; caudal fin truncate; caudal peduncle thick and short.

In fresh condition the body colour is yellowish brown with spot all over the body; in formalin preserved specimens the black spots are light black.

***Epinephelus diacanthus* (Valenciennes, 1828)**

Thornycheek grouper

D XI, 15-17; A III, 8-9; P 18-20; VI, 5; LI 105-120.

Body depth contained 2.8 to 3.2 times in standard length. Pre-opercle border forming nearly a right angle, with 1 to 3 enlarged serrae at the angle; sides of lower jaw with 2 rows of small subequal teeth; anterior nostrils tubular, with a large flap posteriorly extending over rear nostril; lower gillrakers 14 to 16. caudal fin rounded to almost truncate. Pored lateral line scales 53 to 60. Body generally buff, with 5 more or less distinct, vertical dark bars; 4 bars below dorsal fin and 5th on caudal peduncle. Ventral part of head and body reddish. Some specimens with a black streak across cheek at upper edge of maxilla. Dark bars on body sometimes absent.



***Epinephelus malabaricus* (Schneider, 1801)**

Malabar grouper

D XI, 14-16; A III, 8; P 18-20; VI, 5; LI 98-114.

Body depth contained 3.0 to 3.6 times in standard length. Pre-opercle finely serrate, with a shallow notch, the serrae enlarged at the angle; rear nostrils not more than



twice the size of anterior nostrils; lower gillrakers 13 to 16; mid lateral part of lower jaw with 2 rows of teeth. Midlateral body scales distinctly ctenoid with minute auxiliary scales.

Head and body generally pale greyish brown covered with small orange, golden brown, or dark brown spots. Five more or less distinct, slightly oblique, irregular, broad, dark bars on body; these bars are darker dorsally and the last 3 are usually bifurcate ventrally; the first 4 bars usually continued onto the dorsal fin, the last bar covers most of the caudal peduncle; usually 3 dark blotches on interopercle, the first 2 sometimes merging to one blotch; small, irregularly shaped and spaced, white spots visible on head and body of some fish; soft dorsal, caudal, anal and pectoral fins brownish-black with small dark spots on basal half of fins.

FIELD IDENTIFICATION OF SNAPPERS

Family Lutjanidae – SNAPPERS

Body deep, mouth large, protrusible, anterior part of head without scales; some rows of scales on cheek, pre-opercle and on gill cover.

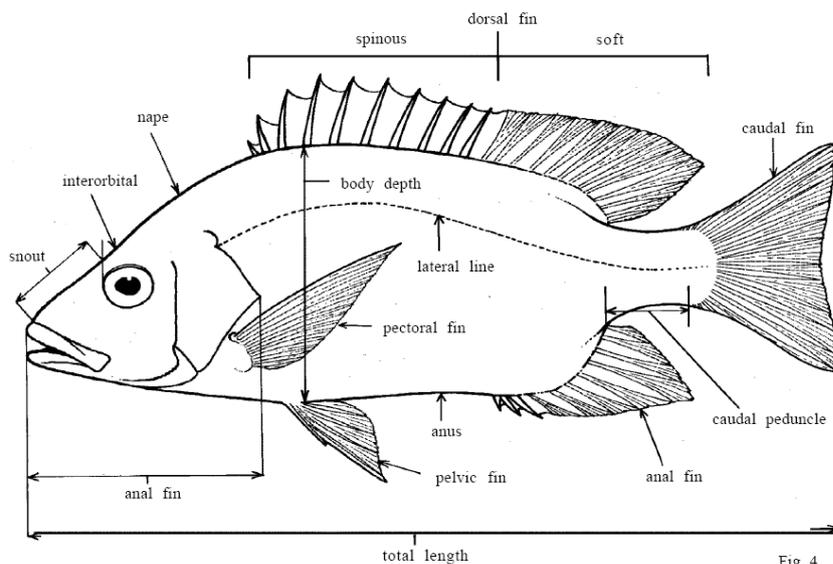
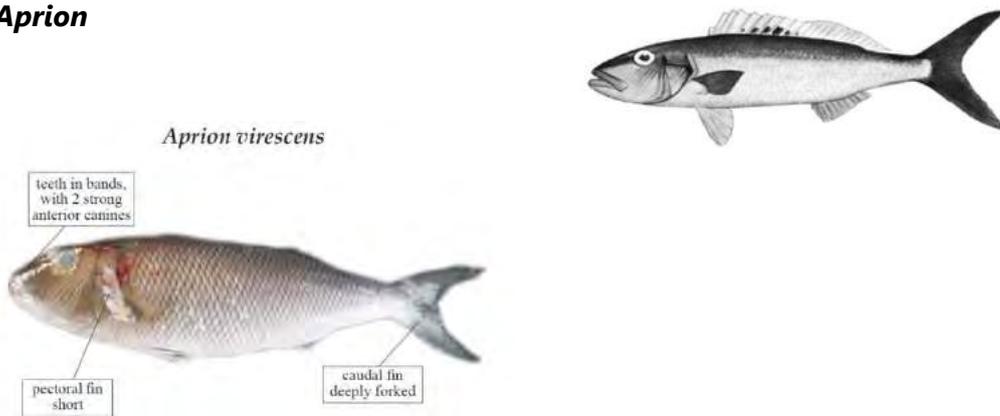


Fig. 4

The Main genera

Aprion



Green jobfish

D X, 11; A III, 8; Gr 14 -15 (lower limb); P 17; LI 48 -50

Elongate fish with rounded body; clear horizontal groove in front of eye; teeth in both jaws in bands, with 2 strong canines anteriorly; vomerine tooth patch crescent-shaped. Pectoral fins short, rounded, about equal to snout length; caudal fin deeply forked, lobes pointed; scales absent on dorsal and anal fins. Moderate-sized scales, on lateral line; scale rows on back parallel with lateral line. Body colour dark green to bluish or blue-grey.

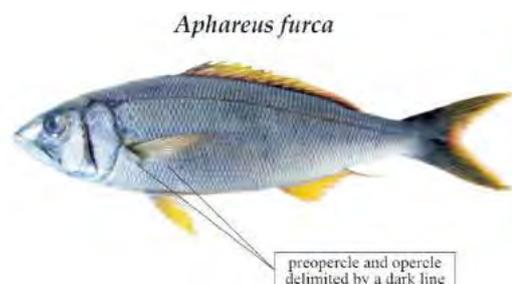
Genus *Aphaerus*

Medium-sized snappers; minute teeth in jaws, canines, vomerine absent; premaxillae not protractile; gill openings extending well forward to front of eye; interorbital space flattened. Continuous dorsal fin, not incised near junction of spinous and soft portions, with 10 spines and 11 soft rays; anal fin with 3 spines and 8 soft rays; pectoral fins long, slightly shorter than head, with 15 - 16 rays; dorsal and anal fins scaleless; caudal fin forked. Scales small, about 65 - 75 in lateral line. Body bluish grey, sometimes with a silvery sheen on lower sides and belly.

Species: *Aphareus furca* (Lacepède 1801)- Small toothed jobfish

D X, 11; A III, 8, P 15 -16, LI65 -75; Gr 16 -18

Elongate compressed body, with lower jaw protruding; maxilla extending to below middle of eye; interorbital space flattened;



teeth in jaws small, disappearing with age; roof of mouth toothless; scale rows on back parallel with lateral line.

Colour: Back and upper sides purplish-brown; blue-grey on sides; a silvery sheen on head and lower sides; edges of pre-opercle and opercle outlined with black; fins whitish to yellow-brown.

Aphareus rutilans - Rusty jobfish

D X, 11; A III, 8, P 15 -16, LI 70 - 73; Gr 15 - 16

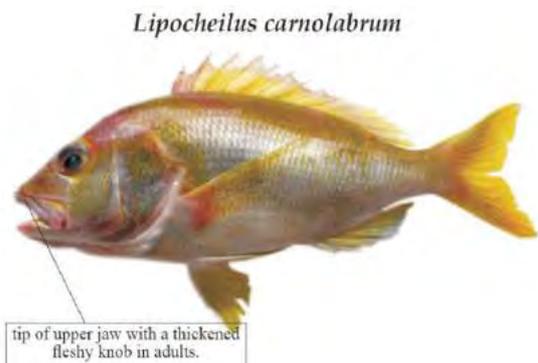
Elongate compressed body, with lower jaw protruding; maxilla extending to below middle of eye; interorbital space flattened; **teeth small, forming narrow uniform band in each jaw**; roof of mouth toothless; gill rakers on lower limb (including rudiments) 30 to 34; scale rows on back parallel with lateral line. Body colour blue-greyish reddish; fins yellowish red, pelvics and anal fin sometimes whitish; margin of maxilla black.



Lipocheilus carnolabrum

D X, 10; A III, 8, P 15 -16, LI65 -75; Gr 16 -18

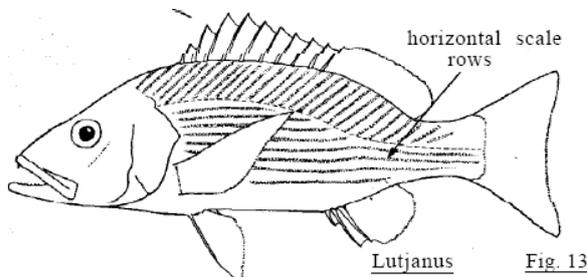
Mouth large, adults with a thick, fleshy protrusion at anterior end of upper lip. Vomerine tooth patch V-shaped, without a medial posterior extension; no teeth on tongue. Maxilla scaleless. Interorbital space flattened to convex. Dorsal and anal fins scaleless. Last dorsal and anal soft rays not produced. Pectoral fins long, reaching beyond level of anus. Scale rows on back parallel to lateral line. Upper part of head brown; yellowish or pinkish on sides; a silvery sheen on ventral portion of body.



Upper lip with a median fleshy protrusion, well developed in adults spines of dorsal and anal fins strong, very robust in large adults ***Lipocheilus carnolabrum***

Genus *Lutjanus*

Small oblong, slender and fusiform sized snappers with relatively deep bodies. Mouth large, protractile; with pointed, conical teeth in jaws arranged in one or more rows, with an outer series of canine teeth, some of which, particularly those at front of jaws, are generally enlarged and fanglike; vomerine tooth patch V-shaped or crescentic, with or without a medial posterior extension, or diamond-shaped; interorbital space convex; pre-opercle serrate, its lower margin with a shallow to deep notch, and opposite portion of interopercle sometimes with a bony knob, most strongly developed in species with a deep pre opercular notch. Dorsal fin continuous, often with a slight notch between the spinous and soft portions, with 10 or 11 spines and, 11 to 16 soft rays; anal fin with 3 spines and 7 to 10 soft rays; pectoral fins with 15 to 18 rays; dorsal and anal fins scaled; caudal fin truncate or emarginate, rarely forked.



Colour: Extremely variable, but often consisting of a reddish, yellow, grey, or brown background and a pattern of darker stripes or bars; frequently with a large blackish spot on upper sides below anterior dorsal soft rays.

Key to the genera of Lutjanidae occurring in the area (adapted and modified from FAO)

Notes: Species names are given when a genus includes a single species. Counts of gill rakers include rudiments, if present.

- 1a. Dorsal and anal fins without scales; dorsal fin with X spines and 10 or 11 soft rays
..... **2**
- 1b. Soft dorsal and anal fins with scales or sheathed with scales basally; dorsal fin with X to XII spines and 11 to 19 soft rays **10**
- 2a. Maxilla with scales **3**
- 2b. Maxilla without scales **5**
- 3a. Spinous portion of dorsal fin deeply incised at its junction with soft portion; dorsal fin with X spines and 11 (very infrequently 10) soft rays ***Etelis***

3b. Spinous portion of dorsal fin not deeply incised at its junction with soft portion; dorsal fin with X spines and 10 soft rays **4**

4a. Last soft ray of both dorsal and anal fins shorter than next to last soft ray
Paracaesio

5a. Premaxillae essentially not protrusible, attached to snout at symphysis by a frenum **6**

5b. Premaxillae protrusible, not attached to snout by frenum **7**

6a. Vomer without teeth (small juveniles may have minute teeth on vomer); teeth in jaws very small, no caniniform teeth; pectoral fins somewhat shorter than head; lateral surface of maxilla smooth **Aphareus**

7a. Dorsal fin with X spines and 11 (rarely 10) soft rays; last soft ray of both dorsal and anal fins longer than next to last soft ray **8**

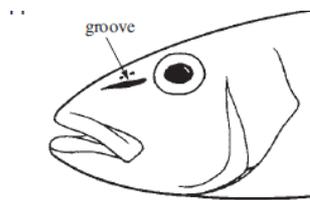
7b. Dorsal fin with X spines and 10 soft rays; last soft ray of both dorsal and anal fins shorter than next to last soft ray **9**

8a. Groove present on snout below nostrils; pectoral fins less than 1/2 length of head **Aprion virescens**

8b. No groove on snout; pectoral fins a little shorter than head to somewhat longer than head **Pristipomoides**

9a. Upper lip with a median fleshy protrusion, well developed in adults spines of dorsal and anal fins strong, very robust in large adults **Lipocheilus carnolabrum**

9b. Upper lip without a median fleshy protrusion **Paracaesio**



Paracaesio



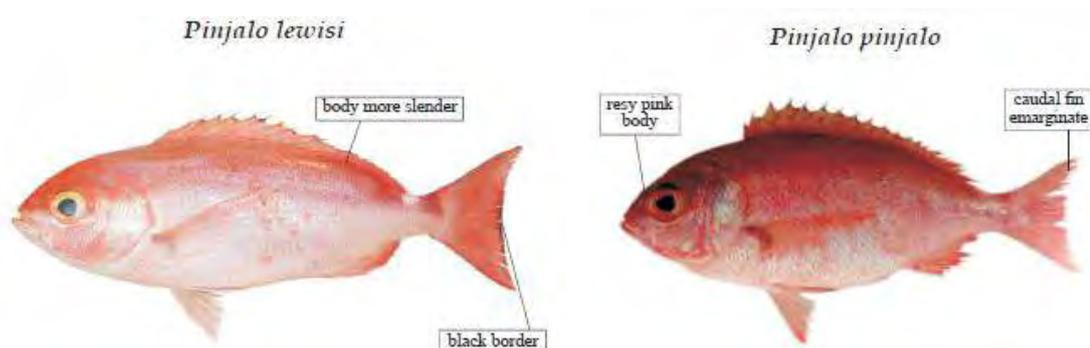
Lipocheilus

10. Vomer with teeth; dorsal fin with X to XII spines and 11 to 16 soft rays; none of anterior soft dorsal-fin rays produced as filaments **11**

11a. First gill arch with 60 or more gill rakers on lower limb **Macolor**

11b. First gill arch with 20 or fewer gill rakers on lower limb **12**

12a. Upper and lower profiles of head equally rounded; eye set toward middle of head; mouth rather small, somewhat upturned; no fang-like canines at anterior ends of jaws **Pinjalo**



12b. Upper and lower profiles of head not equally rounded, upper profile evenly rounded to steeply sloped, and lower profile flattened; eye closer to upper profile of head than to lower; mouth larger, usually not upturned; some fang-like canines usually present at anterior ends of jaws **Lutjanus**

Key to the species of *Aphareus* occurring in Indian waters

Remark on key character: counts of gill rakers include rudiments, if present.

1a. First gill arch with 6 to 12 gill rakers on upper limb and 15 to 18 on lower limb (total 22 to 28); colour of body varying from steel blue to purplish brown

Aphareus furca

1b. First gill arch with 16 to 19 gill rakers on upper limb and 32 to 35 on lower limb (total 49 to 52); colour of body varying from blue-grey or mauve to

Aphareus rutilans

Key to the species of *Etelis* occurring in Indian waters

1a. Total gill rakers on first gill arch 17 to 22. ***Etelis carbunculus***

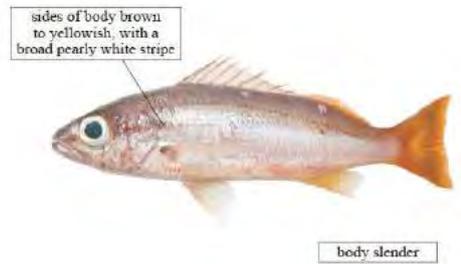
1b. Total gill rakers on first gill arch 23 to 36 upper lobe of caudal fin longer. **2**

Key to the Indo-Pacific species of *Lutjanus* (modified from FAO)

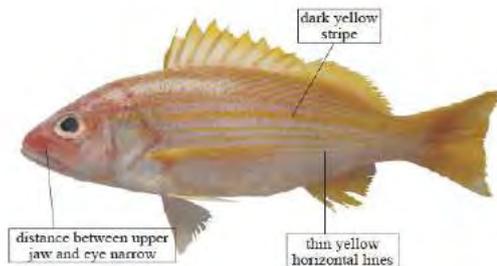
1. Pre-orbital space (distance between upper jaw and eye) very narrow, body slender, dorsal spines usually 11, soft dorsal rays 12.

Body depth 3.5 to 3.8 times in standard length; tongue without teeth; a dark band from snout to caudal fin base and two pearly spots above lateral line, soft portion of dorsal fin

L. biguttatus



Body depth 2.9 to 3.3 times in standard length; tongue with a patch of fine granular teeth; colour generally silvery-white with a broad yellow stripe along middle of side to caudal fin base and narrow yellowish lines, corresponding with longitudinal scale rows (eastern Africa to western Pacific)



Lutjanus lutjanus

3a. Yellow coloured body with a series of 4 or 5 longitudinal blue stripes on sides which become brown when preserved.

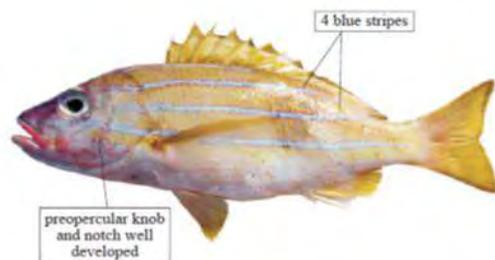
3b. Colour not as above **6**

4a. Dorsal-fin spines XI or XII ***Lutjanus bengalensis***

4b. Dorsal-fin spines X **5**

5a. Four stripes on side, with white whitish belly sometimes with thin grey lines; scale rows on cheek 5 or 6; upper pectoral-fin rays darkish

Lutjanus kasmira



5b. Five stripes on side, belly not whitish, thin lines absent; scale rows on cheek

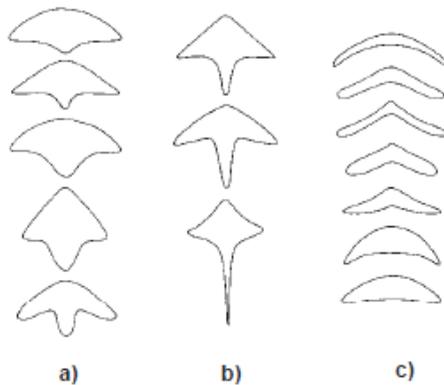
10 or 11; upper pectoral-fin rays pale ***Lutjanus quinquelineatus***

6a. Longitudinal scale rows above lateral line obliquely positioned. **7**

6b. Longitudinal scale rows above lateral line entirely horizontal or some rows rising obliquely from below middle part of dorsal fin

7a. Vomerine tooth patch triangular or diamond-shaped with a medial posterior extension **8**

7b. Vomerine tooth patch crescentic to triangular without a posterior extension . . . **11**

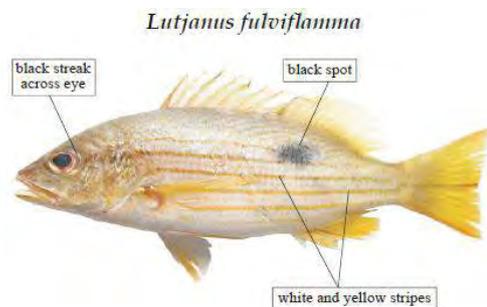


Shapes of the vomerine tooth patch

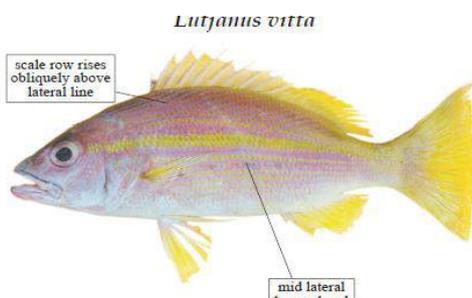
8a. Soft dorsal-fin rays usually 14; a relatively wide gap between temporal scale bands of each side; spot on upper side situated mainly above lateral line; young specimens with series of 4 to 7 broad stripes (blackish to orange or yellow-brown in life) on side, these persisting as thin stripes in adults from the western Indian Ocean ***Lutjanus russelli***

8b. Soft dorsal-fin rays usually 13; little or no gap between temporal scale bands of each side; spot on upper side situated mostly below lateral line or bisected by it, spot sometimes very elongated; young specimens without series of 4 to 7 broad dark stripes on side

Lutjanus fulviflamma



9a.



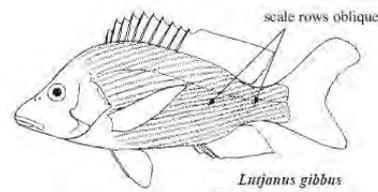
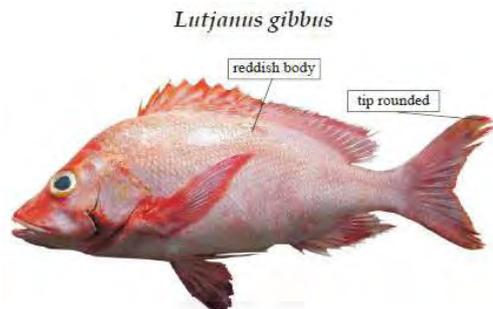
Mid-lateral stripe usually broader and darker than other stripes on side; transverse scale rows on cheek 7 to 10 ***Lutjanus vitta***

9b. Mid-lateral stripe not broader or darker than other stripes on side, yellow in life and faint or absent in preserved specimens; transverse scale rows on cheek usually 6 or 7 (occasionally 8) **12**

10a. Predorsal scales extending to mid-interorbital level; a blunt, flattened spine on upper margin of opercle, above the main centrally located spine; interorbital width 4.4 to 6.5 in head length; total gill rakers on first gill arch (including rudiments) 18 to 21 ***Lutjanus madras***

11. Total gill rakers (including rudiments) on first gill arch (including rudiments) 25 to 30 **12**

12. Dorsal fin with X spines and 13 or 14 soft rays; scale rows below lateral line ascending obliquely caudal fin distinctly forked with rounded lobes; colour deep red to grey, fins red or dark brown to blackish ***Lutjanus gibbus***



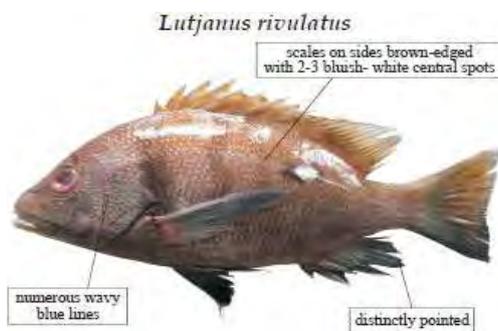
13a. Soft anal-fin rays 10; dorsal fin with XI spines and 16 rays; colour pattern consisting of 3 dark brown to red transverse bars (may be indistinct in large adults) ***Lutjanus sebae***

13b. Soft anal-fin rays 8 or 9; dorsal-fin elements variable, the fin with X or XI spines and 12 to 16 soft rays; colour not as above **14**

14a. Pre-opercular notch distinctive (moderately to well developed) **15**

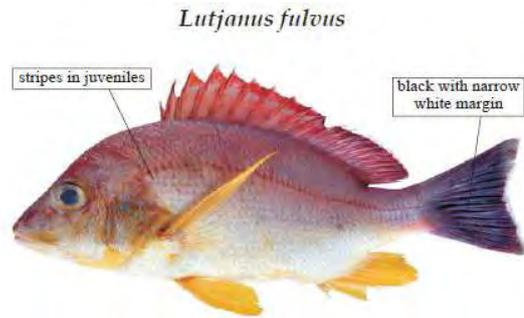
14b. Pre-opercular notch not distinct **21**

15a. Soft dorsal-fin rays 15 or 16; body relatively deep, 2.1 to 2.4 times in standard length; head usually with numerous wavy lines (bluish in life); a chalky spot often present below junction of spinous and soft parts of dorsal fin, bordered with black in juveniles, but lost with age; lipstuck in large adults ***Lutjanus rivulatus***



15b. Soft dorsal-fin rays 13 or 14; body usually more slender, 2.3 to 2.8 times in standard length; colour not as above; lips not thick in adults **16**

16a. Caudal fin and distal third of dorsal fin blackish or dusky brown with a narrow white border ***Lutjanus fulvus***

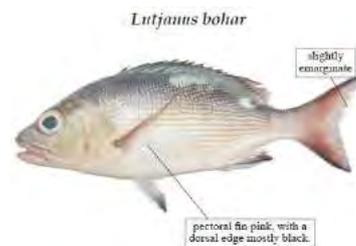
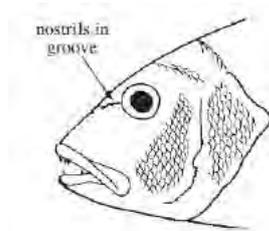


16b. Caudal fin yellow or grey basally and yellow distally without narrow white border; distal third of dorsal fin not noticeably darker than remainder of fin . . .17

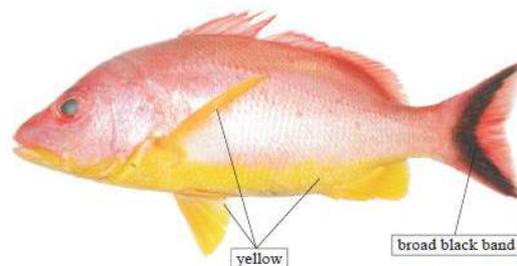
17a. Colour pattern consisting of a series of 5 dark stripes on whitish ground colour; 2 or 3 uppermost stripes crossed by dark vertical bars forming a network of light and dark squares; a large dark spot at base of caudal fin ***Lutjanus decussatus***



17b. Two whitish spots on upper back, anterior spot below last 4 dorsal-fin spines and posterior one under last 6 dorsal-fin rays and meeting that of other side across top of caudal peduncle; colour brown on upper back grading to tan or light brownish ventrally; dorsal and caudal fins dusky; outer portion of anal and pelvic fins distinctly blackish; upper third of pectoral fins dusky brown; tongue with a patch of fine granular teeth ***Lutjanus bohar***



18a. Caudal fin with a distinctive crescentic black marking, remainder of body and fins uniformly yellowish tan (yellow in life) with a silvery sheen on lower sides ***Lutjanus lunulatus***



18b. A black spot on upper side at level of lateral line below soft dorsal fin; rest of body and fins mainly pale; tongue with a patch of fine granular teeth, although sometimes absent in juveniles ***Lutjanus monostigma***

19a



Dorsal-fin spines XII; 5 - 6 yellow stripes; longitudinal rows of scales below lateral line which rise

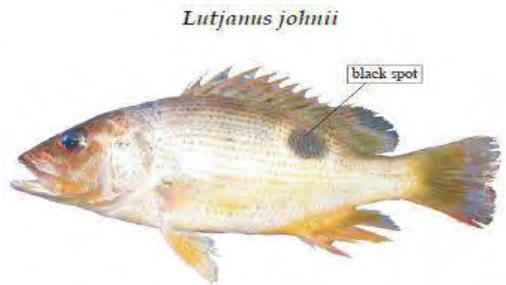
Lutjanus dodecacanthoides

19b Small mouth, length of maxilla less than distance between bases of last dorsal- and anal-fin rays some longitudinal scale rows below lateral line slanting obliquely in posterior direction toward dorsal profile; convex head profile ***Lutjanus erythropterus***



20a. Triangular vomerine tooth patch with medial posterior extension; narrow preorbital space, large prominent black spot, bisected by the lateral line below posterior part of spinous dorsal fin ***Lutjanus ehrenbergii***

21 A large black spot on upper back ground colour pale, each scale on side often with a brownish spot forming longitudinal rows on side ***Lutjanus johnii***



22 Body depth 2.5 to 2.9 times in standard length; least depth of caudal peduncle 3 to 3.5 times in head length; longitudinal scale rows on upper back parallel to lateral line anteriorly and some rows usually ascend obliquely below posterior dorsal fin spines



Lutjanus argentimaculatus

Key to genus *Macolor* species occurring in Indian waters (modified from FAO)

1a. First gill arch with 37 - 42 gill rakers on upper limb and 71 - 81 on lower limb (total 110 to 122); anal fin with III spines and 10



soft rays; long pointed pelvic fins in juveniles and short rounded pelvic fins in adults ***Macolor macularis***

Key to the species of *Paracaesio*

1a. Body dark purplish brown, with violet lines on body ***Paracaesio sordida***



3b. Caudal fin, upper part of caudal peduncle, and upper side of body to anterior end of dorsal fin yellow; rest of body mostly blue; pre-opercle almost always without scales ***Paracaesio xanthura***

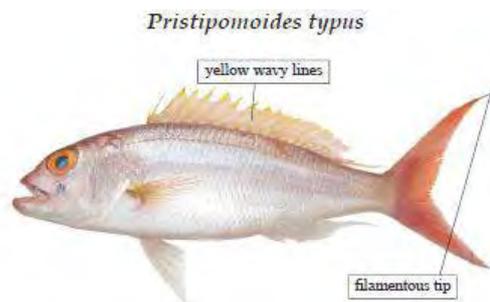
Key to the species of *Pristipomoides* occurring in Indian waters

1a. Lateral-line scales 48 to 50 **2**

1b. Lateral-line scales 57 to 74 **3**

2a. Two golden stripes bordered with blue on snout and cheek; transverse vermiculations on top of head. ***Pristipomoides multidentis***

2b. Golden stripes absent on snout and cheek; longitudinal vermiculations on top of head present ***Pristipomoides typus***

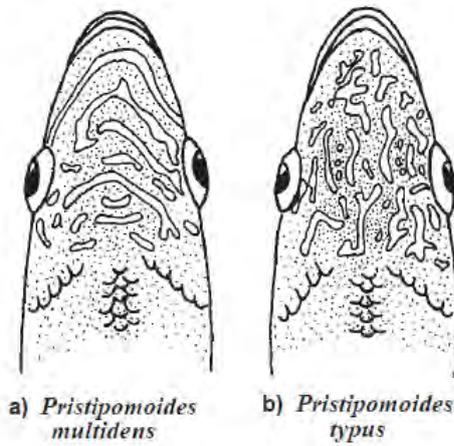


3a. Gill rakers on first gill arch 27 - 33; 67 to 74 lateral-line scales. **4**

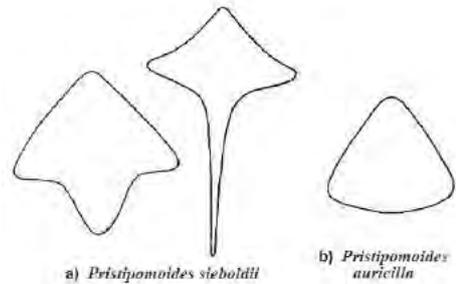
3b. Gill rakers on first gill arch 17 to 27; 57 to 67 lateral-line scales. **5**

4a. Backward prolongation in midline for the vomerine tooth patch; tongue with patch of teeth ***Pristipomoides sieboldii***

- 4b. Vomerine tooth patch triangular backward prolongation absent; teeth absent on tongue ***Pristipomoides auricilla***



Dorsal view of head



Vermiculations on head

- 5a. Lateral-line scales 63 to 67; side of body with alternating oblique red and yellow bars ***Pristipomoides zonatus***

- 5b. Total gill rakers on first gill arch 22 to 27; lateral-line scales 57 to 63; side of body without red and yellow bars; caniniform teeth at anterior ends of jaws. ***Pristipomoides filamentosus***



6

Field Identification of Rays and Some Common Flatfishes of India

Rekha J. Nair

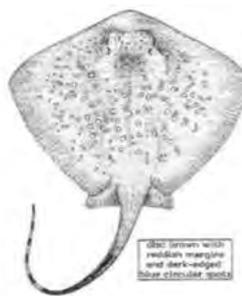
Demersal Fisheries Division

ORDER Myliobatiformes

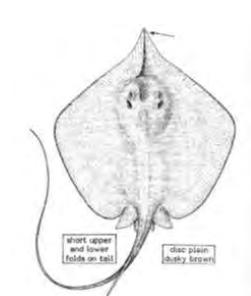
This suborder includes all of the Eagle Rays (Myliobatidae), Cownose Rays (Rhinopteridae) and the Mobulid Rays and includes about 40 species which are characterized by diamond shaped bodies and wing-like pectoral fins which they use to propel themselves through open water. Eagle Rays and Cownose Rays feed on the seabed, using their mouths to dig amongst the substrate in search of buried molluscs and crustaceans, while the mobulid rays lead a complete pelagic life. The order has 8 families under it.

Family Dasyatidae – Whip tail sting rays

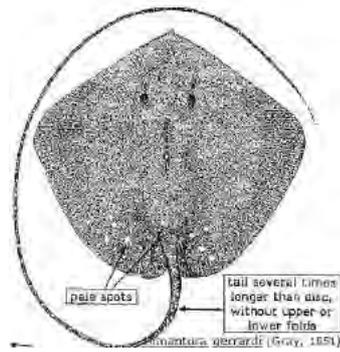
Dorsal fin totally absent or indistinct if when present. Tail long and whip-like. Most species with at least 1 long venomous spine on tail, which can cause excruciating pain to humans.



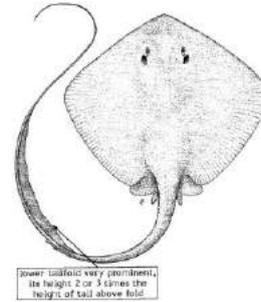
Dasyatis kuhlii



Dasyatis zugei



Himantura gerrardi

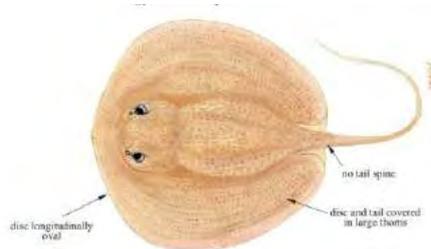


Hypolophus

Cow tail sting ray

A high lower caudal finfold present which is 2 to 3 times depth of tail but not reaching tail tip; no large thorns; 1 or 2 long stings on tail, further behind tail base.

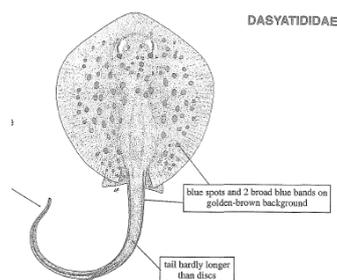
Urogymnus asperrimus – Porcupine ray -
Protected under Wild Life Act, 1972



Himantura uarnak – Honey comb sting ray

Tail with alternating black and white bands, tip mostly pale; skin folds pale at base with dark outer margin, disc with blue dots.

Taeniura lymma (Forsskål, 1775)



Taeniura meyeni Müller & Henle, 1841

Round ribbon tail ray

Black blotches on a grey background

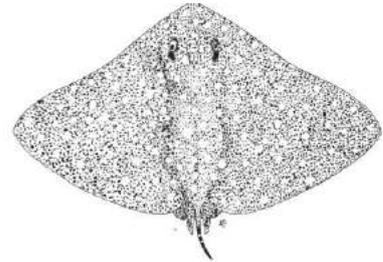
- ✓ **Family Gymnuridae** – Butterfly rays
- ☞ Disc broad, 1.5 times broader than long
- ☞ Dorsal fin and tail spines present
- ☞ Tail very slender and short (shorter than disc).



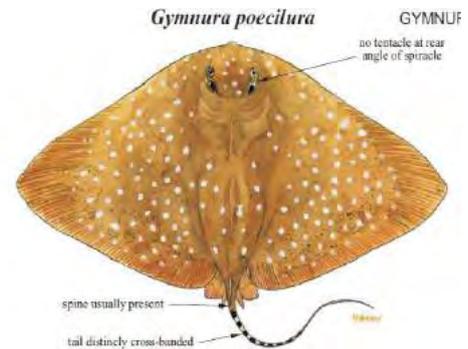
Genus: Gymnura

Gymnura micrura – Smooth butterfly ray

- ☞ Tail without serrated spines
- ☞ No tentacle on posterior margin of spiracle



Gymnura poecilura – Long tailed butterfly ray



Family Myliobatidae –Eagle rays

Aetobatus narinari - Spotted eagle ray

- ☞ Numerous white spots on black or bluish disc, white below
- ☞ Long whip like tail, with a long spine near the base, behind small dorsal fin.
- ☞ No spines on disc



Aetobatus flagellum (Bloch & Schneider, 1801)

Longheaded eagle ray



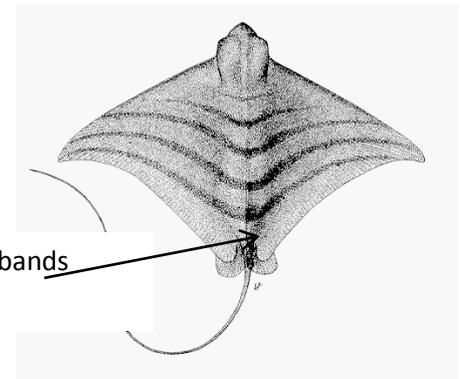
Snout pointed
Dorsal surface plain with no marks



Aetomylaeus nichofii (Bloch & Schneider, 1801)

Banded eagle ray

3 -5 greyish blue cross bands
No spine on tail



Aetomylaeus vesperilio (Bleeker 1852)

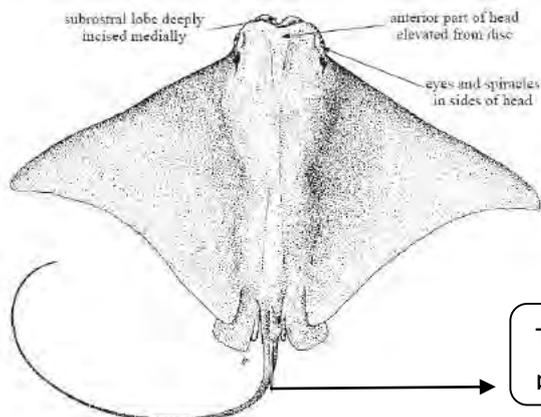
Ornate eagle ray

Ornate pattern on dorsal surface



Rhinoptera javanica - Javanese cownose ray

subrostral lobe deeply incised medially
anterior part of head elevated from disc
eyes and spiracles in sides of head



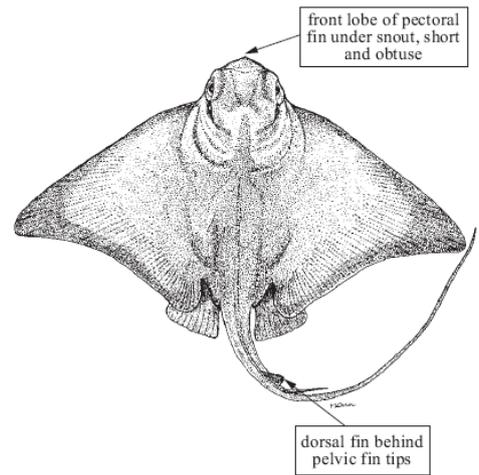
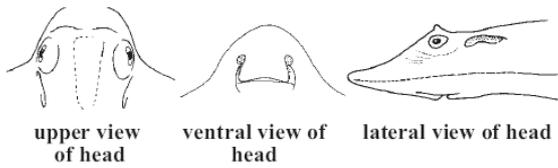
Tail spine present

***Rhinoptera adpersa* Müller & Henle 1841**

Skin rough with small spines



***Myliobatis aquila* (Linnaeus, 1758)**

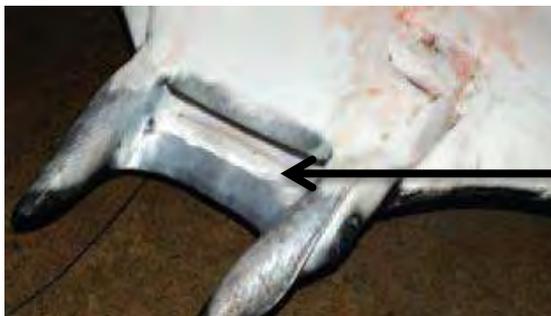


Family Mobulidae

Genus *Manta*

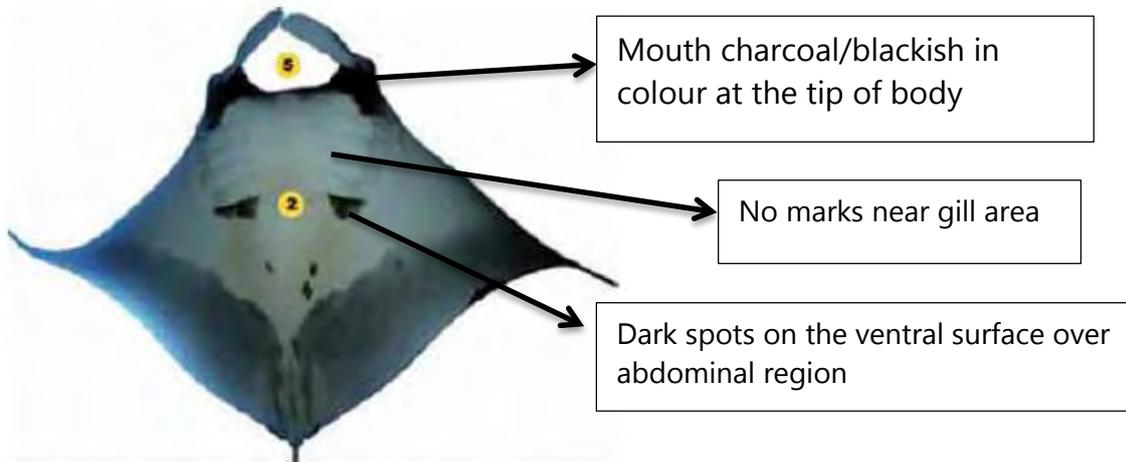


Terminal mouth - ***Manta***

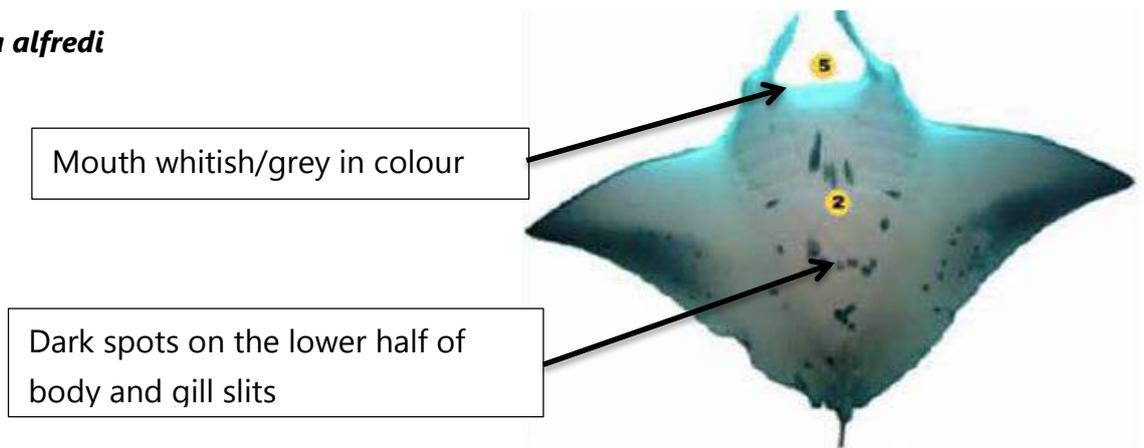


Ventral mouth - ***Mobula***

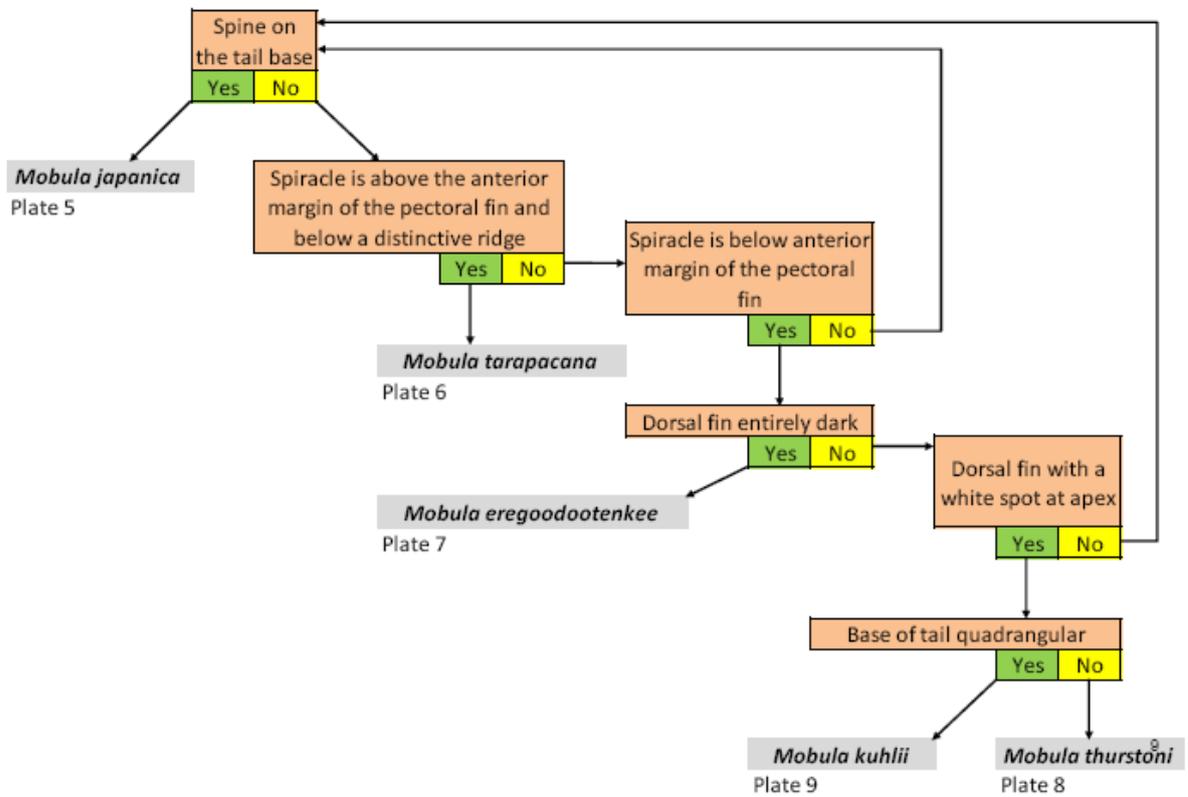
Manta birostris



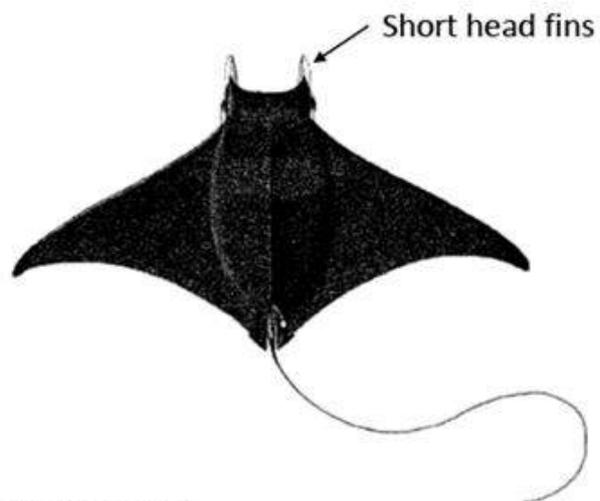
Manta alfredi



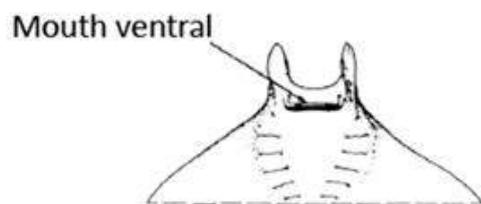
Key to the Indian Ocean species of *Mobula*



Dorsal View

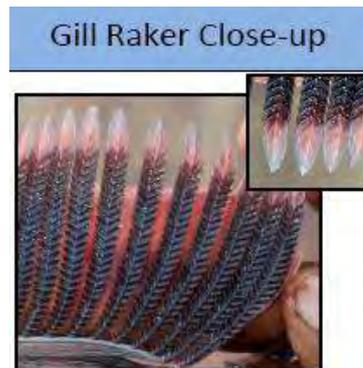


Ventral View



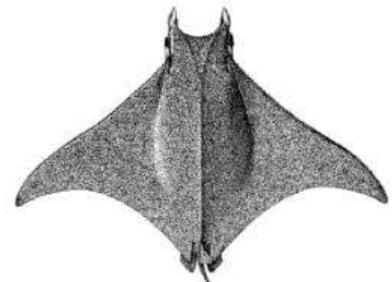
Mobula japonica –Spine tail mobula

- ☞ Spine on base of tail
- ☞ Dorsal fin white tipped
- ☞ Tail very long
- ☞ Spiracles above anterior margin of pectoral fin



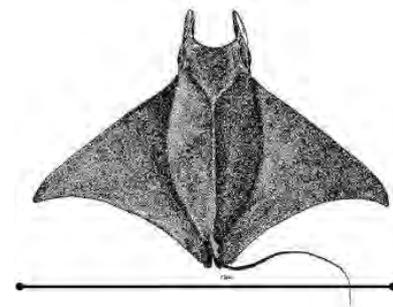
Mobula tarpacana – Chilean devil ray

- ☞ No spine on tail base
- ☞ Spiracles are elongated slit, above pectoral fin.
- ☞ Tail short
- ☞ Dorsal fin plain



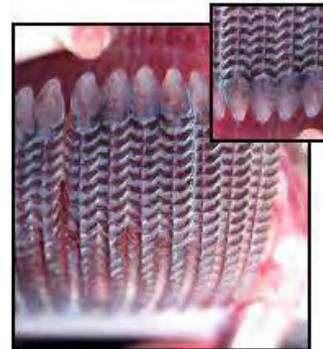
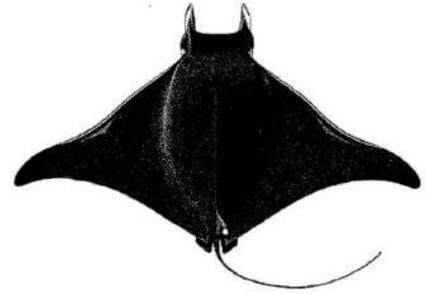
Mobula eregoodootenke

- ☞ Spine absent on tail
- ☞ Spiracle placed below anterior margin of pelvic fin
- ☞ Small subcircular spiracles
- ☞ Fully black dorsal fin



Mobula thurstoni

- ☞ No spine on tail base
- ☞ Spiracle small subcircular, placed below pectoral fin
- ☞ Dorsal fin with a white spot at apex
- ☞ Anterior margin of pectoral fin with an undulated apex
- ☞ Base of tail dorso-ventrally compressed



Field Identification of Some Common Flatfishes of India

Flatfishes represent an interesting order of marine, estuarine, and freshwater euteleostean fishes occurring in all the world's oceans. They are represented by a large number of species and genera and constitute major fisheries in some temperate and tropical areas. They are common species in most marine fish assemblages right from the poles to the tropics.

Table 1 Family wise list of valid species in Order Pleuronectiformes

Family	Subfamily	Valid species	New species in the last 10 years (2004–2013)
Psettodidae		3	0
Citharidae		6	0
Scophthalmidae		9	0
Paralichthyidae		110	2
Bothidae		166	3
Achiropsettidae		4	0
Pleuronectidae		106	4
	Poecilopsettinae	21	3
	Rhombosoleinae	20	0
	Pleuronectinae	64	1
	Paralichthodinae	1	0
Samaridae		27	7
Achiridae		36	2
Soleidae		179	39
Cynoglossidae		145	7
	Symphurinae	78	6
	Cynoglossinae	67	1

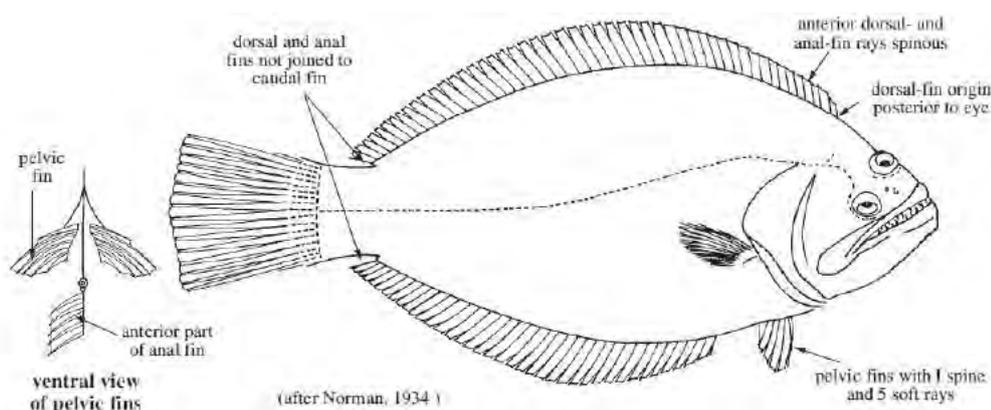
Major families in India and their characteristics:

1. Family Psettodidae:

✓ **Genus *Psettodes***

Psettodes erumei (Bloch and Schneider, 1801) – Indian halibut

- Teeth biserial on upper jaw, outer row of teeth curved inside
- Teeth on lower jaw biserial, more closely placed than that of upper jaw
- Body covered with ctenoid scales on ocular side

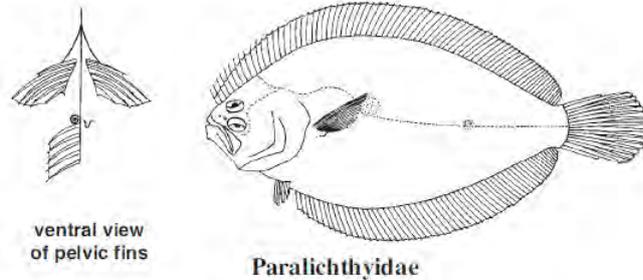


2. Family Paralichthyidae - sand flounders

The principal difference from the Bothidae is in the structure of the pelvic fin.

Genus *Pseudorhombus*

- Eyes sinistral, placed close, separated by a bony inter-orbital ridge which is naked
- Spines absent in the rostral, orbital and mandibular region
- Two nostrils present on either side, one tubular in structure with a flap and the other oval without a flap

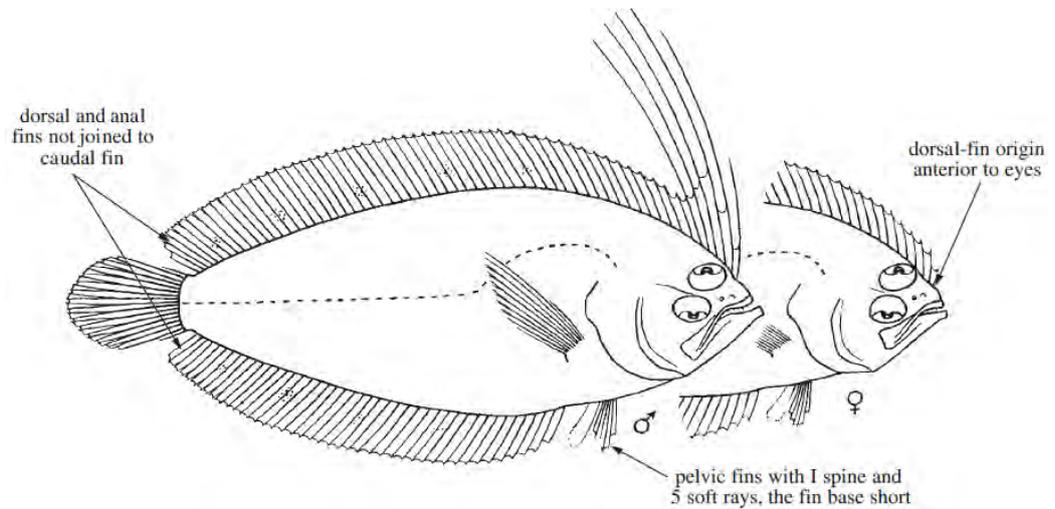


Genus *Chascanopsetta*



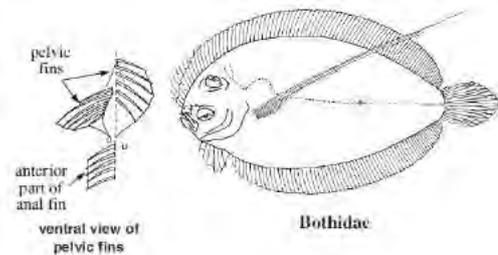
Family Citharidae: Large scale flounders

- Margin of pre opercle distinct, not covered by skin and scales
- Eyes on left side of head in some species, on right side of head in others, reversals rare
- Mouth large, arched; teeth not greatly enlarged
- Gill rakers slender with small spines
- Dorsal-fin origin on blind side above or anterior to anterior margin of upper eye; dorsal and anal fins without spines



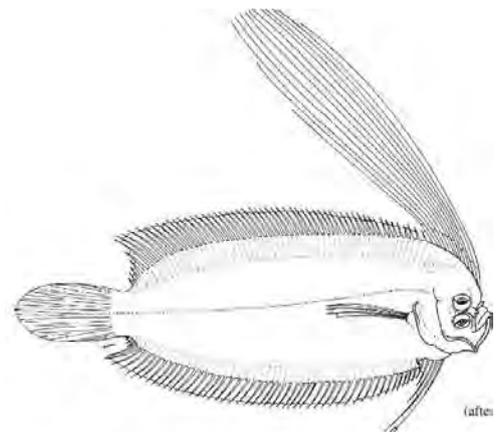
Family Bothidae:

- Bothidae: eyes on left side of head.
- Pelvic fins without spines
- Left pelvic fin with long base on mid-ventralline
- Caudal fin usually with 17 rays



Family Pleuronectidae: Right eye flounders

- Body oval-shaped or elongate
- Margin of preopercle distinct, not covered by skin and scales. Eyes on right side of head
- Mouth, teeth small. Gill rakers elongate
- Dorsal-fin origin anterior to posterior margin of upper eye; no fin spines
- Caudal fin not attached to dorsal and anal fins
- Pectoral fin on blind side smaller than fin on eyed side or missing

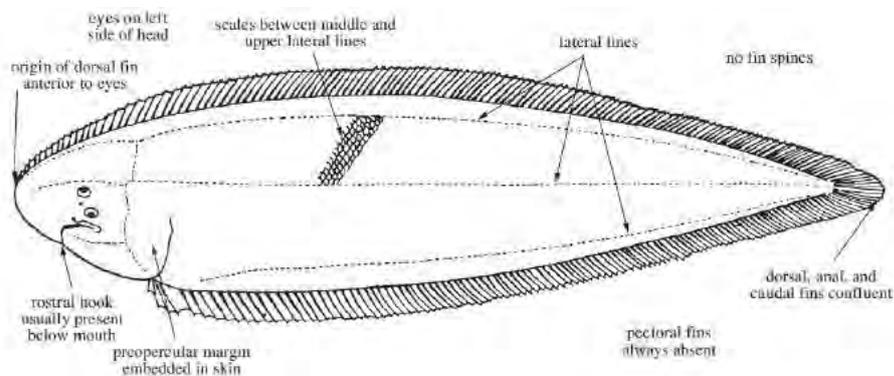


Samaris cristatus: first 10 dorsal-fin rays greatly elongate

Family Cynoglossidae:

- Eyes on left side of body

- Eyes small placed close together
- Mouth small, subterminal, asymmetrical
- Jaws moderately curved on eyed side and well on blind side; teeth minute and usually only on blind-side jaws
- Rostral hook usually present below mouth
- Posterior margin of preopercle strongly attached to opercle, without free margin and covered with skin and scales
- Spiny rays absent in dorsal, anal, and pelvic fins; dorsal fin origin on tip of head; dorsal and anal fins confluent with caudal fin; pectoral fins absent; only right pelvic fin present



Genus *Cynoglossus* and *Paraplagusia*

1. Lips on eyed side of head not fringed with labial papillae ***Cynoglossus***
2. Lips on eyed side of head distinctly fringed with labial papillae. ***Paraplagusia***

Cynoglossus puncticeps

Dorsolateral line slightly undulating; eyed side with dark blotches forming irregular cross bands; eyed-side lower jaw with low, broadly rounded fleshy ridge.



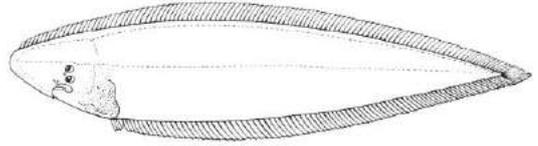
Cynoglossus macrophthalmus

- Midlateral-line scales 100 or greater
- Three lateral lines (dorsal, medial, and ventral) on eyed side of body

- One nostril on eyed side of head
- Large scales on body

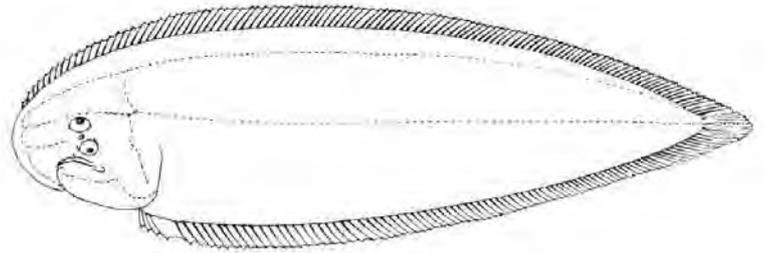
***Cynoglossus arel*:**

- Eyes placed separately
- Midlateral-line scales less (56 - 70)
- 7 to 9 scales between lateral lines
- Scales ctenoid on eyed side of body and cycloid on blind side



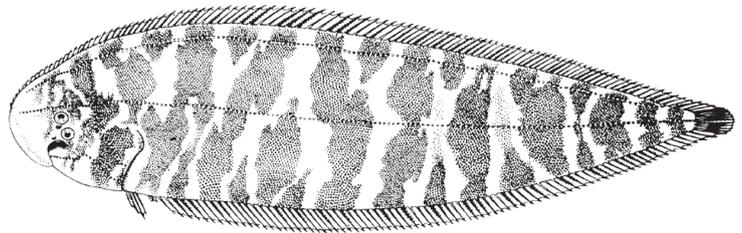
***Cynoglossus bilineatus* – Fourlined tongue sole**

- Two lateral lines on both sides of body
- Midlateral-line scales 88 to 96
- Scales ctenoid on eyed side of body; cycloid on blind side
- 13 to 16 scale rows between lateral lines on eyed side of body



***Cynoglossus puncticeps* - Speckled tongue sole**

- Eyes with a narrow interorbital space
- Rounded snout; rostral
- Hook short; angle of jaws not reaching posteriorly beyond vertical through posterior margin of lower eye, a little nearer to tip of snout than to gill opening. Dorsal-fin rays 90 to 100. Anal-fin rays 72 to 78.
- Two lateral lines on eyed side of body; lines absent on blind side. Midlateral-line scales 78 to 99.
- Scales ctenoid on both sides of body; 15 to 19 scale rows between lateral lines on eyed side.
- Body with very distinct irregular dark brown blotches, often forming irregular cross bands



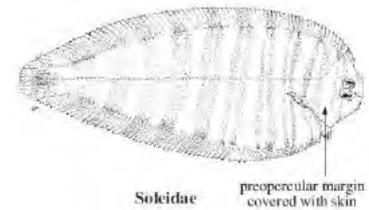
***Paraplagusia bilineata*- Doublelined tongue sole**

- Scaly interorbital space present in between eyes

- Snout rounded
- Rostral hook long and reaching posteriorly well beyond vertical through posterior margin of lower eye
- Corner of mouth not reaching beyond vertical through posterior margin of lower eye, nearer to gill opening than to tip of snout.
- Mouth frienged
- Dorsal-fin rays 105 or more. Anal-fin rays 82 - 85
- 2-3 lateral lines on eyed side, none on blind side

Family Soleidae:

- An oblong or elongated body
- Body coloured on ocular side, head round at anterior region, eyes placed close together, dextral, with or without a bony ridge in between; **snout not prolonged into a rostral hook.**
- Mouth slightly curved to strongly convex, contorted
- Teeth in villiform bands, very small or obsolete
- Pre-opercle adnate, covered by skin and scales; gill openings very narrow
- Dorsal rays not reaching upto snout tip, origin above or in front of eye
- Pectoral fins rudimentary, mostly absent on blind side; if present, fin on ocular side is longer.
- Pelvic fins symmetrical or asymmetrical; fins very small, not attached to the anal fin, sometimes absent
- Dorsal and anal fins not confluent with caudal
- Body covered with either cycloid or ctenoid scales which are sometimes modified into cutaneous flaps fringed with filaments
- Lateral line single and straight but on head may be arched or have short accessory branches

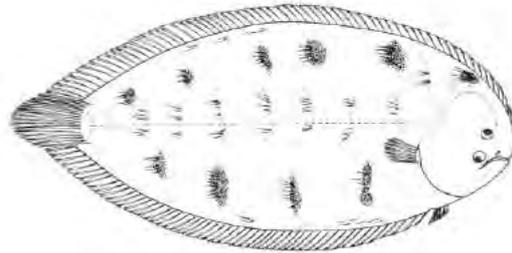


Genus *Aesopia* - Monotypic

***Brachirus orientalis*- Oriental sole**

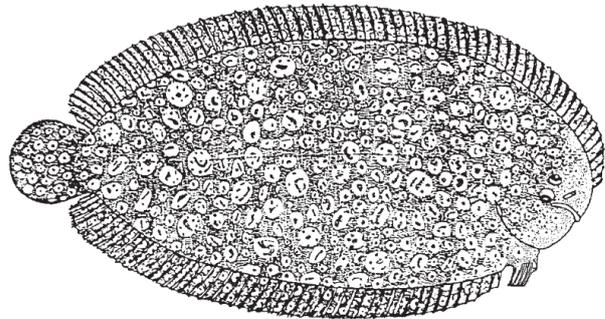
- Body oval, both contours equally arched
- Scales strongly ctenoid on eyed side, weakly ctenoid on blind side with some cycloid
- Eyed side with 3 longitudinal rows of small patches of scales with obvious black sensory filaments on scales

- Head scales of blind side modified into cutaneous sensory processes
- Eyes on right side, separated by small scaly interorbital space
- Mouth small, jaws curved, cleft reaching to vertical through middle of lower eye
- Lateral line with high rounded arch on head not directed posteriorly, ending above upper eye
- Dorsal and anal fins joined to caudal fin; pectoral fins well developed



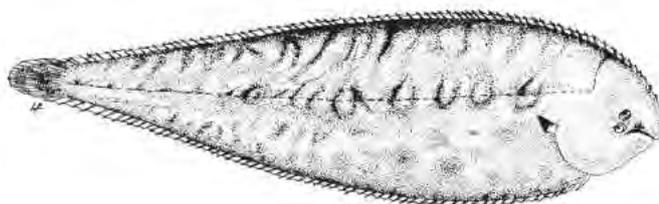
***Pardachirus pavoninus* - Peacock sole**

- Eyes dextral, separated by scaly interorbital space
- Mouth strongly curved
- Nostrils on eyed side with short tubes
- Dorsal and anal fins separate from caudal fin; pectoral fins absent; pelvic-fin bases unequal in length, the right one with an elongated base and attached posteriorly to genital papilla
- Series of toxin glands with pores along bases of dorsal- and anal-fin rays



***Synaptura commersonii*- Commerson's sole**

- Elongate, broad body anteriorly and tapering posteriorly, with ctenoid scales on eyed side, and cycloid scales on blind side
- Scales on blind side of head modified into cutaneous sensory processes.
- Eyes on right side with scaly interorbital space
- Anterior part of snout with a bony process
- Mouth curved
- Dorsal and anal fins joined to caudal fin



7

Field Identification of Threadfin breams, Silverbellies, Croakers and Bullseye

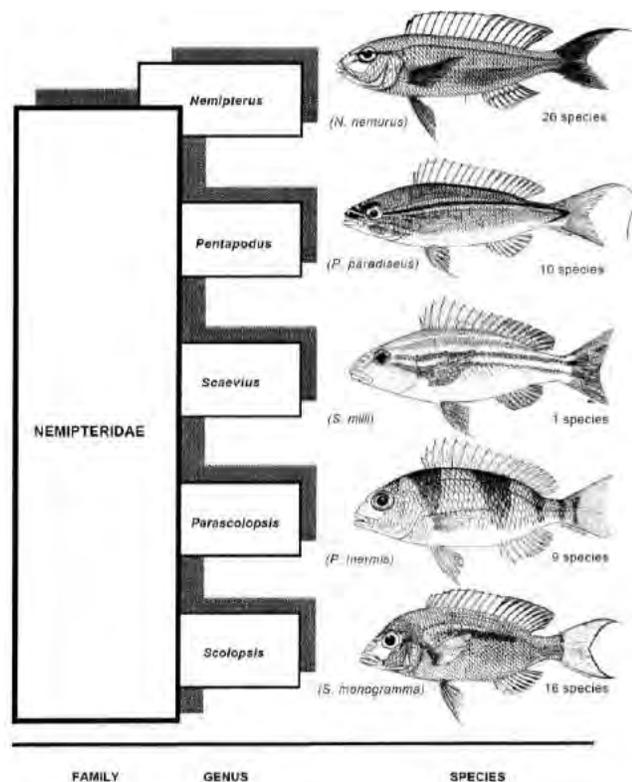
Livi Wilson and P.U. Zacharia

Demersal Fisheries Division

Introduction

Nemipterids are one among the most commercially important groups of marine fishes in the tropical Indo-West Pacific region. Family Nemipteridae comprises of five genera: Nemipterus, Parasclopsis, Pentapodus, Scaevius, and Scolopsis. Nemipterus is popularly known as “**pink perch**”, contributed to 4.78% (1,62,764 t) of the total fish landings in the country during 2015.

Classification of the genera of the family Nemipteridae

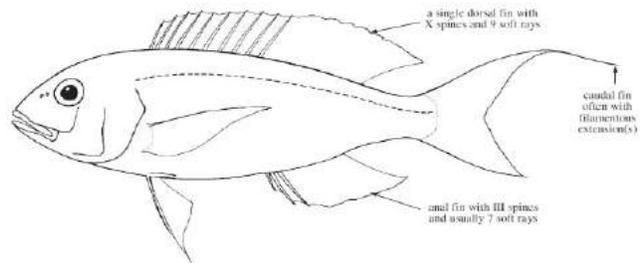


Distribution, Habitat and Biology

The family Nemipteridae is confined mainly to the tropical and subtropical Indo-West Pacific region. Species of the genus *Nemipterus* live on muddy and sandy bottoms at a depth of about 300 m, though most species occupy shallower water. Nemipterids are carnivorous fishes that feed primarily on other small fishes, cephalopods, crustaceans, and polychaetes. They are fractional spawners with protracted spawning season. Nemipterids are caught mainly by bottom trawl.

Diagnostic characters

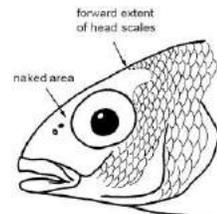
Dorsal fin single and continuous, with X spines and 9 soft rays; anal fin with III spines and 7 soft rays.



Illustrated key to Genera

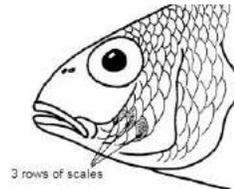
Scaevius

Scales present on top of head but not reaching to the level of eyes; temporal parts of head scaleless.



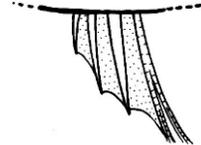
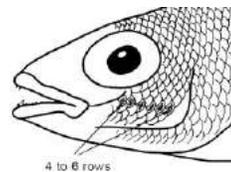
Nemipterus

Presence of 3 transverse rows of scales on preopercle.



Pentapodus

Suborbital spine frail or absent; presence of 4-6 transverse scale rows on preopercle. Second anal spine shorter in length and less stout than third.



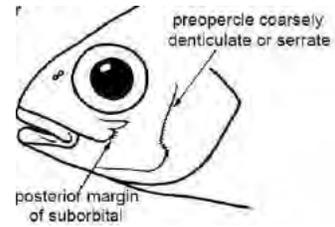
Parascolopsis



Absence of canine teeth in jaws; second anal spine generally longer and more robust than third spine.

Scolopsis

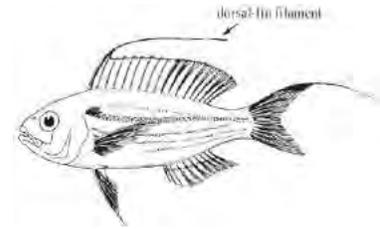
Suborbital scaleless, with a large backwardly facing spine and a series of minor serrations on its posterior margin; posterior margin of preopercle serrated; absence of canine teeth.



Key to the major species occurring in the Western Indian Ocean

Nemipterus nematophorus (Doublewhip threadfin bream)

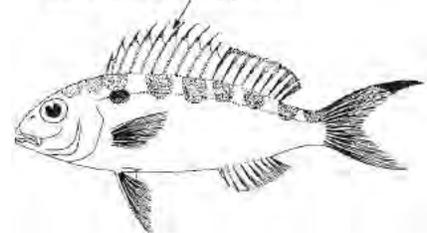
First 2 dorsal-fin spines close together, nearly attached, shaped to form a very lengthy filament.



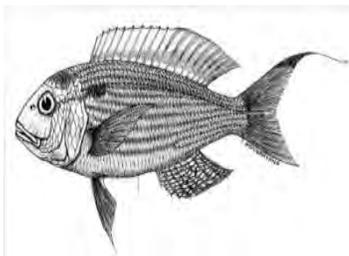
Nemipterus peronii (Notchedfin threadfin bream)

Membrane amongst dorsal-fin spines totally incised.

dorsal-fin membrane deeply incised.



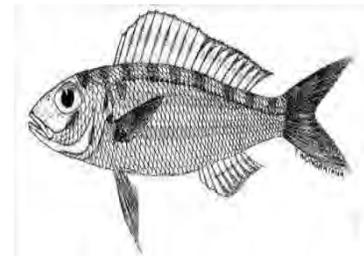
Nemipterus japonicus (Japanese threadfin bream)



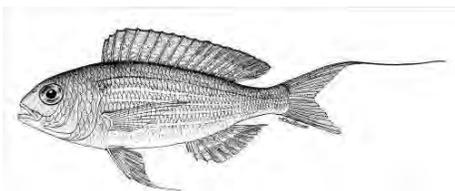
Pectoral fins reaching to or just past the level of origin of anal fin; upper part of caudal fin with moderately long filament, almost equal to head length. Pelvic fins moderately long, reaching to or just beyond anus; caudal filament yellowish; gill rakers count 14 to 17.

Nemipterus furcosus (Fork-tailed threadfin bream)

Pelvic fins short; body pink, with dusky saddle mark on back; lower margin of caudal fin with white-edge; no stripes on dorsal and anal fins.



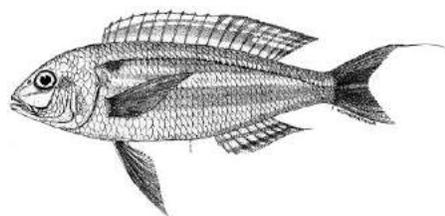
Nemipterus randalli (Randall's threadfin bream)



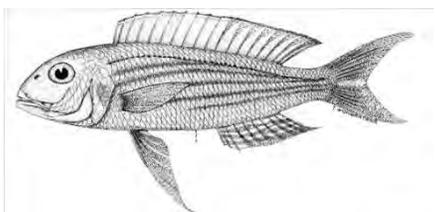
Pectoral and pelvic fins very long, reaching to or just past the origin of anal fin; caudal fin forked and having the upper lobe into moderately long reddish filament; gill rakers 12 to 15. This was

earlier misidentified as *N. mesoprion*.

Nemipterus marginatus (Red filament threadfin bream) : Snout length around equal to or slightly longer than the diameter of eye; upper lobe of caudal fin with short filament.



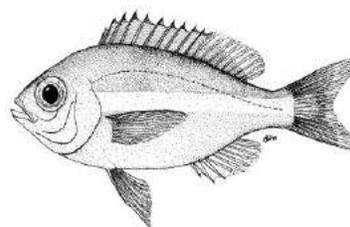
Nemipterus bipunctatus (Delagoa threadfin bream)



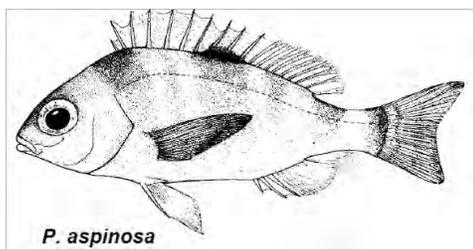
Pelvic fins extended, 0.9 to 1.3 in head length, reaching to or fairly beyond level of origin of anal fin; scale rows on body beneath lateral line upward-curved anteriorly; 3 or 4 pairs of minor recurved canines anteriorly in upper jaw; gill rakers 10 to 14.

Parascalopsis eriomma (Rosy dwarf monocle bream)

Gill rakers on first arch 17 to 19; a greyish, elongate blotch at the beginning of lateral line.



Parascalopsis aspinosa (Smooth dwarf monocle bream)



Posterior margin of suborbital even or with just a few minute spines; black blotch at base of mid of dorsal fin.

Field Identification Key for the family Leiognathidae

Introduction

Leiognathids consists of silverbellies, pony fishes and slip mouths which are locally called as 'Mullan' in Malayalam, 'Karal' in Tamil, 'Karlu' in Telugu. The fishes of the family Leiognathidae belong to an important group of finfishes in the marine fisheries of India. They contributed 2.87% (97,663 t) of the total marine fish landings in the country during 2015.

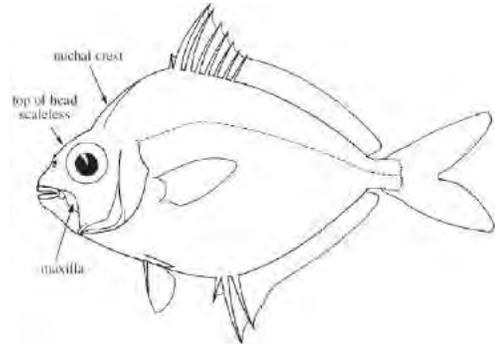
Habitat, biology, and fisheries

The fishes of the family Leiognathidae occur at depth range of 0.5 m to 160 m. They constitute a predominant catch, along the coasts of India and Sri Lanka. They feed on

copepods, phytoplankton and benthic invertebrates. They have a protracted breeding season. The silver bellies are exploited by trawl and a variety of traditional gears like shore seine, boat seine, gillnet, etc.

Diagnostic characters

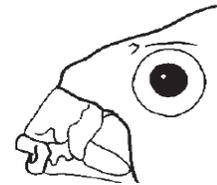
Body moderately to distinctly compressed laterally, maxilla covered under the preorbital. A well-built nuchal crest or spine; mouth highly protrusible; a single dorsal fin with VIII (rarely VII or IX) spines; body covered with small, cycloid (smooth) scales but top of head scaleless.



Key to the major species occurring in the Western Indian Ocean

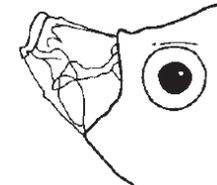
Leiognathus

Absence of caniniform teeth; mouth straight, pointing forward or downward when protracted.



Secutor

Oblique mouth, pointing upward once protracted.



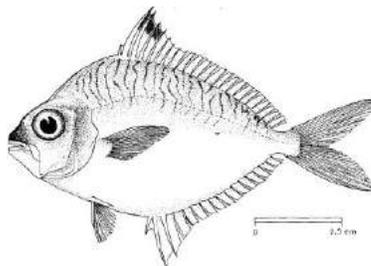
Gazza

Presence of caniniform teeth; mouth pointing forward once protracted.

Genus *Leiognathus* is subdivided into seven different genera: *Aurigequula*, *Equulites*, *Eubleekeria*, *Leiognathus*, *Karalla*, *Nuquequula*, and *Photopectoralis*.



***Eubleekeria splendens* (*Leiognathus splendens*)**



Splendid ponyfish

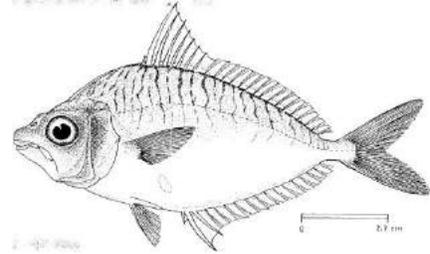
Short snout (shorter than eye diameter) besides blunt; mouth pointing slightly downward once protracted; head scaleless, but presence of prominent scales on breast; grey

wavy vertical lines above lateral line in adults, spinous part of dorsal fin usually has a black spot.

Karalla dussumieri (*Leiognathus dussumieri*)

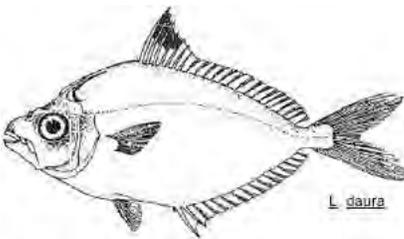
Dussumier's ponyfish

Pointed snout, slightly extended than eye diameter; mouth pointing downward once protracted. Head scaleless, but presence of conspicuous scales on breast. Body extra slender and certainly not a black blotch on dorsal fin.



Karalla daura (*Leiognathus daura*)

Goldstripe ponyfish

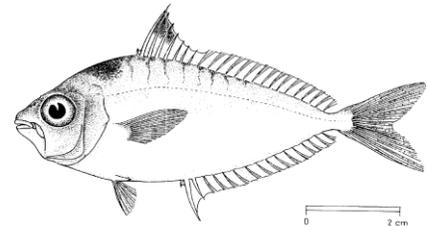


Body more often oval, dorsal and ventral profiles more or less consistently curved; a broad yellow band along lateral line; not any wavy vertical lines above lateral line; dark black blotch on spinous portion of dorsal fin.

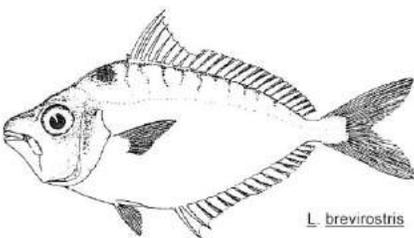
Nuchequula blochii (*Leiognathus blochii*)

Two blotch ponyfish

Pointed snout; unequal vertical lines extending down to about lateral line; a brown blotch on nape; tip of snout, head and ventral half of body with fine black dots; underside of pectoral fin base have black dots. The dorsal fin membrane from about half its height to tips of second to fifth spines black.



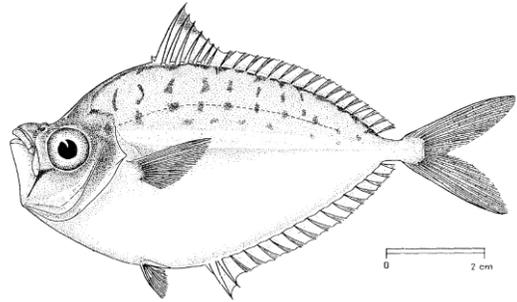
Leiognathus brevirostris (Shortnose ponyfish)



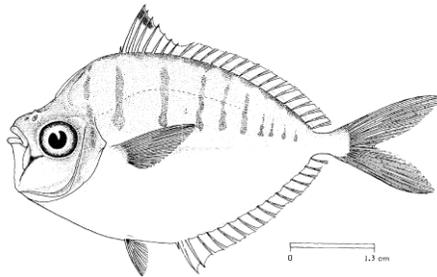
Nape with a dark blotch; grey dots on spinous dorsal fin membrane; a noticeable diffuse golden yellow patch on abdomen about middle between origin of ventrals and anal. Breast scaleless.

Secutor insidiator (Pugnose ponyfish)

Head intensely curved in above eye; pointed snout; mouth pointing upward once protracted. Lateral line reaching backward nearly to below end of dorsal fin. Cheek scaleless.



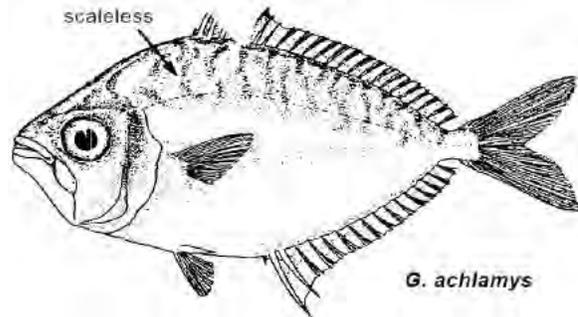
Secutor ruconius (Deep pugnose ponyfish)



Deeper body; lateral line extending to below about middle of soft portion of dorsal fin; presence of scales on cheek.

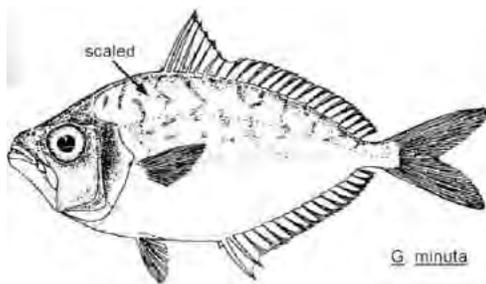
Gazza minuta (Toothpony)

Mouth pointing forward once protracted, presence of distinct caniniform teeth in both jaws. Head scaleless, nonetheless scales casing all of body except for breast ahead of a line from base of pectoral fin to origin of anal fin.



Gazza achlamys (Naked toothpony)

Deeper body; absence of scales anterior to a line from origin of soft dorsal to behind pectoral fin bases and then to origin of anal fin.



Field Identification Key for the family Sciaenidae

Introduction

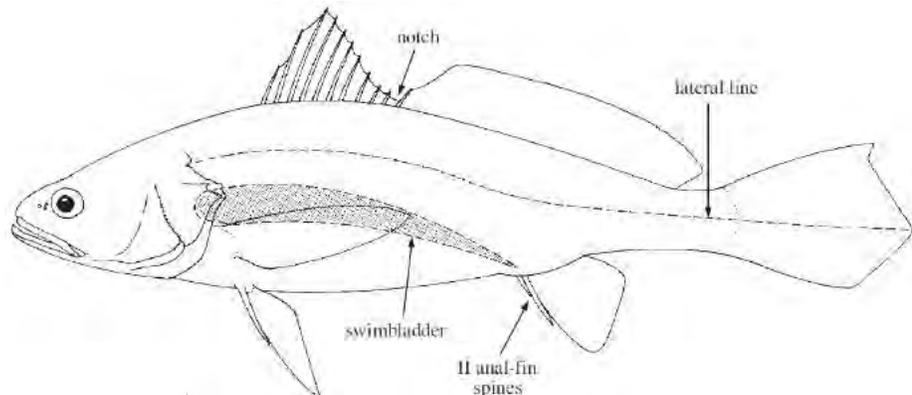
Sciaenid fishes are one of the most important constituents of marine fishes in India. It forms about 4.56% (1,55,383 t) of the total marine fish landings during the year 2015. They are commonly called as drums or croakers in reference to the repetitive throbbing or drumming sounds they make.

Habitat, biology, and fisheries

Predominantly inhabit coastal waters on continental shelves, but also occur in estuaries and rivers, during breeding seasons and when juvenile are young. Croakers are mostly demersal fishes, forming larger aggregations during spawning season. Croakers feed on small crustaceans, fishes and benthic organisms. They are exploited by bottom trawlers and bottom set gill netters.

Diagnostic characters

Moderately elongate to moderately compressed; presence of well developed canines (more than twice as large as other teeth) at front of one or both jaws; absence of teeth in vomer and palatine; dorsal fin



continuous, with deep notch between anterior (spinous) and posterior (soft) portions; anterior portion with VIII to X slender spines (usually X), and posterior portion with I spine and 21 to 44 soft rays; anal fin with II spines and 6 to 12 soft rays. Lateral-line scales covering to hind boundary of caudal fin.

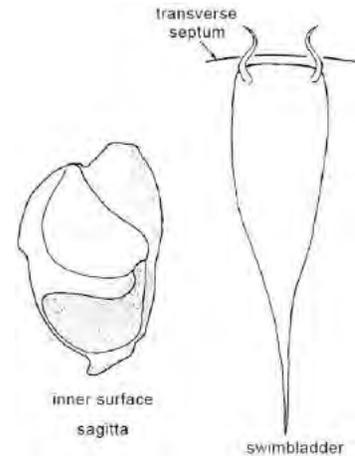
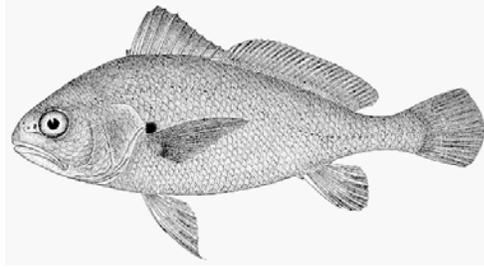
Identification note

Correct identification of genera of this family is possible only by the examination of swimbladder and the otoliths.

Key to the major species of Sciaenidae occurring in the Western Indian Ocean

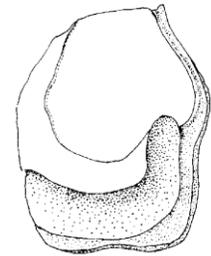
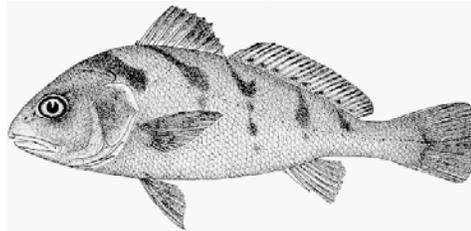
Kathala axillaris (Kathala croaker)

Carrot-shaped swimbladder; black blotch on pectoral fin axil; caudal fin rhomboid; gillraker count 20 to 23 and a dissimilar form of swimbladder.



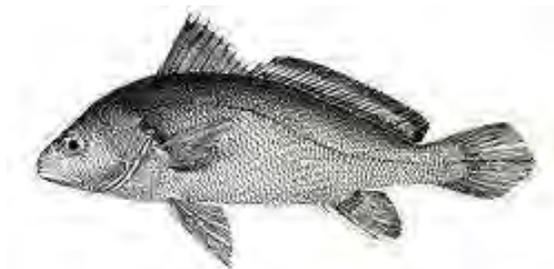
Nibea maculata (Blotched croaker)

Tadpole shaped impression on sagitta (large earstone); a typical colour pattern of 5 dark bars extending obliquely from the back to the lower part of flanks and a sixth dark blotch on top of caudal peduncle.



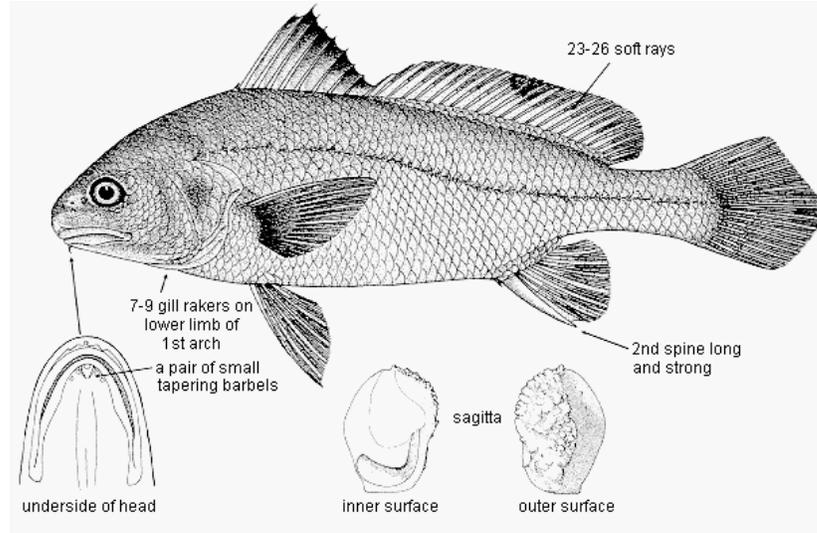
Nibea soldado (Soldier croaker)

Carrot-shaped swim bladder, sharply constricted posteriorly to its tube-shaped end, with about 18 to 22 pairs of appendages; soft dorsal fin rays 28 to 31; no barbels on chin.



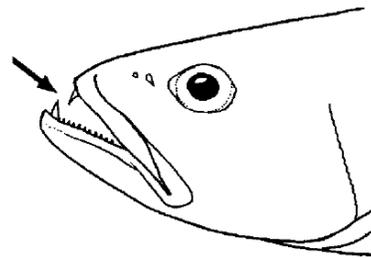
Nibea albida (Two-bearded croaker)

A pair of small tapering barbels on chin; 23 to 26 dorsal soft rays; spinous portion of dorsal fin black.



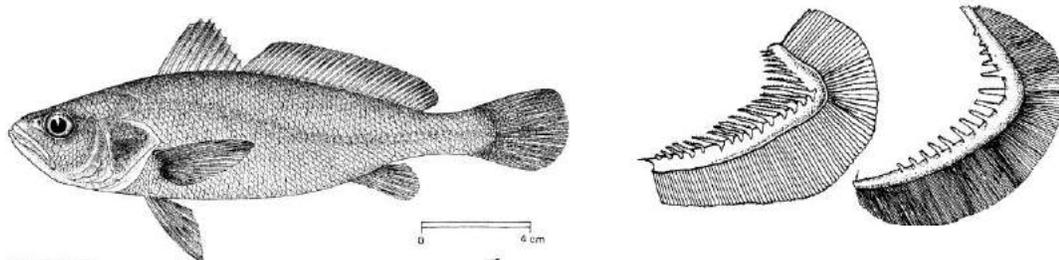
Otolithes cuvieri (Lesser tigertooth croaker)

The body depth $3\frac{1}{4}$ to $4\frac{1}{2}$ times in standard length. 1 or 2 pairs of robust canines in upper jaw and 1 pair at tip of lower jaw; gillrakers on lower limb of first arch 12 to 17; Carrot-shaped swimbladder, with about 28 pairs of arborescent appendages.

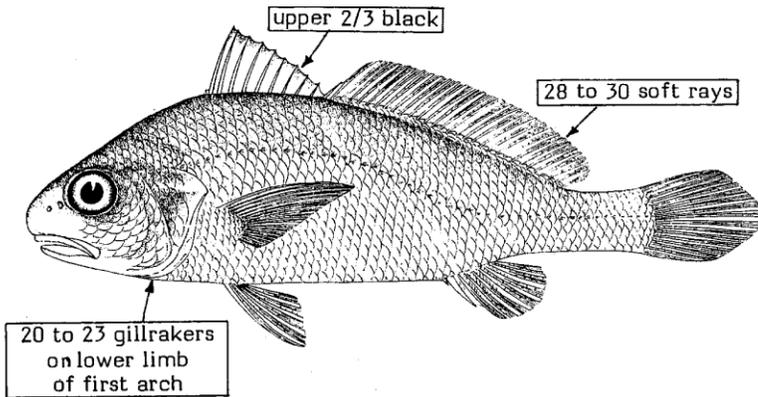


Otolithes ruber (Tigertooth croaker)

The body depth 4 or 5 times in standard length; gillraker count 8 to 11.

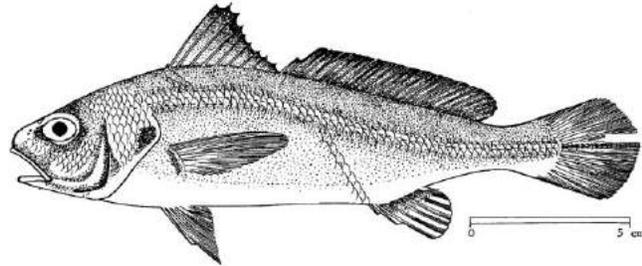


Johnius glaucus (Pale spotfin croaker)

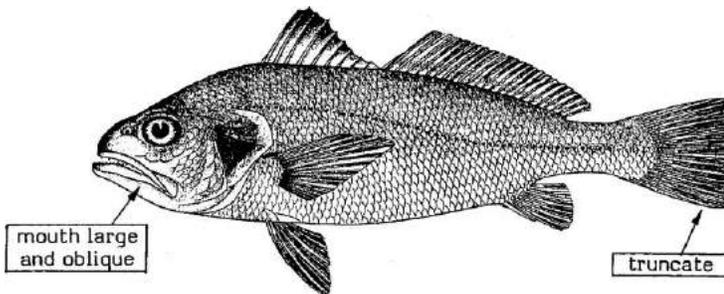


Johnius carutta (Karut croaker)

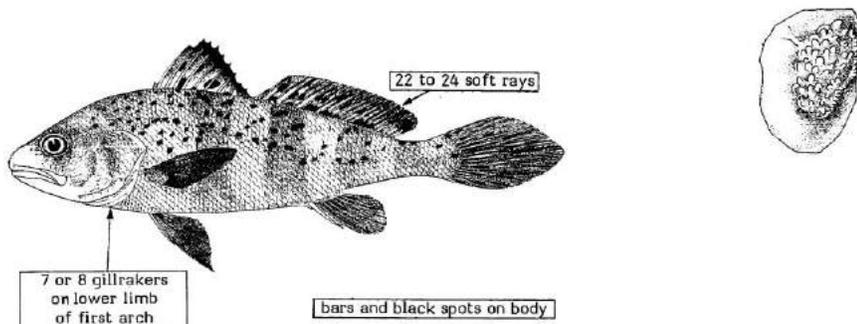
A small species with a rounded snout; Dorsal fin with 9 to 10 spines, trailed by a deep notch, second part of the fin with 1 spine and 25 to 28 soft rays; Teeth distinguished into large and small in upper jaw only.



Pennahia macrophthalmus (Bigeye croaker)



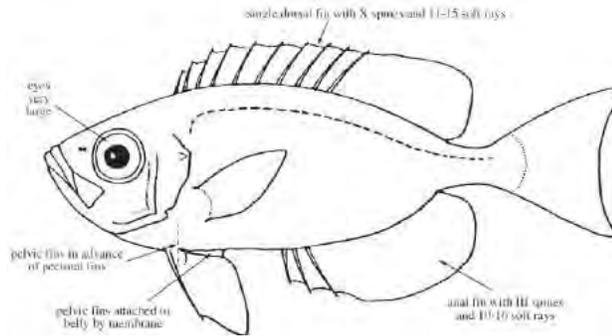
Protonibea diacanthus (Spotted croaker)



Field Identification Key for the family Priacanthidae (Big Eyes)

Diagnostic characters

Body deep with extremely large eyes and upturned mouth. Pelvic fins with 1 spine and 5 soft rays, broadly attached to belly by membrane and positioned in advance of pectoral fins.

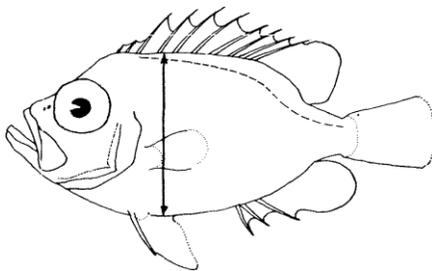


Habitat, biology and fisheries

Epibenthic fishes occurring near coral reefs but at times a depth range of 5 to 400 m; most active nocturnally; feed primarily on crustaceans, small cephalopods, polychaetes, and small fishes.

Key to genera

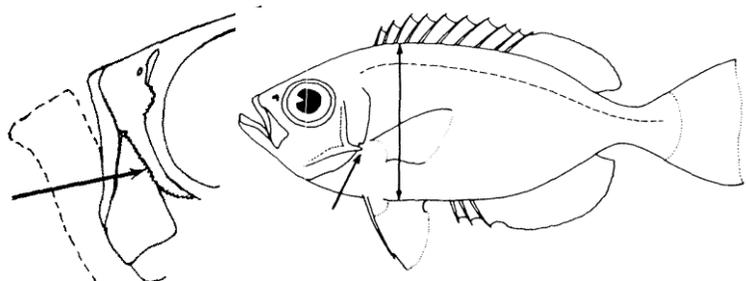
Pristigenys



Rounded spinous part of dorsal fin, with posterior spines shorter than the middle ones; lateral line scales 32 to 50; anal soft rays 9 to 11; body very deep in young (less than 10 cm TL), the depth about 1.7 to 1.9 times in standard length (2.2 times in large adults).

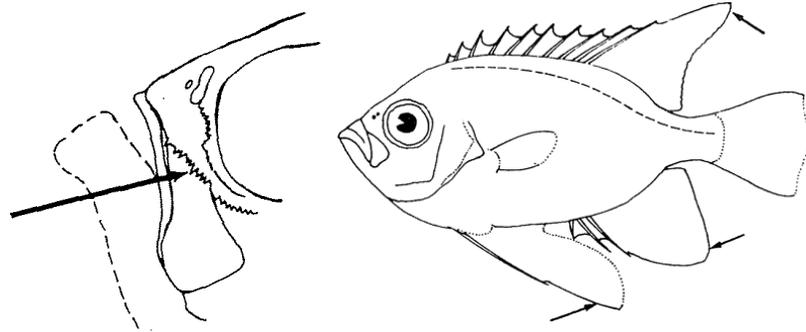
Priacanthus

Denticles on prominent edge of lachrymal (bone before eye); pelvic fins less than, or about equal to head length.



Cookeolus

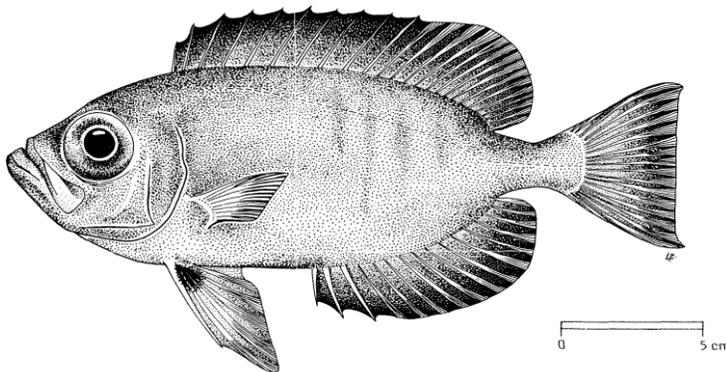
Upper 10 or so denticles of the lachrymal bone distended to spinous parts, protruding over maxilla; pelvic fins very long, 1.4 (young) to 1.1 (adults) times longer than head.



Key to the major species occurring in the Western Indian Ocean

Priacanthus hamrur (Moontail bullseye)

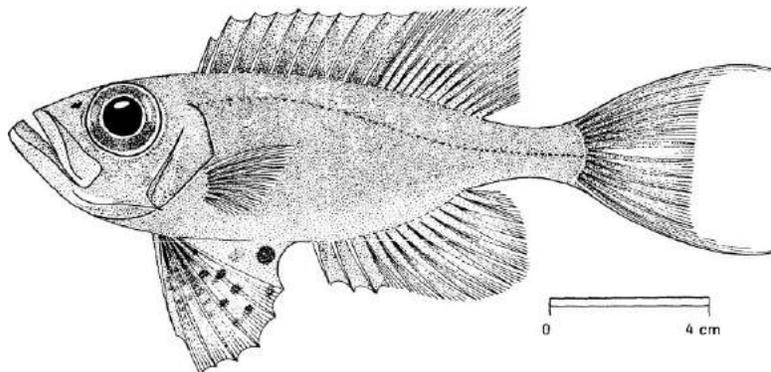
Presence of scales on the posterior portion of preopercle; soft portions of dorsal and anal fins rounded, each with 13 to 15 rays; pelvic fins shorter than head contained about 1.2 to 1.3 times therein, and fused to body by a membrane; caudal fin emarginate, fetching crescentic with age. Scales small, ctenoid (rough to touch), 73 to 93 in lateral line; a black basal spot on the pelvic fin bases.



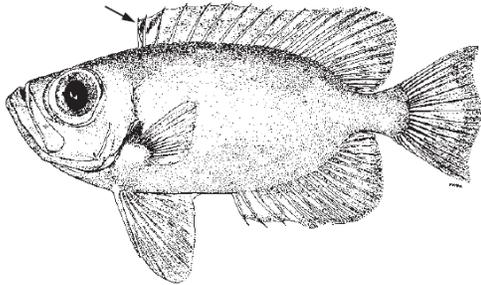
basal spot on the pelvic fin bases.

Priacanthus tayenus (Purple-spotted bigeye)

Well-built preopercular spine in adults; soft dorsal and anal fins angulate, having 11 or 12 and 12 or 13 rays, respectively; lunate caudal fin in large adults; pelvic fins with numerous dusky spots.



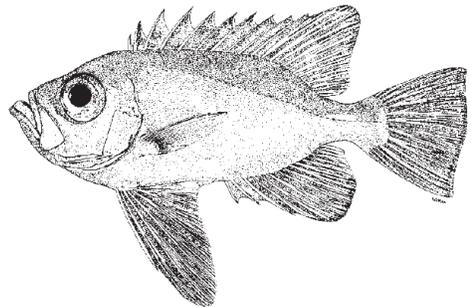
Priacanthus sagittarius (Arrow bulleye)



First 2 spinous dorsal-fin membranes having a black blotch; length of second dorsal-fin spine about twofold in length of tenth spine; scales in lateral series 67 to 74.

Cookeolus japonicas (Longfinned bullseye)

Dorsal spines: 10; dorsal soft rays: 12-14; anal spines: 3; anal soft rays: 12-14; last (10th) dorsal spine double the length of the second.



8

Basic Shellfish Features

Vivekanand Bharti

Fishery Resources Assessment Division

The shellfish includes two highly diversified phyla *i.e.* phylum Arthropoda and phylum Mollusca. These two groups are named as shellfishes because of the presence of exoskeleton made of chitin in arthropods and shells made of calcium in molluscs. These two major phyla are invertebrates. Phylum Arthropoda includes spiders, scorpions, ticks, mites, crustaceans, millipedes, centipedes and insects. The economically important groups of two phyla include lobsters, shrimps, crabs, clam, mussel, oysters, chank, squid and cuttlefish.

Crustaceans

Body of crustacean is divisible into head, thorax and abdomen. It has jointed appendages. These appendages get specialized for walking, swimming and reproduction. The appendages around the mouth get modified for different methods of feeding. It comes under Class - Crustacea.

Shrimp

Shrimp head is fused with the chest called the cephalothorax. This section consists of 13 sections. 8 segment on the chest and 5 segments on the head.

Body and the abdomen consists of 6 segments; each segment has a pair of swimming feet are also segmented.

The head protected by a shell called carapace. The front of the carapace tapered and curved, which is called rostrum. There are serrations at rostrum known as teeth. If serrations are present at the top of the rostrum it is called dorsal teeth, while teeth are present at ventral side of rostrum it is called ventral teeth. Another section present in the head includes: a pair of compound eyes, mouth with strong jaws (mandibles), a pair of large antennae, a pair of fins - head (scaphocerite), a pair of jaws auxiliaries (maxilliped), and 5 pairs of feet road (pereopod). In some shrimp, the propodus is prolonged beyond its articulation with dactylus and it looks like a chela or pincer. Abdomen enclosed by a 6 segment of one another connected by a thin membrane. There are five pairs of swimming legs attached to the first segment to

fifth segment, while the sixth segment swimming legs changes its form into a tail fan (Uropod). In some male shrimps, endopods of first pair of pleopods form petasma.

Functions of petasma is transferring spermatophores into thelycum of female. Above tail fan, there is a tail that tapers at the edges called the telson.

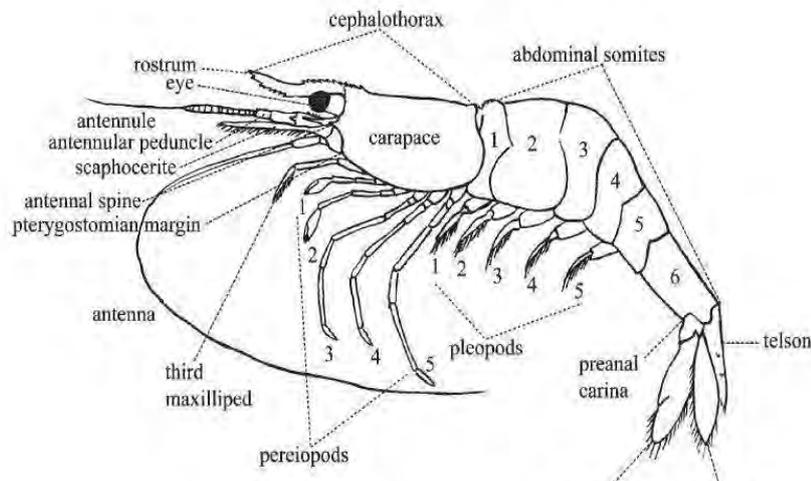


Figure 1. Morphology of shrimp

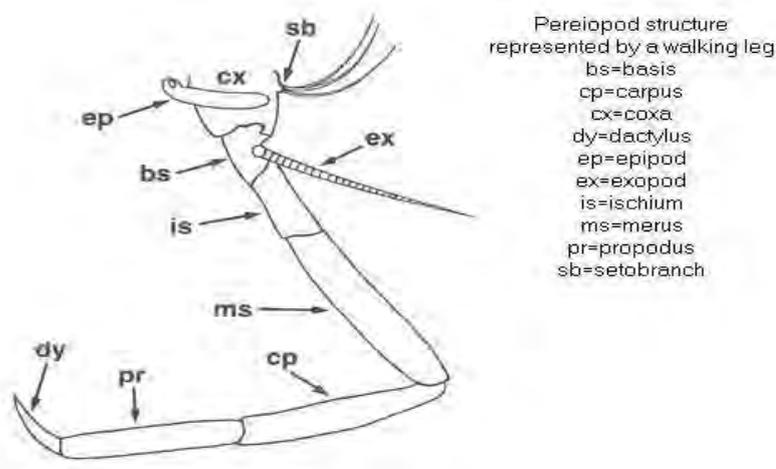


Figure 2. Morphology of pereopods in shrimp

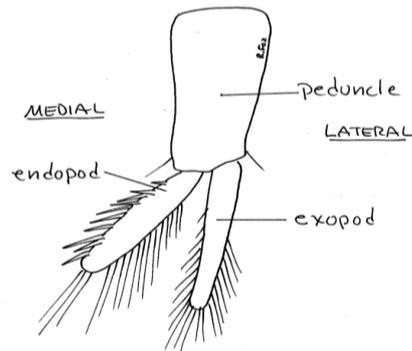


Figure 3. Morphology of pleopods in shrimp

CRAB

The axes and orientation, abdomen, carapace and limb structures are used to describe major morphological features as well as these characteristics are often used to distinguish among species.

Axes and Orientation

Axes and Orientation may be following:

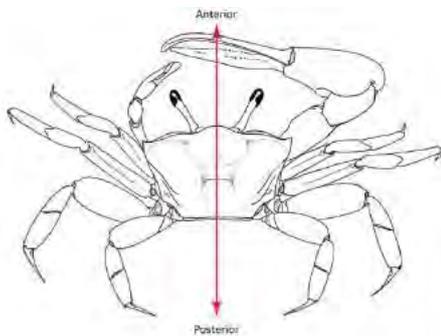


Figure 4. Front to-back

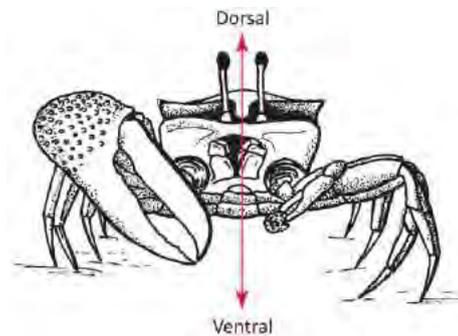


Figure 5. Top-to-bottom

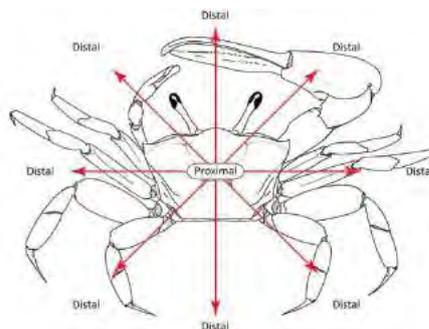


Figure 6.Center-to-exterior

Abdomen

In true crabs, the abdomen is normally wrapped under the body and pressed against the thorax. The width of the abdomen generally varies quite a bit, between male and female crabs. In males, the abdomen is relatively narrow. In females, the abdomen is substantially wider and round, taking up most of the ventral surface of the crab. The sex organs (gonopods and gonopores) are located on the hidden side of the abdomen, which can be moved away from the body during mating.

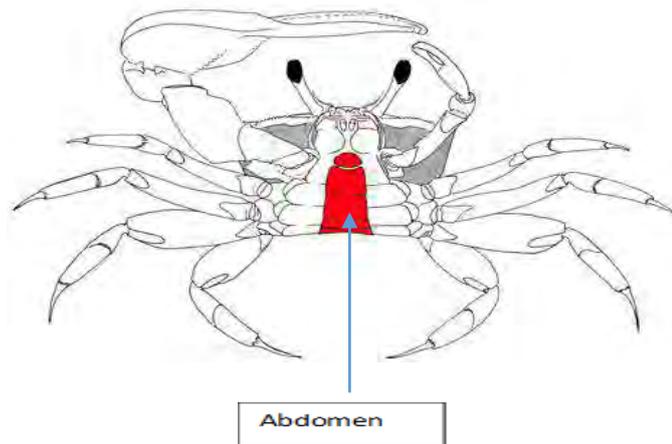


Figure 7. Abdomen

Limbs

Crabs have ten limbs. The first two limbs at the front of the crab with the claws are known as chelipeds; the other eight are walking legs (ambulatories).

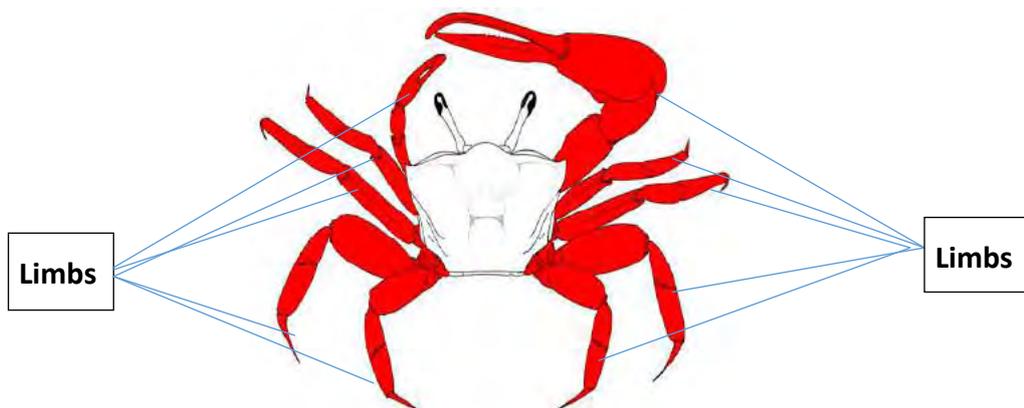


Figure 8. Limbs

Lobster

The body of a lobster consists of two recognizable parts: the cephalothorax with its appendages. The abdomen of lobster consists its appendages.

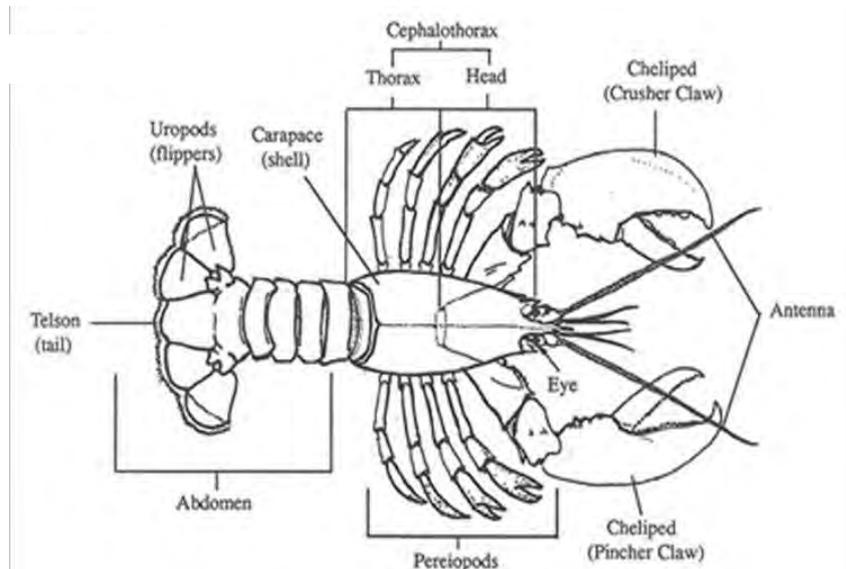


Figure 9. Dorsal view

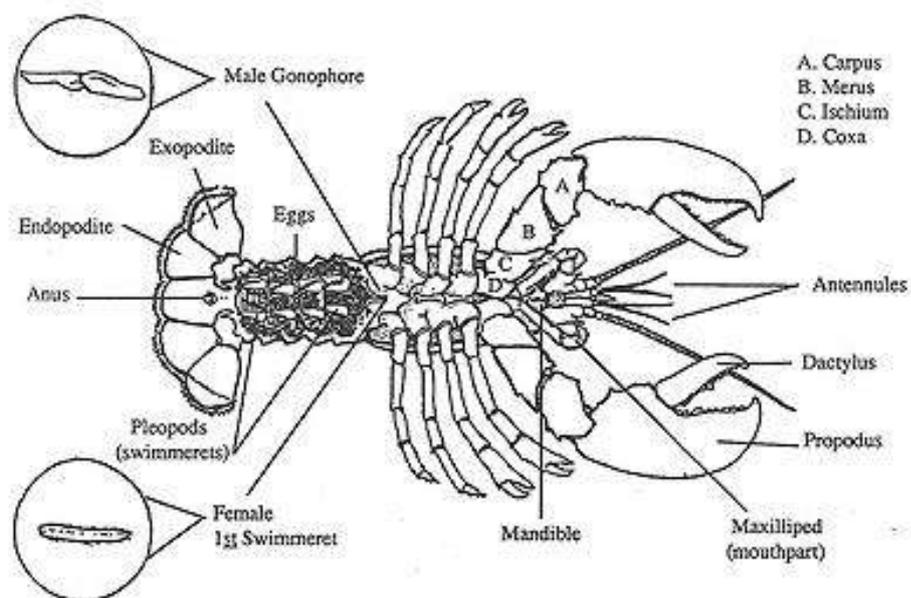


Figure 10. Ventral view

Mollusc

All organisms of mollusc belong to Phylum Mollusca. A great variety of organism are available in marine waters. This phylum can be segregated into seven classes: Aplacophora, Monoplacophora, Polyplacophora, Bivalvia, Gastropoda, Cephalopoda, and Scaphopoda. But, commercially important molluscan fisheries come under mainly in three class such as Bivalvia, Gastropoda and Cephalopoda.

Bivalvia

Bivalvia is also referred as Lamellibranchiata and Pelecypoda. Organism of bivalvia has shells in two halves. It has adductor muscle for opening and closing the shell. Bivalvia includes the clams, oysters, cockles, mussels and scallops.



Figure 11. Bivalvia

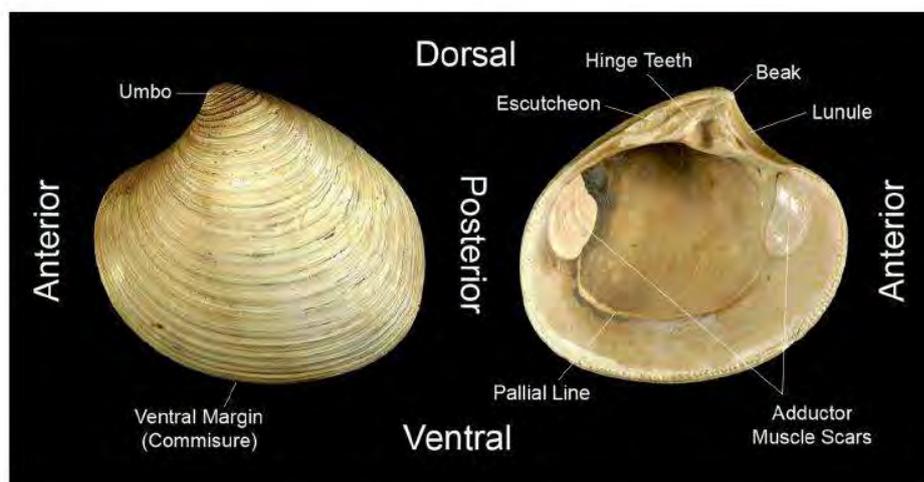


Figure 12. Different views

Gastropoda

Gastropoda is also known as univalves. They have coiled shell. They can live in the ocean, fresh waters, and land.



Figure 13. Gastropods

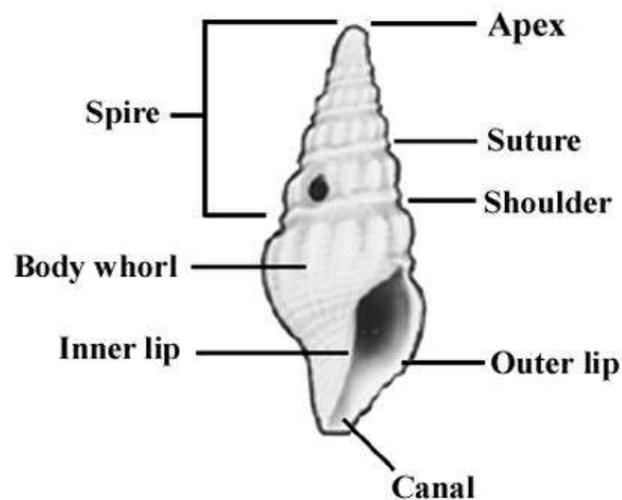


Figure 14. Parts of gastropods

Cephalopod

Cephalopod consist of head, muscular foot, visceral mass and mantle. Mantle is a sheet of tissue that covers the body and secretes a calcareous shell. These exclusively marine animals are characterized by bilateral body symmetry. Octopus, squid and cuttlefish are commercially important organisms in this class.

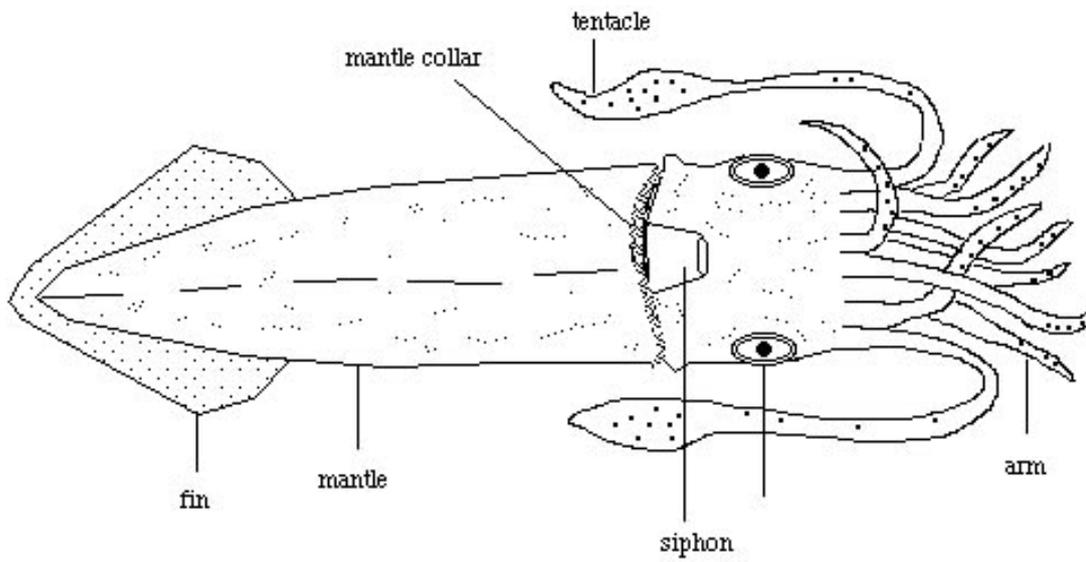


Figure 15. Parts of Cephalopod

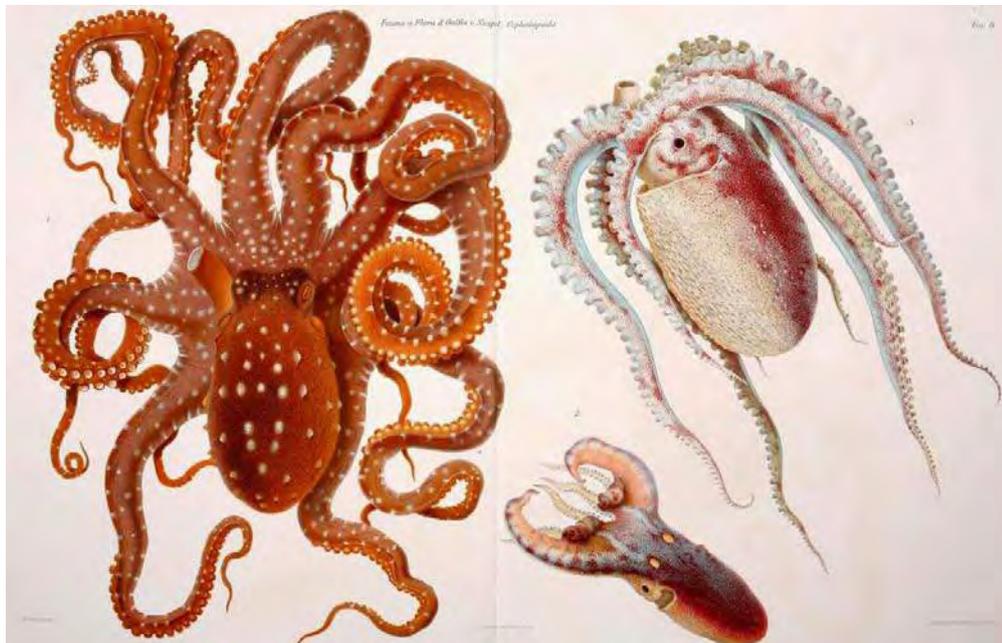


Figure 16. Octopus



Figure 17. Squid



Figure 18. cuttlefish

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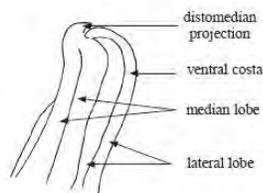
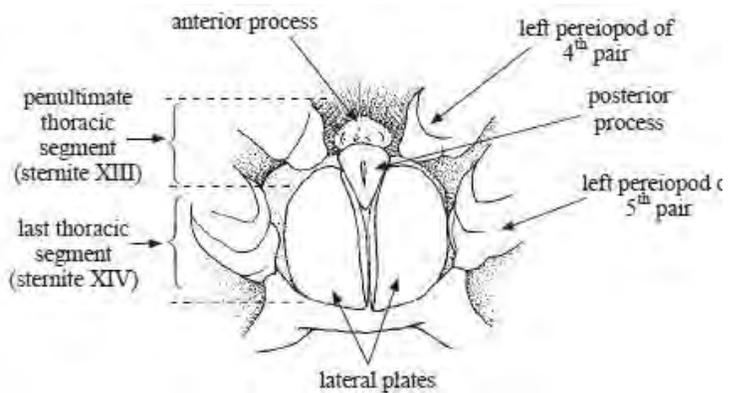
Commercially Important Coastal Prawns- Identification Characters

S. Lakshmi Pillai

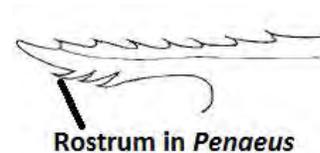
Crustacean Fisheries Division

Penaeus- Rostrum serrated on dorsal and ventral margins. Hepatic carina prominent. Thelycum closed. Abdomen smooth. Petasma with ventral costa long, reaching distal margin of lateral lobe.

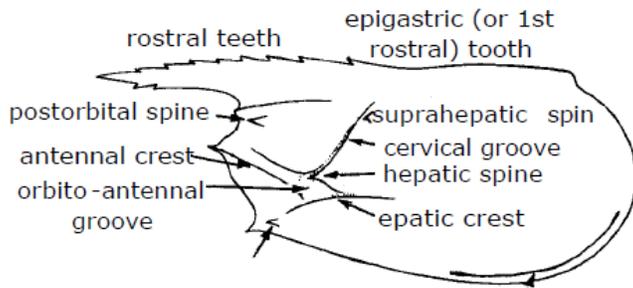
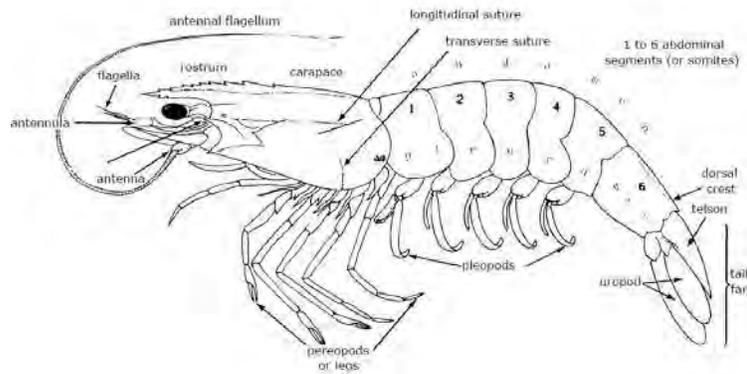
Thelycum



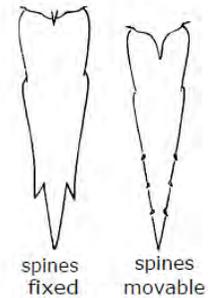
Petasma



Penaeidae: Rostrum well developed with ventral teeth and sometimes with dorsal teeth. Petasma semi open or semi closed. Thelycum open or closed.

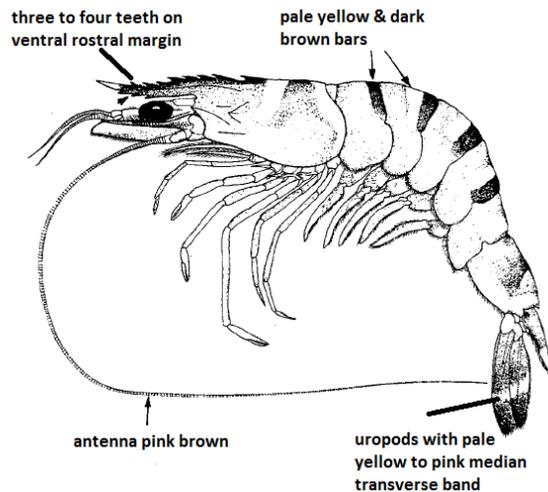
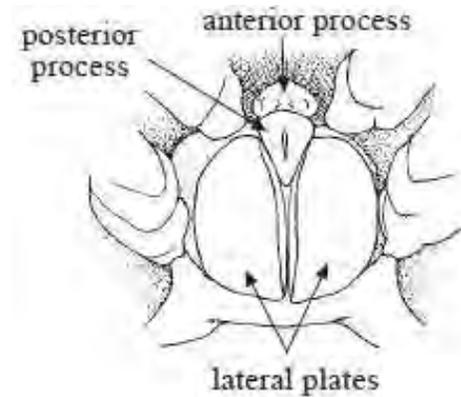


carapace (lateral view)

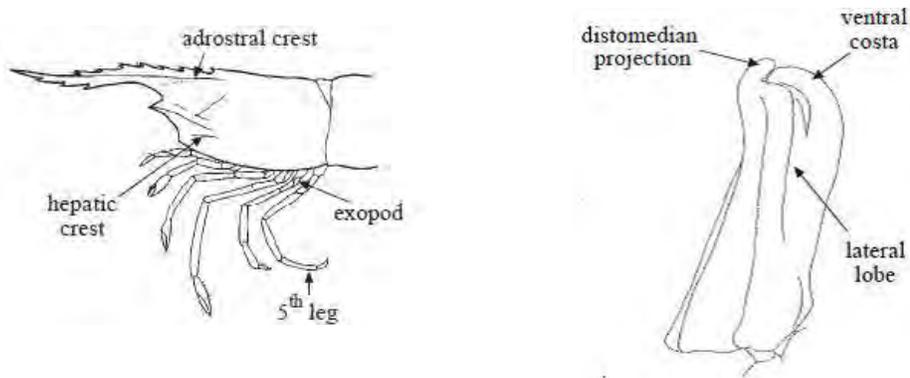


types of spined telsons

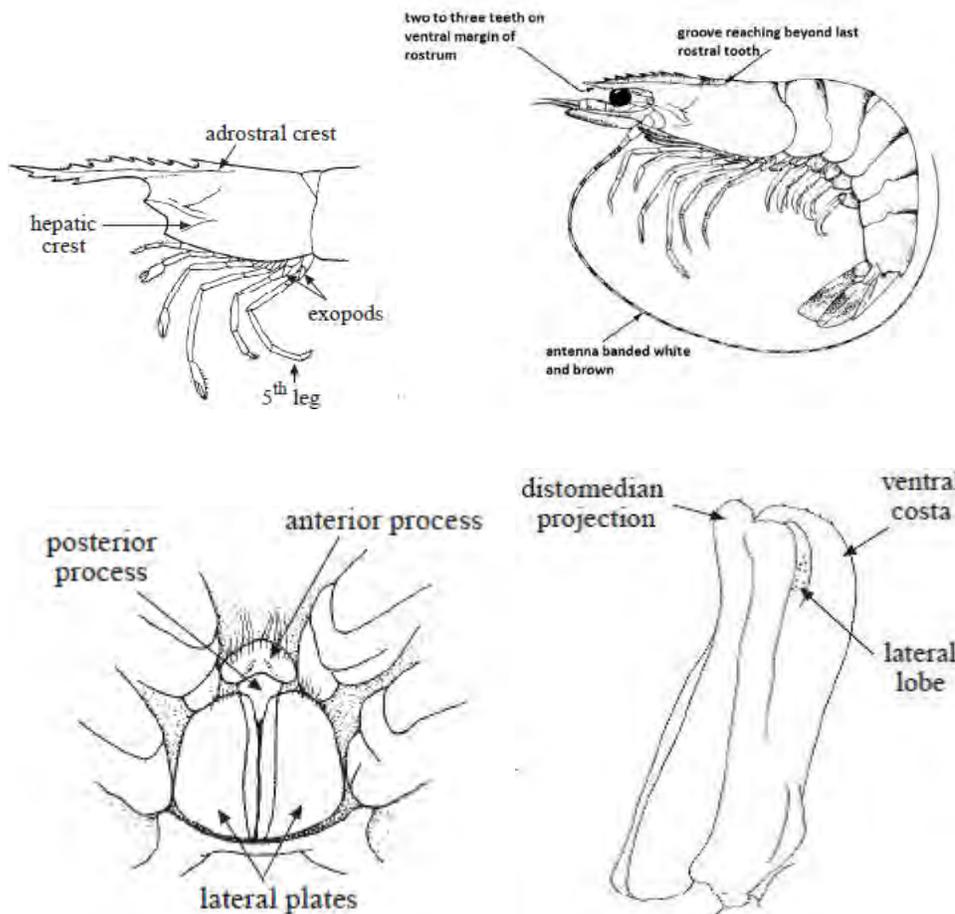
P. monodon: 3-4 teeth on ventral margin of rostrum. Fifth leg without exopod. Anterior process of thelycum subtriangular. Distomedian process of petasma slightly overhanging distal



margin of costae. Body grey, abdomen with dark brown to dark grey and pale yellow transverse bands. Uropods with a pale yellow to pink median transverse band.



P. semisulcatus: 2-3 teeth on ventral margin of rostrum, hepatic crest sloping anteroventrally. Adrostral crest reaching beyond last postrostral tooth. Antennal flagella banded. Fifth leg bearing a small exopod. Anterior process of thelycum subtriangular with raised edges. Body pale brown, sometimes greenish. Carapace often with two yellow cream dorsal transverse bands. Abdomen with brown grey and pale yellow dorsal transverse bands. Antennae banded white and brown.

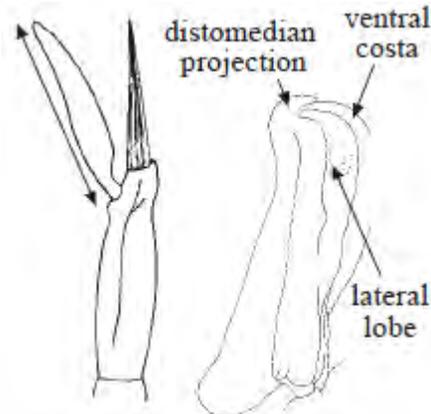
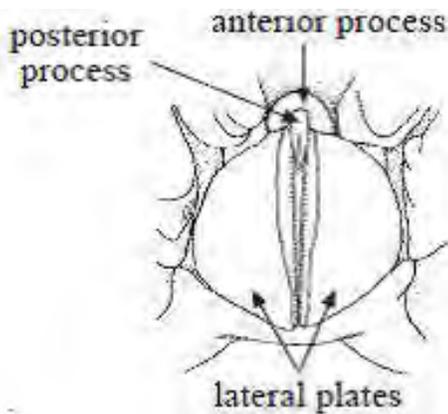
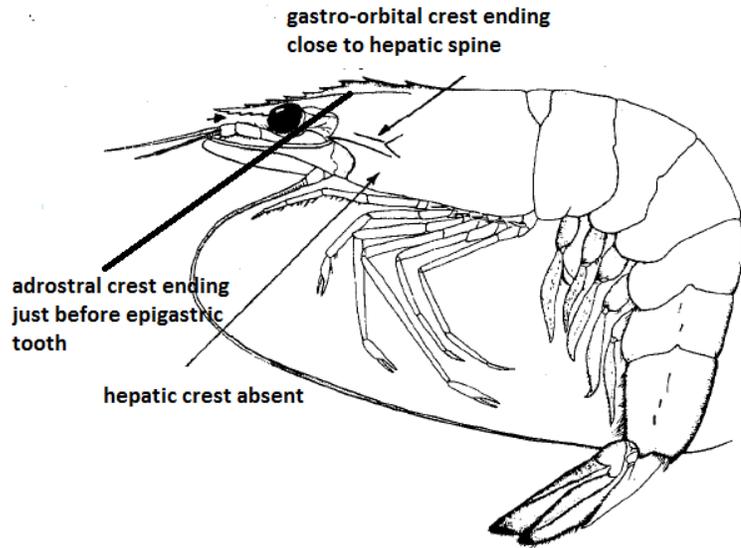


Fenneropenaeus: Rostrum serrated on dorsal and ventral margins. Hepatic carina generally absent, if present only feeble. Petasma semiclosed. Thelycum closed. Antennal and hepatic spines pronounced on the carapace.

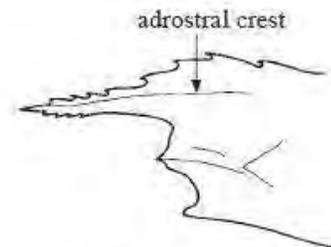
F. indicus: Adrostral crest extending as far as or just before epigastric tooth.

Telson lacking lateral spines.

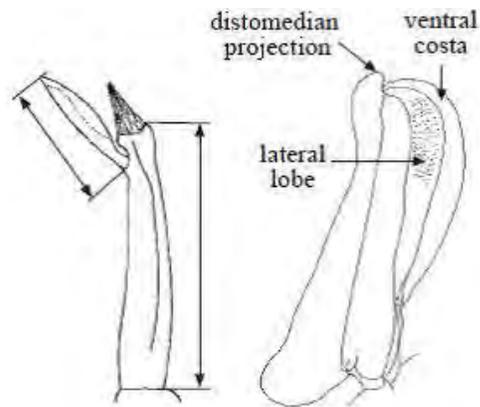
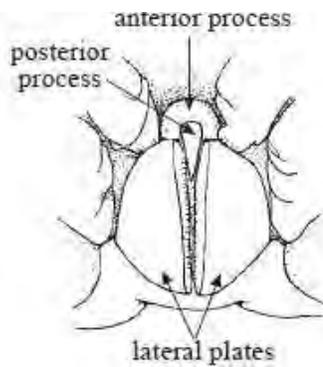
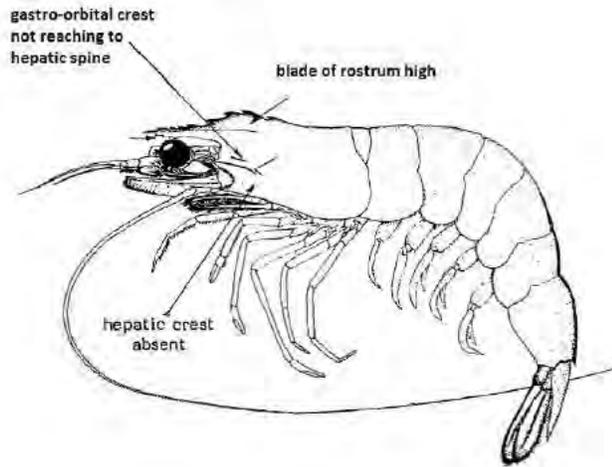
Thelycum formed by 2 semicircular lateral plates with their median margins forming tumid lips. Distomedian projection of petasma strongly curved and overhanging distal margin of costae. Body yellowish white, pereopods (pereopods) generally of same colour as body. Pleopods and uropods pink or red.



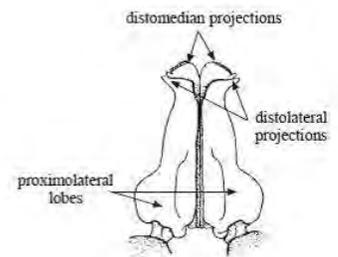
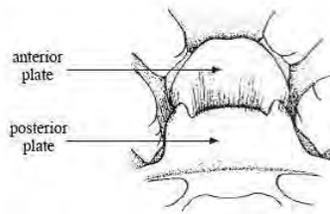
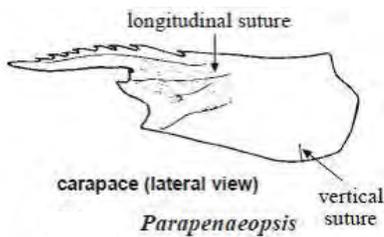
F. merguensis: Adrostral crest extending to or just before epigastric tooth, tip of rostrum horizontally straight. Rostral crest very high and broadly triangular in large specimens and in females. Telson lack lateral spines. Anterior process of thelycum slightly rounded and concave. Distomedian projection of petasma short, not reaching distal margin of costae.



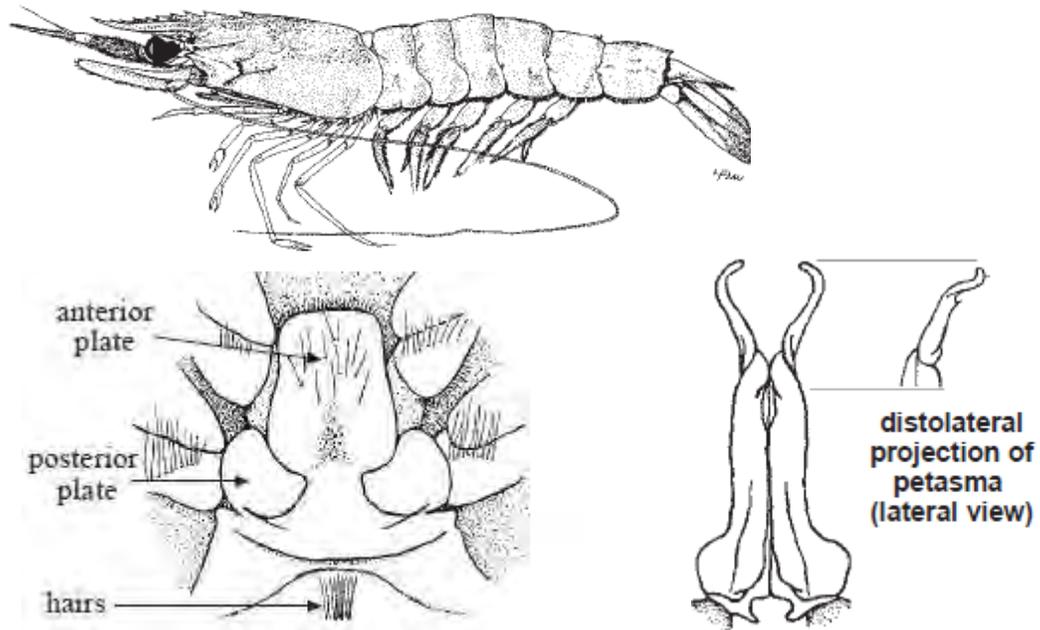
Penaens merguensis



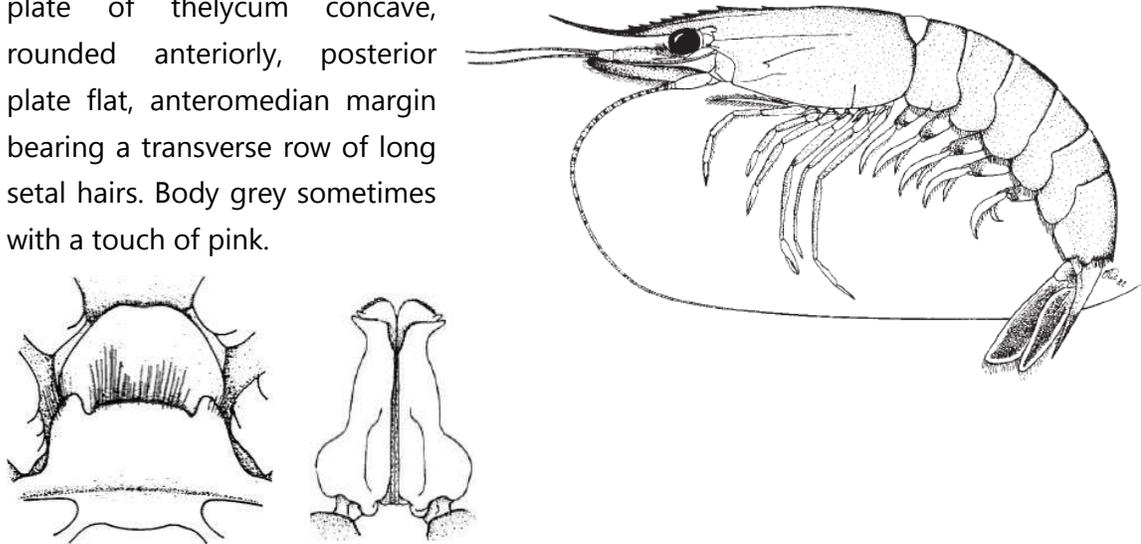
Parapenaeopsis: Rostrum serrated only on dorsal margin. Telson without fixed subapical spines but with lateral movable spines. Exopod present on all pereopods. Third pereopod without epipod.



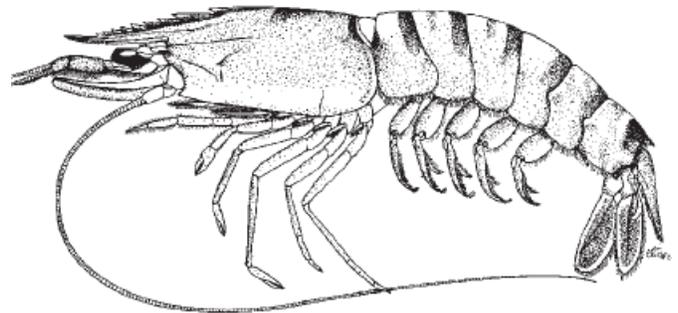
P. cornuta: Petasma with long and slender horn like distolateral projections with the distal part curving inwardly. Thelycum oblong, concave and fused posteromedially with posterior plate. A median tuft of long setae behind the thelycum. Transverse brown bands on abdomen.



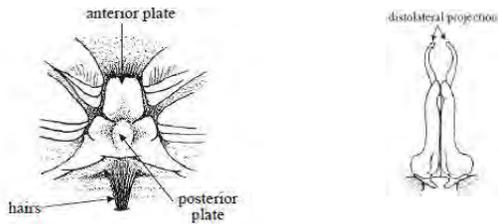
P. hardwickii: Distomedian projection of petasma wing like, wider than long. Anterior plate of thelycum concave, rounded anteriorly, posterior plate flat, anteromedian margin bearing a transverse row of long setal hairs. Body grey sometimes with a touch of pink.



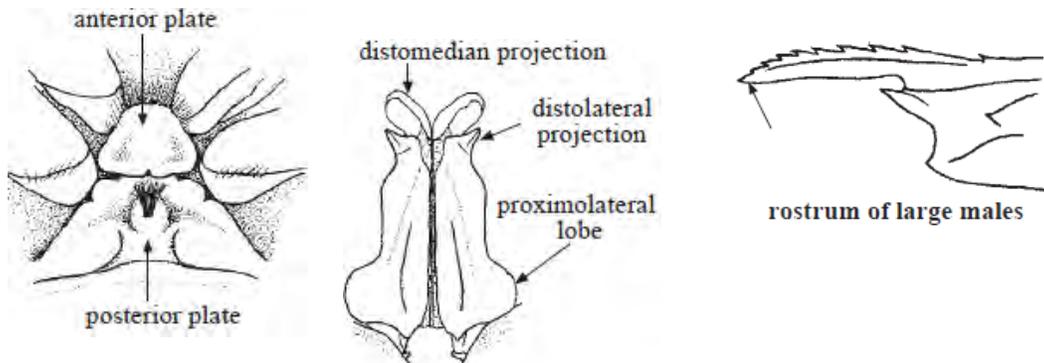
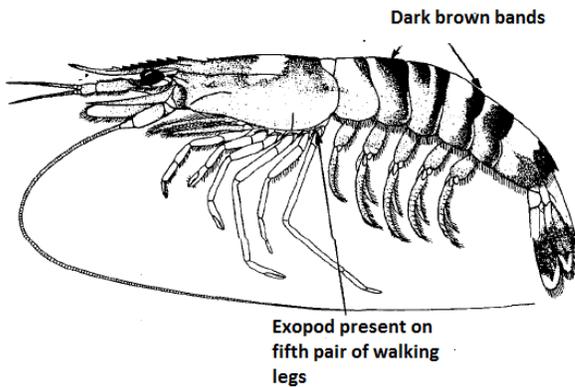
P. maxillipedo: Distolateral projection of petasma slender, long and horn like. Thelycum subquadrate, posteriorly depressed and medially fused to posterior plate. Median tuft of long setae behind the thelycum. Pale brown in colour. Abdomen with dorsal transverse dark bands. Uropods greenish to red brown with a pale



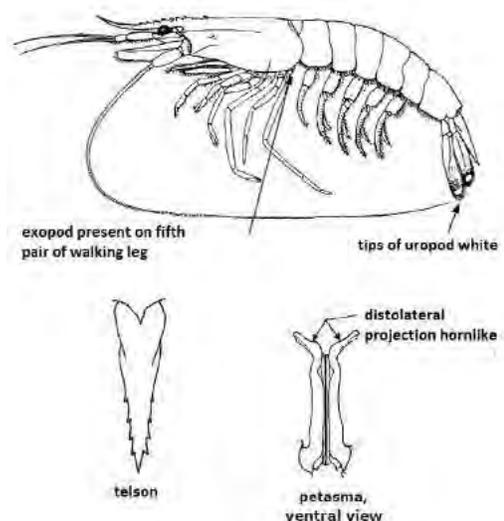
stripe along margins.



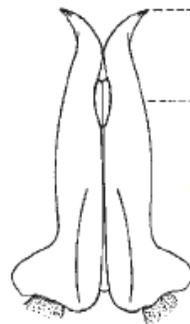
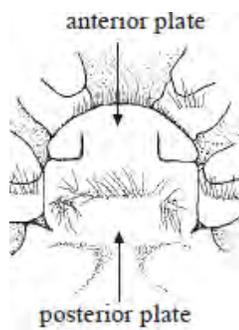
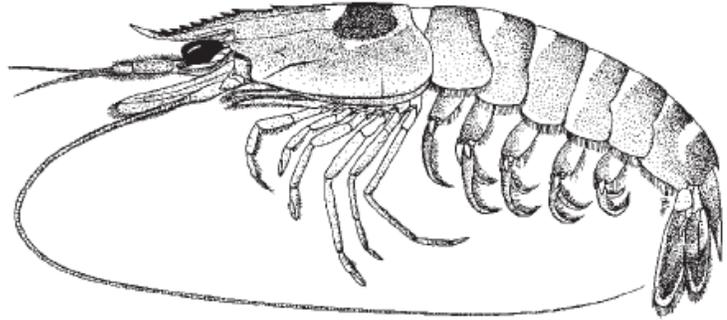
P. sculptilis: Rostrum sigmoid in females and upcurved in large males, curving downwards. Distomedian projection long and rabbit ear shaped. Distolateral projection of petasma directed anteriorly and short. Thelycum with anterior plate distally rounded and broadly articulating with posterior plate. The latter has a median tubercle bearing a tuft of long setae. Body pale with black transverse bands. Carapace dark brown dorsally except for a white band about its middle.



P. stylifera: Distolateral projection of petasma slender, horn like and directed anterolaterally. Anterior plate of thelycum square, concave with a slender stem like posterior process. Posterior plate deeply notched anteromedially. Body pale brownish or pinkish in colour.

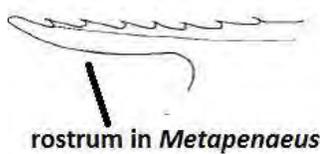


***P. uncta*:** Distolateral projection of petasma tapering to ends each with a long dorsomedian spine like process. Anterior plate of thelycum wide and short with curved anterior margin and with two longitudinal ridges medially fused with the quadrate posterior plate. Body brown. Carapace with a large dorso-posterior dark brown patch.

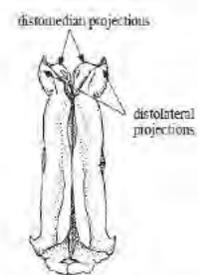
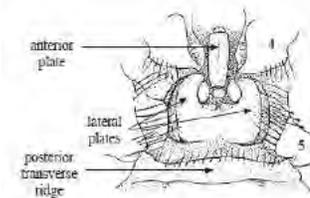


rostrum of large males

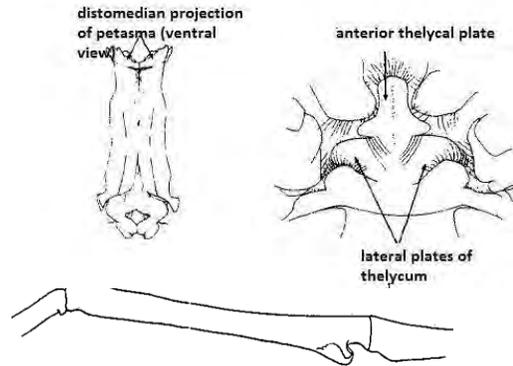
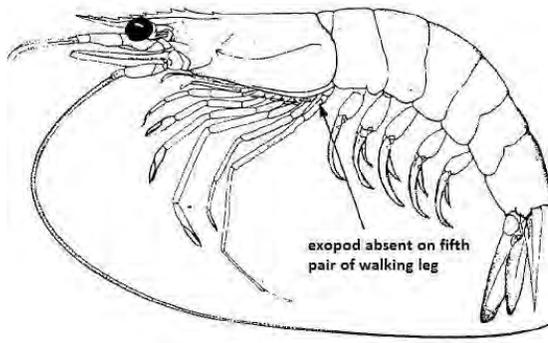
***Metapenaeus*:** Rostrum serrated only on the dorsal margin. Telson generally without fixed subapical spine, but usually with movable lateral spines; antennular peduncle lacking parapenaeid spine. Fifth pereopod without exopod.



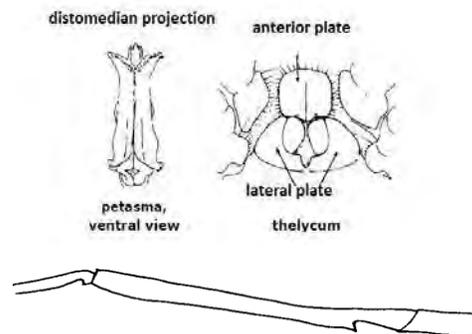
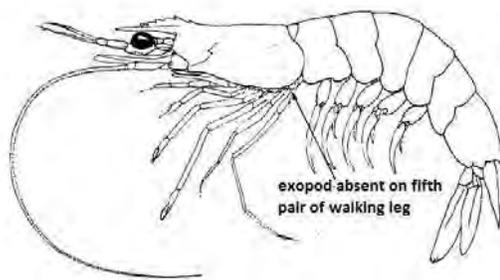
rostrum in *Metapenaeus*



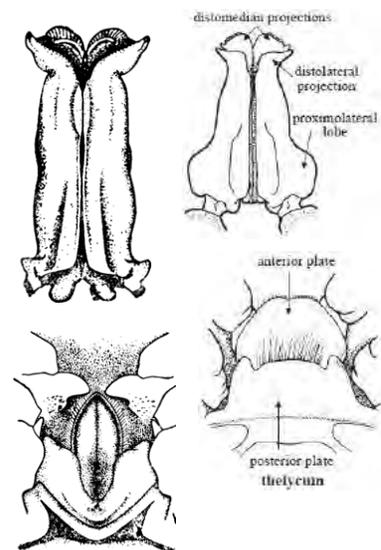
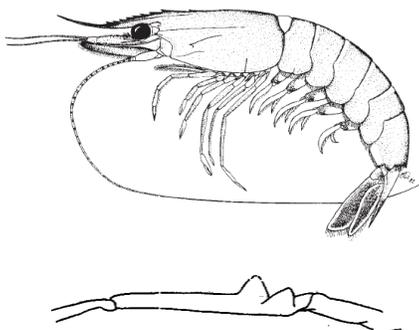
***M. affinis*:** Merus of fifth pereopod bears a proximal notch followed by a twisted keeled tubercle. Distomedian projection of petasma crescent shaped. Anterior plate of thelycum long and deeply grooved. Lateral plates with strongly raised lateral margins forming two longitudinal crests. Body pale pinkish/pale greenish in colour.



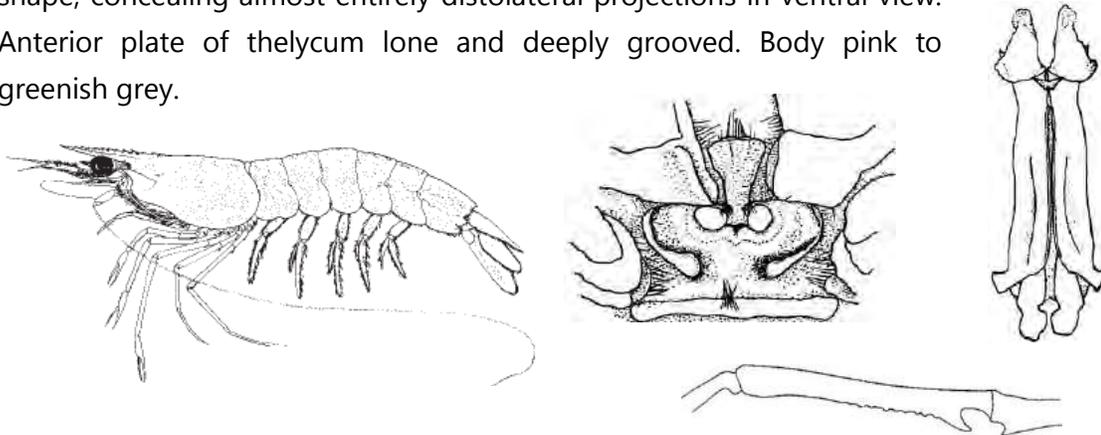
M. brevicornis: Distomedian projection of petasma with long and slender apical filament. Anterior plate of thelycum square and grooved; lateral plates boomerang shaped and enclosing 2 pear shaped plates. Distal part of uropods brown to rusty red sometimes only the tips are coloured.



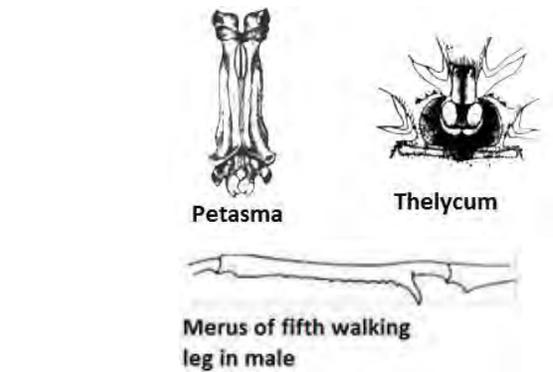
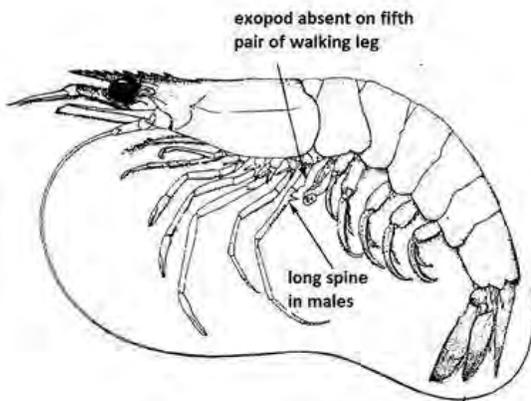
M. dobsoni: Merus of 5th pereopod with one or two large triangular teeth. Distomedian projection of petasma with a short filament on ventral surface and another on the dorsal surface. Thelycum with a long grooved tongue like anterior plate partially ensheathed in a horse shoe like process formed by lateral plates. Body pale yellow to brown.



M. ensis: Merus of 5th pereiopod with a proximal notch in adult males. Distomedian projection of petasma convoluted, greatly swollen and directed forward, triangular in shape, concealing almost entirely distolateral projections in ventral view. Anterior plate of thelycum lone and deeply grooved. Body pink to greenish grey.



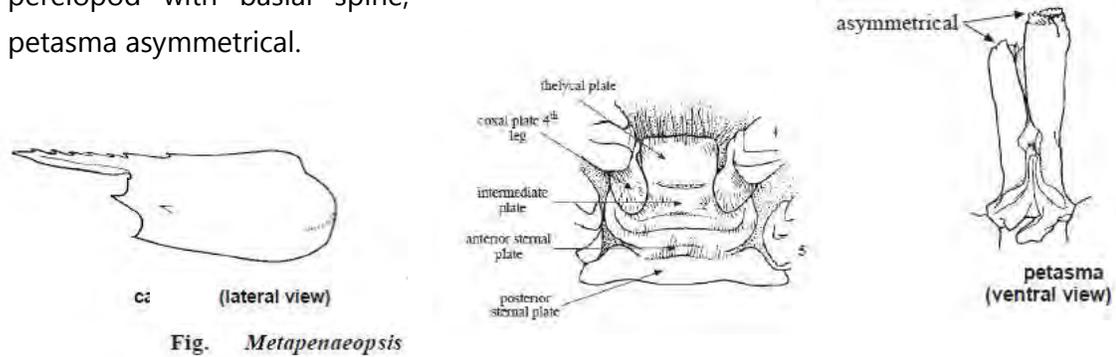
M. monoceros: Distomedian projection of petasma hood like. Lateral thelycal plates with salient end parallel ear shaped lateral ridges. Body greenish. Distal part of uropods purple-blue.



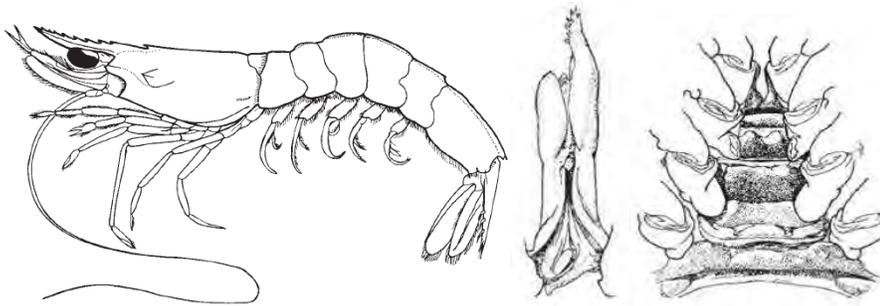
M. moyebi: Merus of fifth pereiopod with a proximal notch followed by a twisted keeled tubercle. Anterior plate of thelycum flask shaped and lateral plates kidney shaped.



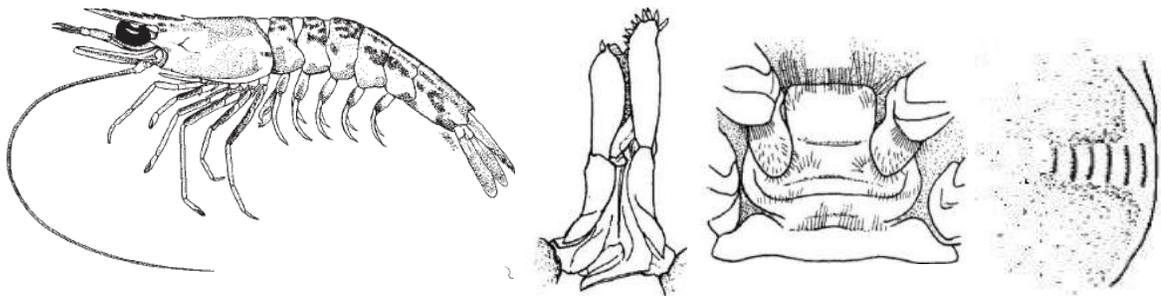
Metapenaeopsis: Rostrum serrated only on the dorsal margin. Telson with two or more pairs of conspicuous spines anterior to subapical spines. Third maxilliped and second pereiopod with basal spine; petasma asymmetrical.



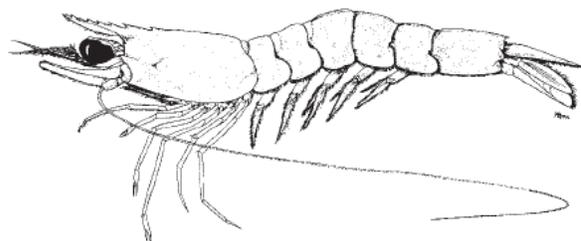
M. barbata: Left distoventral projection of petasma long. Thelycal plate broadly subquadrate. Posterolateral part of carapace with 16-27 stridulating organ. Body whitish mottled with irregular red blotches. Antennal flagella crossed with red and white bands.



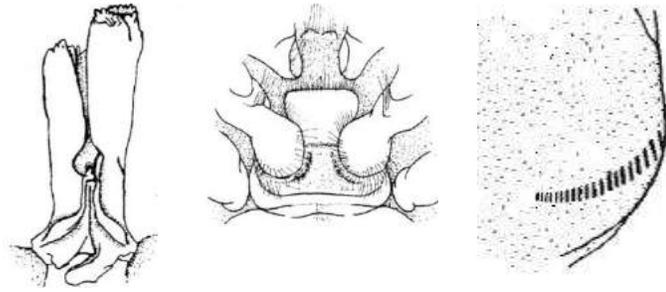
M. stridulans: Carapace, abdomen and telson with red patches. Stridulating organ present consisting of 5-7 strong ridges in a wide straight band on the carapace.



M. toloensis: Stridulating ridges 14-22 in a curved band. Left distoventral projection of petasma short and left distoventral projection broadly swollen.

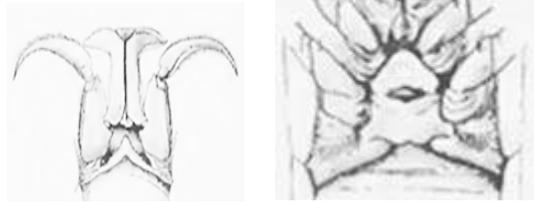


Thelycal plate subquadrate with rounded corner. Body with dark red to brown mottling.

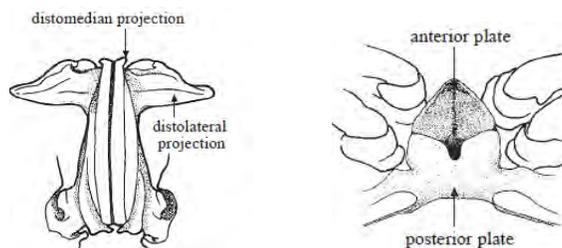
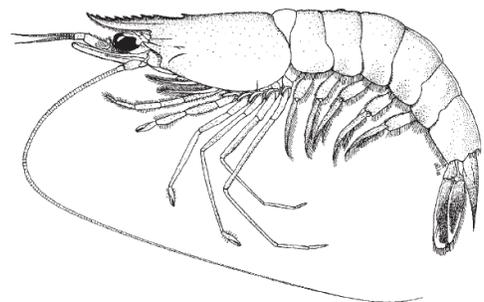


Trachysalambria: Rostrum serrated only on the dorsal margin. Third pereiopod with epipod; body thick set; third maxilliped lacking basal spine. Petasma with disto-lateral projections tapering gently from relatively narrow base, extending almost straight laterally or curving slightly backwards.

T. aspera: Red band on the third and fourth abdominal segment. Rostrum slightly curved upwards with 7 dorsal teeth. Telson with 2 pairs of spines of which posterior pair is much longer. Petasma 'T' shaped bearing a pair of distal pointed wing like process. Anterior plate of thelycum semicircular in outline. Uropods red with purple margins.



T. curvirostris: Rostrum with 7-11 dorsal teeth reaching distal half of second antennular segment. Telson armed with 3 to 4 small movable lateral spines subequal in size. Petasma with broad wing like disto lateral projection directed laterally and curved distoventrally. Anterior plate



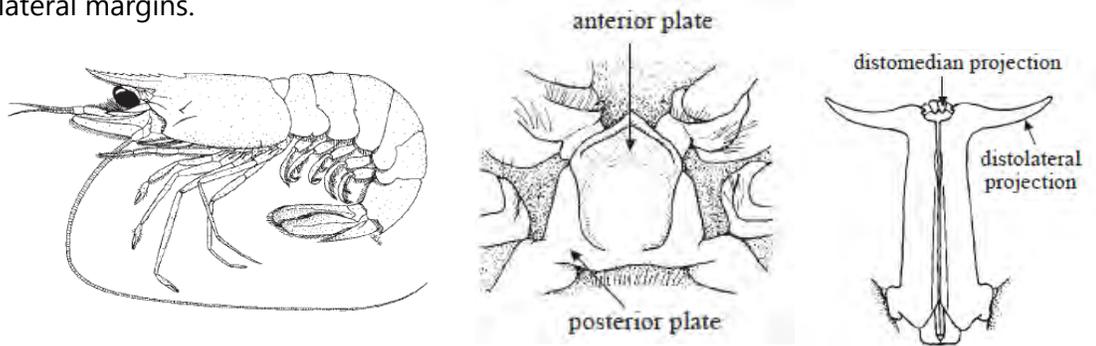
of thelycum curved anteriorly with a middle groove posteriorly. Uropods bright red to reddish brown,

sometimes dark brown with distinct white margins.

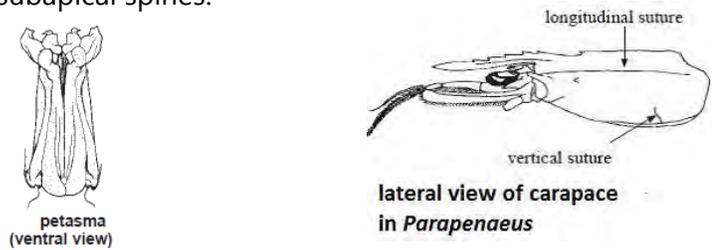
Megokris: Third pereiopod with epipod; body thick set; third maxilliped lacking basal spine. Telson with 3 pairs of movable lateral spines. Petasma symmetrical. Thelycum

closed. Petasma with disto-lateral projections either moderately broad to rather narrow basally and extending laterally or forward directed hook-like tip or extremely broad basally but narrowing rapidly, ending in forward directed tip.

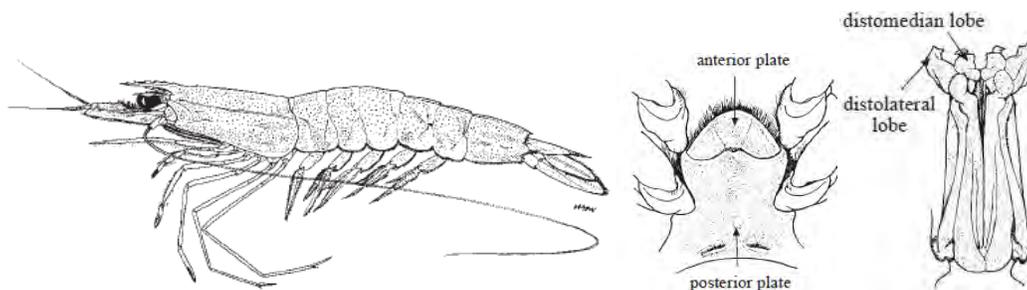
M. sedili: Distolateral projection of petasma horn like directed laterally their tips slightly curving forward. Anterior and posterior plates of thelycal plates with strongly raised lateral margins.



Parapenaeus: Rostrum serrated only on the dorsal margin. Telson with only one pair of minute lateral spines anterior to subapical spines.

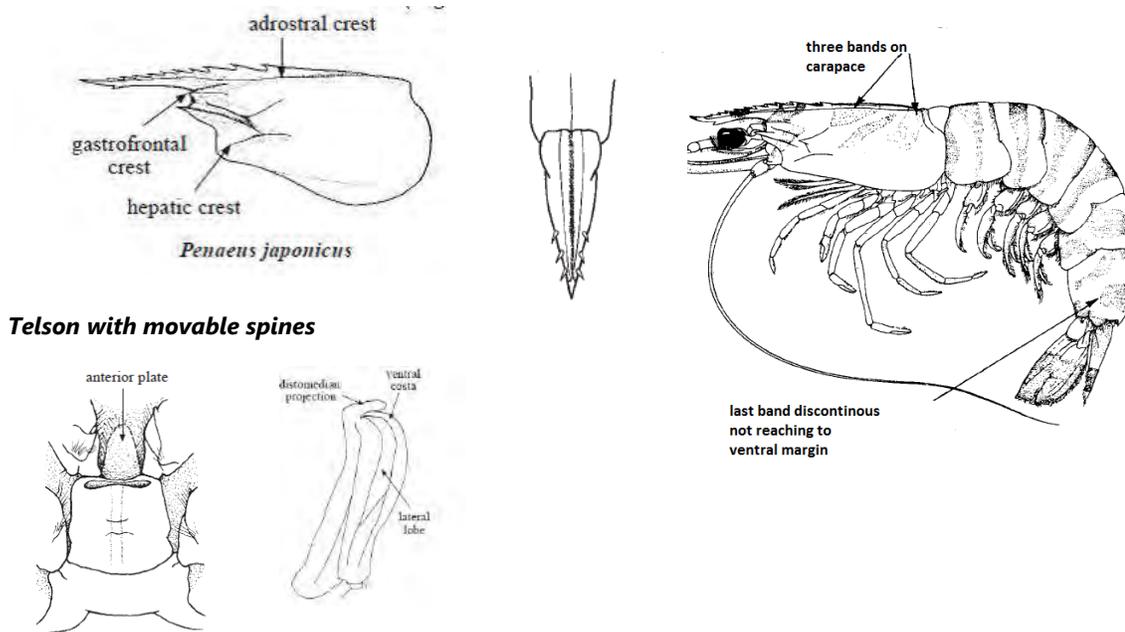


P. longipes: Rostrum reaching just beyond the eyes. Third maxilliped reaches the tip of the antennal scale. The process on the distomedian lobe of the petasma directed backwards.



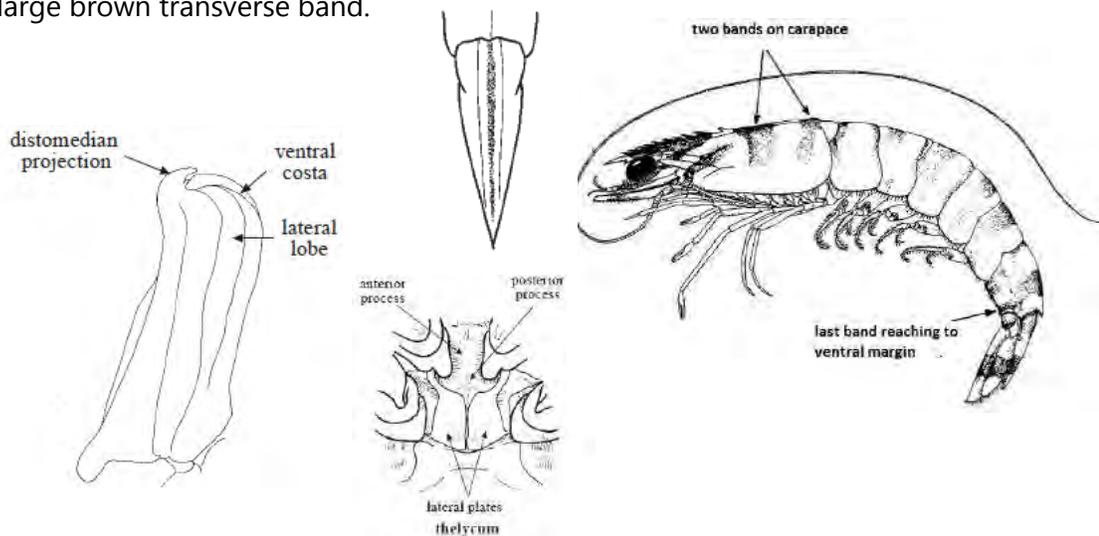
Marsupenaeus: Adrostral carina and sulcus extends behind epigastric tooth, gastrofrontal carina present. Gastro-frontal sulcus markedly bifid posteriorly; thelycum with a ventral undivided plate on sterniteXIV infolded laterally, forming pouch opening anteriorly.

M. japonicus: Rostrum with single ventral tooth. Carapace with a round white colour spot. Last abdominal band discontinuous. Telson with lateral movable spines.

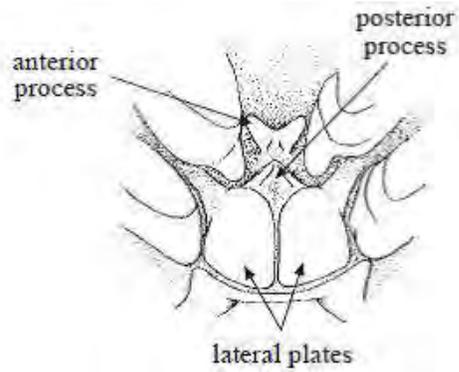
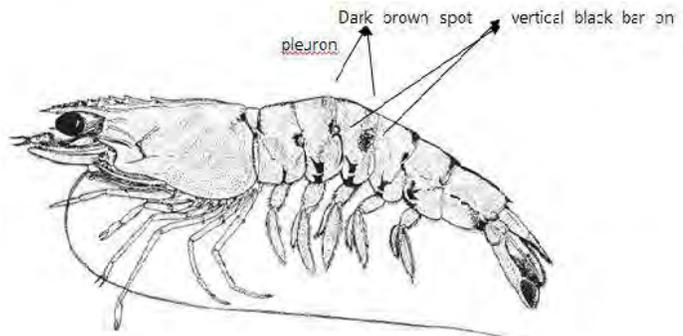
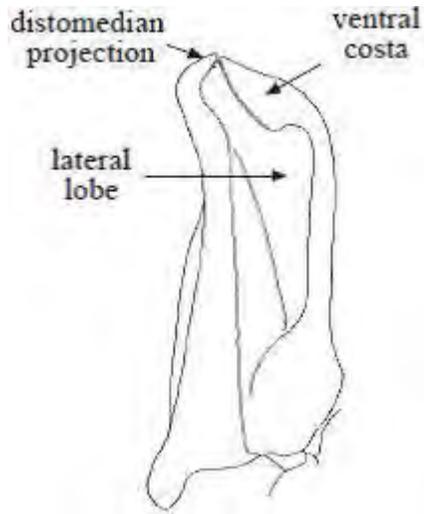


Melicertus: Adrostral carina and sulcus extends behind epigastric tooth; gastro-frontal carina present. Gastro-frontal sulcus not markedly bifid posteriorly; thelycum with a pair of lateral plate on sternite 14 shielding sac like seminal receptacle opening midline. Telson usually armed with three pairs of movable lateral spines (absent only in *M. canaliculatus*).

M. canaliculatus: Rostrum with single ventral tooth. Body yellow with red brown to brown transverse bands. Last abdominal band reaching the ventral margin. Uropods with a large brown transverse band.



M. latisulcatus: Each abdominal segments with a short vertical black bar on pleuron. Hinges on abdomen bear dark brown spots. Uropods bright yellow with distal half and outer margins of exopods bright blue.



10

Taxonomy, Biology and Distribution of Deep Sea Shrimps

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Shellfish systematics is the most unique one in fisheries science in view of its importance and implications in diversity. The systematic zoology is the science that discovers names, determines relationships, classifies and studies the evolution of living organisms. It is an important branch in biology and is considered to be one of the major subdivisions of biology having a broader base than genetics, biochemistry and physiology. The shellfish includes two highly diversified phyla *i.e.* phylum Arthropoda and phylum Mollusca. These two groups are named as shellfishes because of the presence of exoskeleton made of chitin in arthropods and shells made of calcium in molluscs. These two major phyla are invertebrates. They show enormous diversity in their morphology, in the habitats they occupy and in their biology. Phylum Arthropoda includes economically important groups such as lobsters, shrimps, crabs. Taxonomical study reveals numerous interesting phenomena in shellfish phylogeny and the study is most indispensable for the correct identification of candidate species for conservation and management of our fishery resources and aquaculture practices. On the whole taxonomic study on shellfishes furnishes the urgently needed information about species and it cultivates a way of thinking and approaching of all biological problems, which are much needed for the balance and well being of shellfish biology as a whole.

Shrimp resources are available both from inshore and from offshore waters. As the fish resource from inshore waters remained static during the last two decades, fishing pattern underwent several changes in the previous decade, leading to the exploitation of deep sea resources either with deployment of large sized vessels or modified medium/small sized vessels. Deepwater shrimps appear to have a world-wide distribution in tropical waters. They have been caught in surveys using baited traps in depths between 200 m and 800 m off continents and at 200- 500 m depth in the Indian Ocean.

Deep sea decapod crustaceans constitute one of the dominant high price groups of invertebrates in the marine fishery sector of Kerala although the structure and organization of their community are not well known as that of coastal penaeid prawns. In view of the increasingly prominent role played by deep sea prawns and prawn products in the economy of the country, the taxonomic identity of various species exploited from the deep sea fishing grounds off Kerala is an essential prerequisite for the sustainable development and management of deep sea prawn wealth of Kerala. The deep sea prawns landed at various harbours of Kerala is an assemblage of wide array of species representing various families, the prominent being Pandalidae, Aristeidae, Solenoceridae and Penaeidae while family Oplophoridae contributes to only a minor portion of the deep sea trawl catches in Kerala.

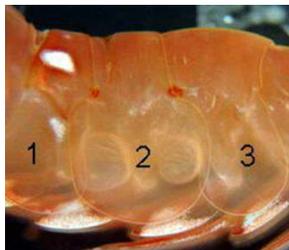
Difference between penaeid and non penaeid shrimps

Penaeid shrimp

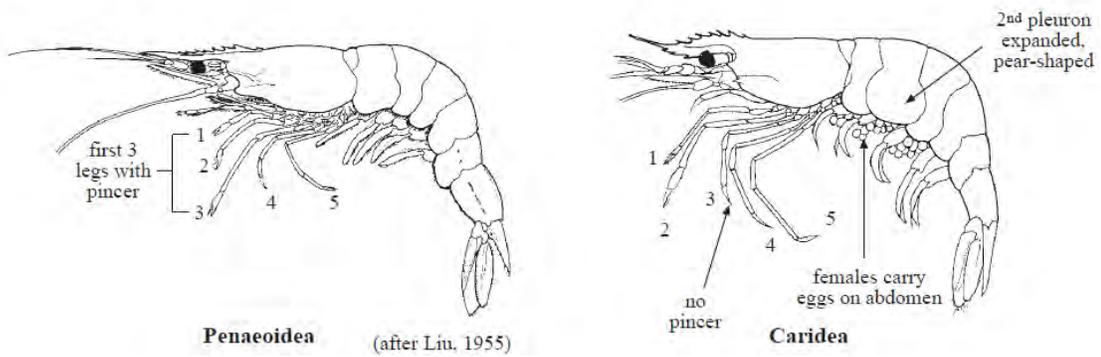
- Abdomen with posterior part of pleura covering anterior part of succeeding pleura
- Thelycum and petasma present, eggs are released directly into water and not attached to the female

Caridean shrimp

- 2nd abdominal pleuron greatly expanded, pear shaped and overlapping posterior part of 1st pleuron and anterior part of 3rd pleuron

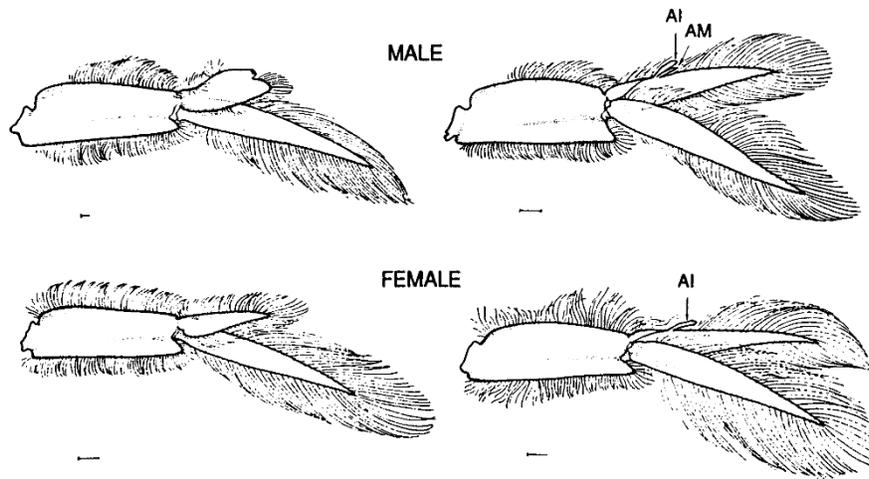


- No specific copulatory organs, females carry eggs on the abdomen until hatching



FIRST PLEOPOD

SECOND PLEOPOD



Key to the deep sea prawns of Penaeidae, Pandalidae and Oplophotidae

Penaeidae

- Inner border of the antennular peduncle with a setose scale; Podaobranchiae absent.....2
 No setose scale on the inner border of the antennular peduncle; podobranchiae present; pleurobranchia on 10-13 segments reduced to mere papillae.....***Aristeus alcocki***
- Exopodite of the external maxillipeds large, absence of a brachio-cardiac sulcus in the branchiostegal region.....3
- Symmetrical petasma; no basal spine at 3rd maxilliped.....4

4. A long fissure on either side of the carapace throughout the entire length; rostrum not glabrous and less than $1/3^{\text{rd}}$ the length of carapace.....***Parapenaeus Investigatoris***

No fissure on carapace wall; rostrum glabrous, as long as carapace.....***Penaeopsis jerryi***

Pandalidae

1. Carapace hard and rigid with longitudinal carinae; 2nd pair of pereopods unequal.....***Heterocarpus***.....3
2. Carapace smooth without a longitudinal carinae; 2nd pair of pereopods carapace equal.....2
3. 3rd abdominal somite unarmed or with fixed postero-medial tooth; terminal segment of 2nd maxilliped broader than long, attached strip like to penultimate segment with its longer side.....***Plesionika***.....5
4. 3rd abdominal tergum without spines, length of 6th abdominal segment less than 5th.....4
5. 3rd abdominal tergum ends in a sharp spine dorsally; 6th segment more than double the length 5th.....***Heterocarpus woodmasoni***
6. Only one tooth present anterior to orbit; dorsal carapaceal ridge not prominent***Heterocarpus laevigatus***
More than two teeth anterior to the orbit; dorsal carapaceal ridge very prominent***Heterocarpus gibbosus***
7. Posterior 10 ventral rostral teeth corresponding to 8 or fewer dorsal teeth, penultimate segment on 3rd maxilliped usually less than 1.5 times as long as terminal segment.....***Plesionika quasigrandis***
8. Posterior 10 ventral rostral teeth corresponding to more than 8 dorsal teeth, penultimate segment of 3rd maxilliped more than 1.5 times as long as terminal segment.....6
9. Dactylus of 3rd pereopod less than $1/7$ times, as long as propodus, posterior 10 ventral rostral teeth usually corresponding to more than 13 dorsal teeth.....***Plesionika spinipes***
10. Dactylus of 3rd pereopod more than $1/7$ times, as long as propodus, posterior 10 ventral rostral teeth usually corresponding to 13 or fewer dorsal teeth.....***Plesionika grandis***
11. Rostrum armed with a series of closely packed spines ventrally; distinct ocellus.....8
12. Rostrum armed with distantly placed spines; ocellus absent.....***Plesionika alcocki***

13. 3rd abdominal tergum posteriorly protrudes as a sharp dorsal spine....***Plesionika ensis***
14. 3rd abdominal tergum without spines but protrudes as a wavy margin.....***Plesionika martia***

Oplophoridae

1. Rostrum with atleast as many dorsal as ventral teeth; abdomen with 4th and 5th somites usually armed with posteromesial tooth; left mandible with incisor process not tapering sharply toward opposable margin, armed with 9-14 subacute teeth.....***AcanthePHYra***
2. Abdomen with 6th somite shorter than 5th (not including posteromesial spine); telson simply pointed posteriorly, not terminating in spinose endpiece; 3rd maxilliped and 1st pereopod with broadly compressed rigid exopods.....***Oplophorus***
3. Carapace without carina supporting branchiostegal spine; abdomen with posterior margin of 3rd somite distinctly excavate either side of posteriomedian tooth.....***AcanthePHYra armata***

Carapace with strong carina extending from branchiostegal spine to branchial region; abdomen with posterior margin of 3rd somite not distinctly excavate either side of posteriomedian tooth.....***AcanthePHYra fimbriata***
4. Abdomen with posteriomedian tooth on 4th and 5th somites; telson armed with four pairs of dorsolateral spines.....***AcanthePHYra sanguine***
5. Rostrum distinctly overreaching antennal scale; posterior extension of upper lateral rostral carinae on carapace subparallel in dorsal aspect; pleuron of 1st abdominal somite armed with small tooth on ventral margin; antennal scale unarmed on only distal 1/6 of lateral margin.....***Oplophorus gracilirostris***
6. Rostrum rarely overreaching antenna scale; posterior extension of upper lateral rostral carinae on carapace converging posteriorly in dorsal aspect; pleuron of 1st abdominal somite unarmed; antennal scale with distal ¼ of lateral margin unarmed.....***Oplophorus typus***

SCIENTIFIC CLASSIFICATION

Kingdom	Animalia
Phylum	Arthropoda
Subphylum	Crustacea
Class	Malacostraca
Subclass	Eumalacostraca
Superorder	Eucarida
Order	Decapoda
Suborder	Dendrobranchiata
Superfamily	Penaeoidea

Penaeid shrimps

***Aristeus alcocki* (Ramadan 1938)**

Common name: Red ring, Family Aristeidae

Diagnostic characters: Large size red abdominal rings. Rostrum in female long and slender upper margin curved downwards till distal end of 2nd segment of antennular peduncle. Rostrum in males much shorter and seldom surpassing tip of antennular peduncle, armed with three teeth above orbit; **and no teeth on ventral side, lacks**



Petasma (Male)

Thelycum (Female)

hepatic spine, upper antennular flagellum very short, eyestalk with a tubercle. Petasma simple, membranous, right and left halves united with each other along the whole length of dorsomedian with a papilla-like projection directed posteromedially.

Thelycum represented by a shield shaped plate directed anteroventrally bordered by an oblique ridge on either side.

Colour: Pink with reddish bands on the posterior border of all abdominal segments.

Fishery & Biology: The catches were mainly composed of females and their size ranged from 78 mm to 188 mm in total length. The size distribution showed unimodal pattern with majority in size groups 146-165 mm. The males, which were very poorly represented in the catches were relatively smaller in size and their total length varied from 67 mm to 110 mm.

Distribution: Indian Ocean; Arabian Sea and Bay of Bengal, at depth of 350-450 m off Quillon and Alleppey.

***Plesiopenaeus edwardsianus* (Johnson, 1868)**

Scarlet shrimp, Family: Aristeidae

Diagnostic characters: Rostrum very long in females and young males but becoming considerably short in adult males, with three or more dorsal teeth; carapace without postorbital spine; eye stalks with a tubercle on inner border; upper antennular flagella very short and flattened almost throughout their length; endopods of second pair of pleopods in males bearing appendix masculine and appendix interna; third and fourth pairs of pleopods biramous; telson armed with 1 or 4 movable spines on each side; two well developed arthrobranchs on penultimate thoracic segment.



Colour: Deep pink

Fishery & Biology: Three female specimens ranging in total length from 207 to 245 mm (rostrum partly broken in all specimens) and carapace length from 79 to 96 mm obtained in Bobbin Trawl at 876-976 m depth.

Distribution: During one of the deep-sea trawling operations of FORV *Sagar Sampadaa* few specimens of prawns, which were unusually large in size, were taken from about 900 m depth off Trivandrum on the southwest coast.

***Solenocera hextii* (Wood-Mason & Alcock, 1891)**

Deep sea mud shrimp, Family : Solenoceridae

Diagnostic characters: Flattened rostrum with 7 teeth on dorsal side and no teeth on

ventral side of the rostrum. Postrostral carina sharp but not laminose. Antennular flagella with red and white bands. The spines on the cervical groove situated ventral to the posteriormost rostral tooth which is well developed. The characteristic 'L' shaped groove on either side of the branchiostegal region is also clearly defined.



Petasma (Male)



Thelycum (Female)

Colour: Pink to red

Distribution: Found all along the east and west coast of India at depths between 250 to 547 m.

***Solenocera alfonso* (Perez Farfante, 1981)**

Deep water mud shrimp

Diagnostic characters: Antennular flagella flattened and tube like, rostrum horizontal, exopod of uropod without distolateral spine (family character). Telson armed with lateral spines; post rostral crest elevated but not plate like. The postrostral crest is not separated from postrostral teeth by a distinct notch but postrostral crest behind cervical groove sometimes with an upper tooth. Posterior part of hepatic groove and anterior part of branchiocardiac groove both very distinct and strongly curving downward; median part of first abdominal segment very narrow and dorsal crest of second abdominal segment distinct.



Colour: Pink to red

Distribution: Found at depths between 176 to 547 m. Though an Indo-West Pacific species, earlier records were only from Philippines, Indonesia and Northwestern Australia. In 2011, the species was recorded from Tuticorin, southeast coast of India from a depth of 250 to 350 m.

***Metapenaeopsis andamanensis* (Wood-Mason, 1891)**

Rice velvet shrimp, Family: Penaeidae

Diagnostic characters: Rostrum more or less horizontal and straight with 6 to 7 teeth on dorsal side and no teeth on the ventral side. Lower antennular flagellum longer than the upper, much longer than the entire antennular peduncle but 0.7 times the carapace length. 3rd pereopod surpass the rostrum by the length of the entire chela. Assymetrical petasma. 3rd maxilliped and 1st pereopod with a basal spine, distal fixed pair of spines on telson.



Petasma (Male)



Thelycum (Female)

Colour: Pale pink to red

Fishery & Biology: The total length of males varied from 67 mm to 115 mm and that of females from 68 mm to 130 mm.

Distribution: A penaeid prawn commonly encountered in the trawl catches at all depths ranges upto 400 m and was obtained from all areas.

Penaeopsis jeryii

Common name: Dagger shrimp, Family: *Penaeidae*

Diagnostic characters: Dagger shaped rostrum with teeth on dorsal side of the rostrum.

Specimen appears to be pale red in color with white bands on the body. Cervical groove very prominent, antennal scale as long as rostrum. Thelycum trilobed and sub elliptical in structure.

Fishery & Biology: Size range of female specimens ranged from 74-115 mm and males ranged from 70-110 mm.



Distribution: All along the southwest coast of India particularly off Cochin, Quilon and Alleppey at depth of 275-350 m.

SCIENTIFIC CLASSIFICATION

Kingdom	Animalia
Phylum	Arthropoda
Subphylum	Crustacea
Class	Malacostraca
Subclass	Eumalacostraca
Superorder	Eucarida
Order	Decapoda
Suborder	Pleocyemata
Infraorder	Caridea

Non-Penaeid shrimps

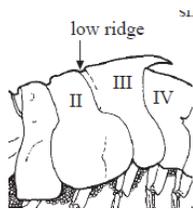
***Heterocarpus woodmasoni* (Alcock, 1901)**

Indian Nylon Shrimp, Family : Pandalidae

Diagnostic characters: Carapace with 2 longitudinal crests on each side, extending over full length of carapace – post antennal crest and branchiostegal crest. A conspicuous elevated, sharp tooth at middle of dorsal crest of 3rd abdominal segment, telson bears 5 pairs of dorsolateral spinules besides those at the tip.



Fishery & biology: Size in the catches ranged from 72 to 135 mm in total length but dominated by 111-120 mm size groups in both the sexes. The fertilized eggs on the



pleopods and the head-roe are light orange and this colour stands out in contrast with the pink colour of the prawn. The berry becomes greyish in advanced stages of development.



Male



Female

Distribution: Andamans, Southwest of India off Cochin and Alleppey at depths of 250-400 m.

***Heterocarpus gibbosus* (Bate, 1888)**

Humpback nylon shrimp

Diagnostic characters: The teeth on the dorsal crest and the rostrum together vary from 8 to 10. Teeth on the rostrum proper varying from 2 to 4 and 13-15 on ventral side. The dactyli of the 3 posterior legs short, median carination of the 3rd abdominal tergum is quite prominent. Carapace with 2 longitudinal crests on each side, extending over full length of carapace- post-ocular crest and branchiostegal crest. Post antennal crest very short.



Male



Female

Fishery & biology: The size of the individual prawn varied from 67 to 140 mm in total length and the catches were represented by all groups of the females. Males are mostly in 90-100 mm

size groups. The colour of the berry is light **orange** and turns dirty grey as

embryo develops.

Distribution: Southeast and Southwest coast off Cochin, off Alleppey at depths of 250-400 m. Immature specimens were found in greater numbers in shallow waters while the bigger prawns seemed to prefer deeper grounds beyond 350 m.

***Heterocarpus sibogaede* (Man, 1917)**

Diagnostic characters: Integument tomentose formed by lanceolate scale-like spines, rostrum about 2/3 as long as carapace, gradually recurved upwards, armed dorsally with 8 teeth followed by 6 on postrostral crest of which the first one placed behind middle of two small ones situated closely on distal part; a dark reddish spot covering almost the entire width of 3rd abdominal somite on either side appears to be characteristic; tip of rostrum, orbital margin, carinae of 1st and 2nd abdominal terga, distal portion of spines on 3rd and 4th terga, tip of dorsal antennular flagellum and pereopods and the entire pleopods reddish; telson long, nearly as long as uropods, armed with 5 small dorsolateral movable spines on right side and 4 on left side in addition to 3 pairs at distal end; antennular flagella about the same length of carapace, stylocerite pointed and reaching middle of second segment of antennular peduncle; scaphocerite narrower distally, reaching 3/4 of rostrum; distolateral spine projecting well beyond anterior margin.

Colour: Fresh specimen appears pink

Fishery: One female, total length 114 mm, carapace length 34 mm; off Quilon at 310-320 m depth.

Distribution: Southeast and Southwest coast of India

***Plesionika spinipes* (Bate, 1888)**

Oriental Narwal Shrimp, Family : Pandalidae

Diagnostic characters: Rostrum upturned at the tip. Rostrum is armed with 46 teeth on the dorsal side and 31 teeth on the ventral side and very long slender legs. Telson is double the length of the 5th abdominal somite. Lower antennular flagellum longer than the upper and about 5.4 times the



Male

Female

carapace length. 3rd maxilliped extends beyond the antennal scale by the length of its dactylus. Second pereopod exceeds the tip of antennal scale by its chela and 1/8 length of carpus.

Minute tubercle on the dorsal surface of the carapace at about 1/6th of its length from the hinder edge which corresponds in position to the small blunt median spine which is present in all the specimens.

Colour: Body pale red in colour

Fishery & biology: The size of this prawn in the catches ranged from 63 to 125 mm but the size groups 95-110 mm in both sexes predominated. Berry is greenish-blue in colour with ovoid shape of fertilized eggs.

Distribution: In Indian waters, this species is known to occur in south-east and south-west coast of India abundantly noticed from Quilon and Mangalore regions from the depth of 250-400 m.

***Plesionika martia* (A. Milne-Edwards, 1883)**

Golden Shrimp

Diagnostic characters: Rostrum very long pointed with 7-9 dorsal teeth including 2-5 teeth on carapace posterior to the level of orbital margin while ventral margin of the rostrum is armed with 34-56 teeth.



Fishery & biology: The size of this prawn in the catches ranged from 71 to 120 mm in males and 80 to 130 mm in females. The modal lengths for males and females were at 90-95 mm and 96-100 mm respectively. Berry is deep blue in colour in the early stages and to light grey in advances stages of development.



Distribution: In Indian waters, this species is known to occur along the south-west coast

particularly through out the Kerala coast abundantly noticed from Quilon and Alleppey regions from the depth of 200-450 m.

Family : Ophlophoridae

Antennal scale sharply serrated; exopod of 1st pair of pereopods foliaceous.....***Ophlophorus typus***

Antennal scale smooth without any serrations. Exopod of 1st pereopods not foliaceous.....***Acanthephyra***

***Ophlophorus gracilirostris* Alcock, 1901**

Diagnostic characters: Carapace with dorsal carina extending to the posterior margin.

Rostrum very long almost equal in length to the carapace. Branchiostegal spine quite distinct, with a well-defined keel, spine on the 3rd abdominal tergum very much longer than those on the 4th and 5th. In the male the anterior border of the first abdominal somite is bilobed with the posterior lobe more pronounced and angular.



Distribution: Arabian Sea, Bay of Bengal, Andaman Sea and Hawaii Islands, Southwest of Cochin, off Alleppey 300-450 m depth.

***Acanthephyra armata* (A. Milne-Edwards, 1881)**

Diagnostic Characters: The carapace is without a straight ridge or carina running on the entire length of the lateral surface *i.e.* from the hind margin of the orbit to the posterior edge of the carapace. Rostrum long, upcurved with 5 to 6 teeth on the dorsal side and only one tooth on the ventral side of rostrum. Dorsal carina of 3rd to 6th abdominal somites ending in pointed spines. Sometimes the posterior spine on the sixth somite may be absent. Telson generally more or less truncated at the tip and laterally, it is armed with spines. Eyes are well pigmented. Incisor process of the mandible is provided with teeth throughout the entire length of its cutting edge. Pereopods are not abnormally broad and flattened. Exopods of the third maxilliped and all pereopods are neither foliaceous nor rigid.



Male



Female

Distribution: Southeast and Southwest coast of India

***Acanthephyra sanguinea* (Wood-Mason, 1892)**

Diagnostic Characters: Rostrum longer than carapace with 7 dorsal and 5 ventral teeth, extending much beyond the tip of the antennal



scale. Branchiostegal spine small, forming a small projection on frontal border of carapace and without a carina. Surface of carapace finely pitted as in all the species of the purpurea group. Dorsal carinae of 3rd to 6th abdominal somites ending in pointed spines, that of 3rd somite the longest and of 4th and 5th of equal size and smallest. Four pairs of dorsolateral spines present on the telson.

Distribution: Southeast and Southwest coast of India

List of Deep sea shrimps from Indian waters

	Species	Common name (English)	Distribution
Family	Sicyoniidae (Ortmann,1898)	Rock shrimps	India (Southwest & Southeast)
	1 Genus, 4 Species		
Genus	Sicyonia (H. Milne Edwards,1830)		
	<i>Sicyonia fallax</i> (De Man,1907)		
	<i>Sicyonia lancifer</i> (Olivier,1811)		
	<i>Sicyonia longicauda</i> (Rathbun, 1906)		
	<i>Sicyonia parajaponica</i> (Crosnier, 2003)	Knight rock shrimp	
Family	Pandalidae (Haworth,1825)	Armed nylon shrimp	Southeast & west coast A & N Islands
Genus	Heterocarpus (A. Milne-Edwards,1881)		
	<i>Heterocarpus ensifer</i> (A. Milne Edwards,1881)		
	<i>Heterocarpus gibbosus</i> (Spence Bate,1888)		
	<i>Heterocarpus laevigatus</i> (Spence Bate,1888)		
	<i>Heterocarpus longirostris</i> (Macgilchrist,1905)		
	<i>Heterocarpus tricarinatus</i> (Alcock & Anderson,1894)		
	<i>Heterocarpus woodmasoni</i> (Alcock,1901)		
	<i>Heterocarpus sibogae</i> (De Man,1917)	Indian nylon shrimp	
		Mino nylon shrimp	Arabian sea Bay of Bengal
		Smooth nylon shrimp	Arabian Sea, Lakshadweep
		Scarred nylon shrimp	Southeast & West coast, Andaman
			Southeast & West coast, Andaman's

Training Manual on Species Identification

Genus	Plesionika (Bate, 1888) <i>Plesionika martia</i> (A. Milne-Edwards, 1883) <i>Plesionika spinipes</i> (Spence Bate, 1888)	Golden Shrimp Oriental Narwal Shrimp	East & West coast West & south east coast, India
Family Genus	Aristeidae (Wood-mason, 1891) Aristeus (Duvernoy, 1840) <i>Aristeus alcocki</i> (Ramadan, 1938)	Aristeid shrimps Arabian Red shrimp	Southeast, Southwest, Lakshadweep sea
Family Genus	Solenoceridae (Wood-Mason, 1891) Solenocera (Lucas, 1849) <i>Solenocera alfonso</i> (Perez farfante, 1981) <i>Solenocera hextii</i> (Wood-Mason and Alcock, 1891)	Solenocerid shrimps Deep water Mud shrimp Deep sea Mud shrimp	Off Tuticorin East & West coast
Family Genus	Penaeidae (Rafinesque, 1815) Metapenaeopsis (Bouvier, 1905) <i>Metapenaeopsis andamanensis</i> (Wood-Mason in Wood-Mason & Alcock, 1891)	Penaeid Prawns Rice velvet shrimp	Southwest, Southeast & Andaman
Genus	Parapenaeus (Smith, 1885) <i>Parapenaeus investigatoris</i> (Alcock & Anderson, 1899)	Explorer Rose Shrimp	Southwest, SE & A & N Islands
Genus	Penaeopsis spence (Bate, 1881) <i>Penaeopsis jerryi</i> (Perez Farfante, 1979)	Gondwana Shrimp	Southwest, SE & A & N Islands
Family Genus	Oplophoridae (Dana, 1852) AcanthePHYra (A. Milne-Edwards, 1881) <i>AcanthePHYra sanguinea</i> (Wood-Mason in Wood-mason & Alcock, 1892) <i>AcanthePHYra armata</i> (A. Milne-Edwards, 1881)		Off Kerala, West coast Off Kerala, West coast

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11

Classification, Biodiversity and Conservation of Marine Commercial Crabs of India

Josileen Jose

Crustacean Fisheries Division

One of the best known and most intensely studied groups is the true crabs of the infraorder Brachyura. Brachyuran crabs belong to the Order Decapoda, the most diverse group of crustaceans alive today (Ng *et al.*, 2008). The known size of crabs now ranges from a maximum leg span of approximately 4 m in the giant Japanese spider crab *Macrocheira kaempferi* and a maximum carapace width of 46 cm in the giant Tasmanian crab *Pseudocarcinus gigas* to a minimum of 1.5 mm across the carapace for a mature ovigerous female pinnotherid, *Nannothers moorei*, the smallest known species of crab. Every living thing is classified into one of the three domains. Archaea, Bacteria, and Eukarya are the three domains. The eight levels of classification are domain, kingdom, phylum, class, order, family, genus, and species. True crabs are classified as follows:

Phylum: Arthropoda

Subphylum: Crustacea

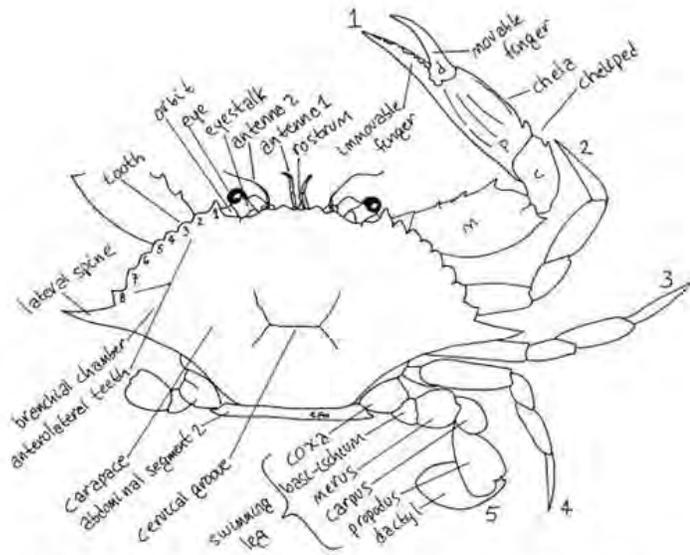
Class: Malacostraca

Order: Decapoda

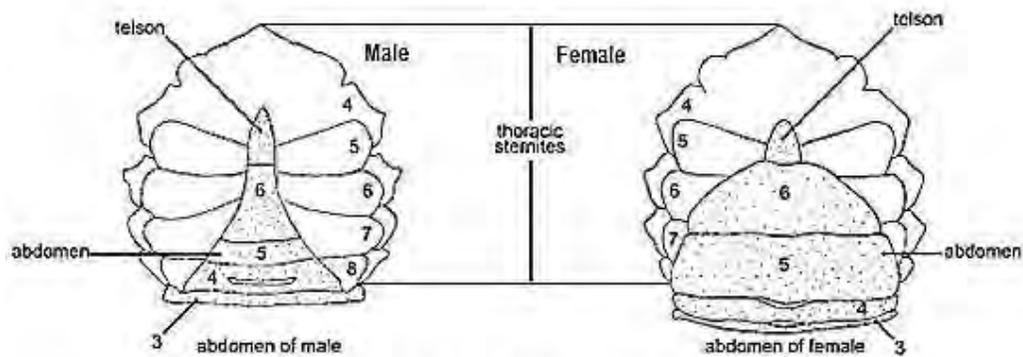
Suborder: Pleocyemata

Infraorder: Brachyura Linnaeus, 1758

The basic crab design consists of an expanded carapace (formed by a fusion of the head and some thoracic somites), and a strongly reduced abdomen that is tightly tucked underneath the thorax. In addition, the first pereopods of brachyurans are fully chelate, and the walking legs are placed at the sides of the body. True brachyuran crabs are often confused with hermit and porcelain crabs belonging to the infraorder Anomura. In general, most anomuran crabs have only three pairs of walking legs clearly visible, with the last pair being very small and normally positioned under the abdomen and not visible externally.



General shape of a Brachyuran Crab (Dorsal view)-Portunidae



Thoracic sternum and abdomen ventral view

Fishery Resources and their distribution

In India, most of the edible crabs caught from marine and brackish water environments belong to the family Portunidae. In the Indian Ocean, the crab fauna of Portunidae family is included under sub families, Podophthalmidae (Borradaile), Catoptrinae (Sakai), Portuninae (Rafinesque), Caphyrinae (Alcock), Carcininae (Macleay) and Polybiinae (Ortmann). Most of the edible crabs caught from marine and brackishwater environments belong to the sub family Portuninae. In the seas around India, five genera of Portuninae have been reported by various authors. They are *Scylla*, *Portunus*, *Charybdis*, *Lupocyclus* and *Thalamita*. Among them the first three genera contribute to

the commercial crab fishery Commercially important species are *Scylla* spp. (Mud crabs), *Portunus pelagicus* (blue swimmer crab), *P. sanguinolentus* (three spotted crab), *Charybdis feriatus* (crucifix crab), *C. lucifera* (Yellowish brown crab), *C. natator* (line crab) and *Podophthalmus vigil* (long eye-stalk crab; sub fly., Podophthalmidae).

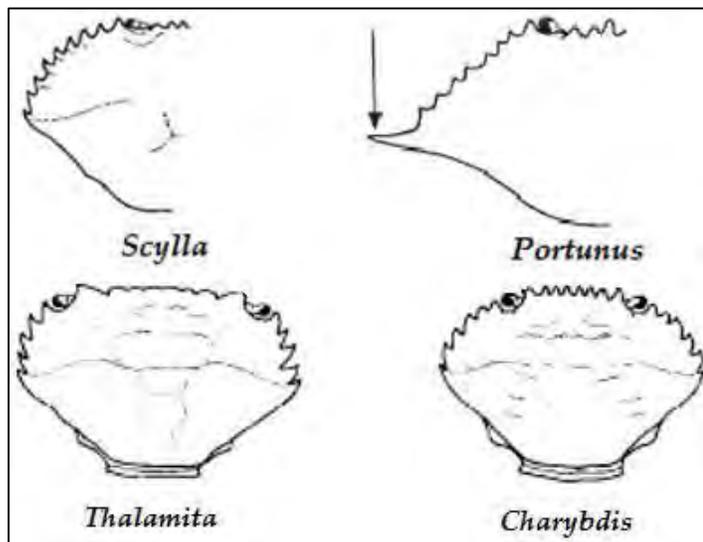
Distribution of commercially important species along the Indian Coast

Gujarat	Maharashtra	Karnataka
<ul style="list-style-type: none"> • <i>Portunus sanguinolentus</i> • <i>Charybdis feriatus</i> • <i>P. pelagicus</i> 	<ul style="list-style-type: none"> • <i>C. feriatus</i> • <i>P. sanguinolentus</i> • <i>P. pelagicus</i> 	<ul style="list-style-type: none"> • <i>C. feriatus</i> • <i>P. sanguinolentus</i> • <i>P. pelagicus</i>
Andhra Pradesh	Odisha	West Bengal
<ul style="list-style-type: none"> • <i>P. pelagicus</i> • <i>P. sanguinolentus</i> • <i>C. feriatus</i> • <i>Scylla serrata</i> • <i>S. olivacea</i> 	<ul style="list-style-type: none"> • <i>P. pelagicus</i> • <i>P. sanguinolentus</i> • <i>C. feriatus</i> • <i>S. serrata</i> • <i>S. olivacea</i> 	<ul style="list-style-type: none"> • <i>S. olivacea</i> • <i>S. serrata</i>
Tamil Nadu		
<ul style="list-style-type: none"> • <i>P. pelagicus</i> • <i>P. sanguinolentus</i> • <i>C. feriatus</i> • <i>C. natator</i> • <i>C. smithi</i> • <i>C. annulata</i> • <i>C. lucifera</i> • <i>C. helleri</i> • <i>Podophthalmus vigil</i> • <i>P. gladiator</i> • <i>S. serrata</i> 		

Portunidae

Carapace hexagonal, transversely ovate to transversely hexagonal, sometimes circular; dorsal surface relatively flat to gently convex, usually ridged or granulose; front broad, margin usually multidentate; usually 5 to 9 teeth on each anterolateral margin, posterolateral margins usually distinctly

converging. Endopodite of second maxillipeds with strongly developed lobe on inner margin. Legs laterally flattened to varying degrees, last 2 segments of last pair paddle-like. Male abdominal segments 3 to 5 completely fused, immovable.



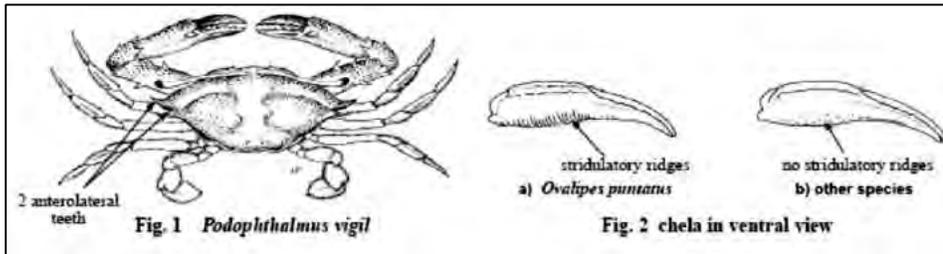
Key to species of interest to fisheries occurring in the area

1a. Carapace with 2 anterolateral teeth; eyes very long, reaching lateral edge of carapace (Fig. 1) ***Podophthalmus vigil***

1b. Carapace with more than 2 anterolateral teeth; eyes normal in size **2**

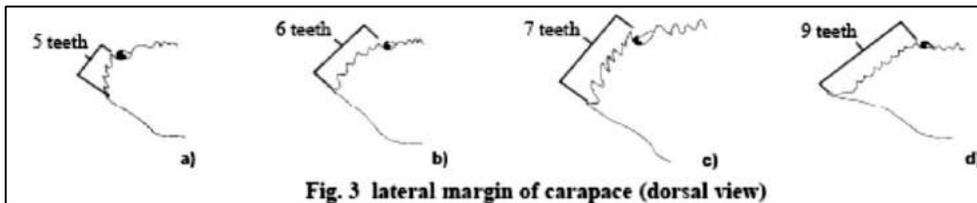
2a. Carapace rounded; ventral surface of palm with stridulatory (sound-producing) ridges (Fig. 2a) ***Ovalipes punctatus***

2b. Carapace transversely ovate; palm without any stridulatory (sound-producing) ridges (Fig. 2b) **3**



3a. Five to 7 teeth on each anterolateral margin (Fig. 3a-c) **4**

3b. Nine teeth on each anterolateral margin (Fig. 3d) **12**

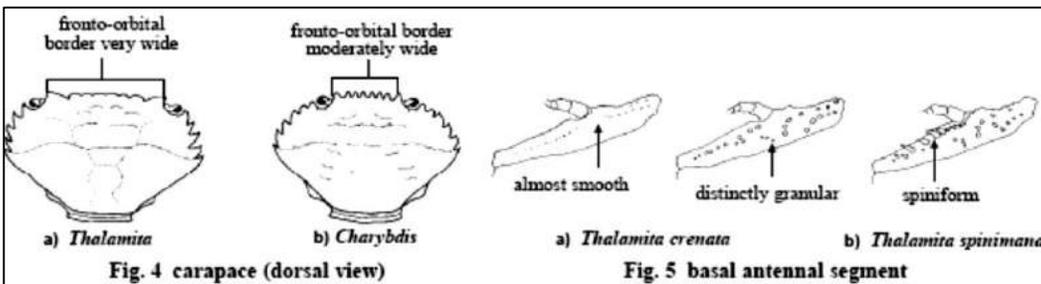


4a. Width of fronto-orbital border not much less than greatest width of carapace; 5 teeth on each anterolateral margin (first tooth sometimes with accessory denticle) (Fig. 4a) **5**

4b. Width of fronto-orbital border distinctly less than greatest width of carapace; 6 or 7 teeth on each anterolateral margin (Fig. 4b) **6**

5a. Basal antennal segment with a smooth or granulated ridge (Fig. 5a) ***Thalamita crenata***

5b. Basal antennal segment with several sharp spines (Fig. 5b) . . . ***Thalamita spinimana***

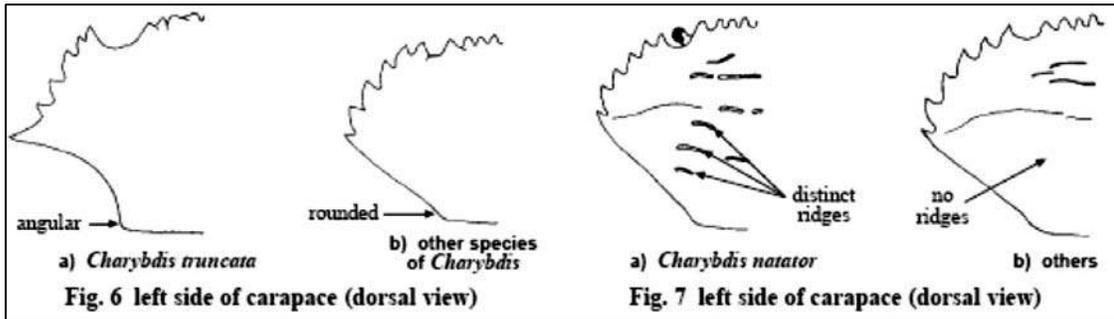


6a. Posterior border of carapace forming an angular junction with posterolateral border (Fig. 6a); merus of cheliped without distal spine on posterior border ***Charybdis truncate***

6b. Posterior border of carapace forming a curve with posterolateral border (Fig. 6b); Merus of cheliped with distal spine on posterior border **7**

7a. Carapace with distinct ridges or granular patches behind level of last pair of anterolateral teeth (Fig. 7a) ***Charybdis natator***

7b. Carapace without distinct ridges or granular patches behind level of last pair of anterolateral teeth (Fig. 7b) **8**

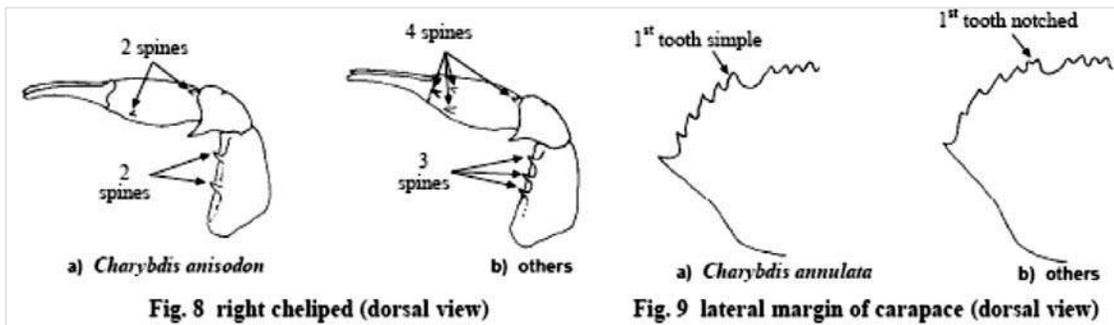


8a. Merus of cheliped with 2 spines on anterior border; palm with 2 spines on upper surface (Fig. 8a) ***Charybdis anisodon***

8b. Merus of cheliped with 3 or 4 spines on anterior border; palm with more than 2 spines on upper surface (Fig. 8b) **9**

9a. First anterolateral tooth not truncate or notched (Fig. 9a) ***Charybdis annulata***

9b. First anterolateral tooth truncate or notched (Fig. 9b) **10**



10a. Palm of cheliped with 4 spines on upper surface (Fig. 10a); male abdominal segment 4 keeled (Fig. 11a) ***Charybdis feriatus***

10b. Palm of cheliped with 5 spines on upper surface (Fig. 10b); male abdominal segment 4 not keeled (Fig. 11b) **11**

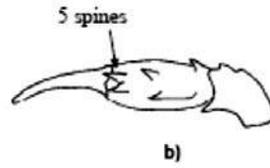
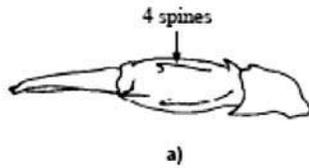


Fig. 10 right cheliped (dorsal view)

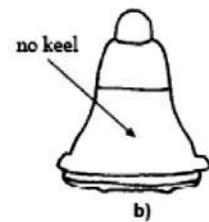
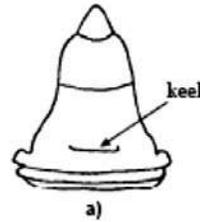


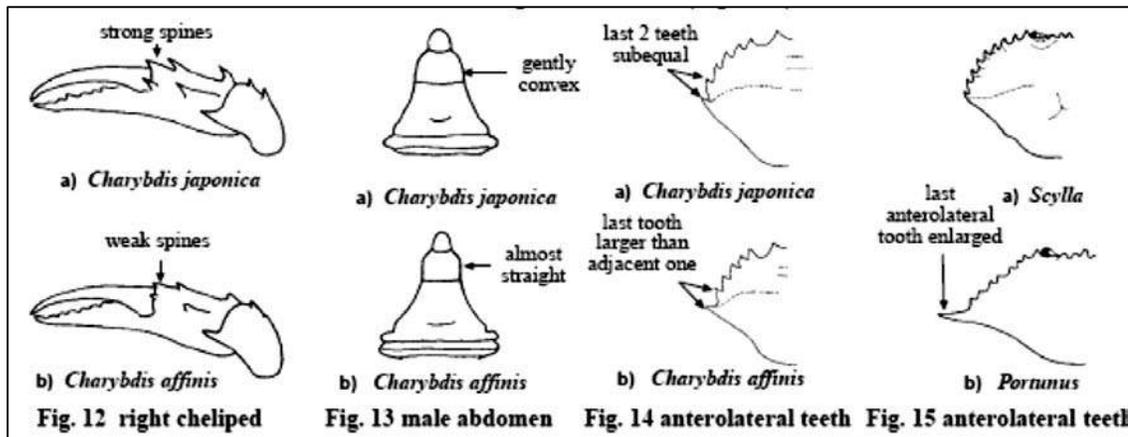
Fig. 11 male abdomen

11a. Palm with well-developed spines (Fig. 12a); male abdominal segment 6 with convex lateral borders (Fig. 13a); last anterolateral tooth smallest and spiniform, not projecting beyond preceding tooth (Fig. 14a) ***Charybdis japonica***

11b. Palm with poorly developed spines (Fig. 12b); male abdominal segment 6 with lateral borders parallel in proximal half (Fig. 13b); last anterolateral tooth elongate, projecting laterally beyond preceding tooth (Fig. 14b) ***Charybdis affinis***

12a. Last anterolateral tooth subequal in size to others (Fig. 15a) **13**

12b. Last anterolateral tooth at least 2 times larger than others (Fig. 15b) **16**



13a. Carpus of cheliped with only 1 low to very low granule on outer surface, never spiniform (Fig. 16a); colour of palm usually with at least some patches of orange or yellow in life **14**

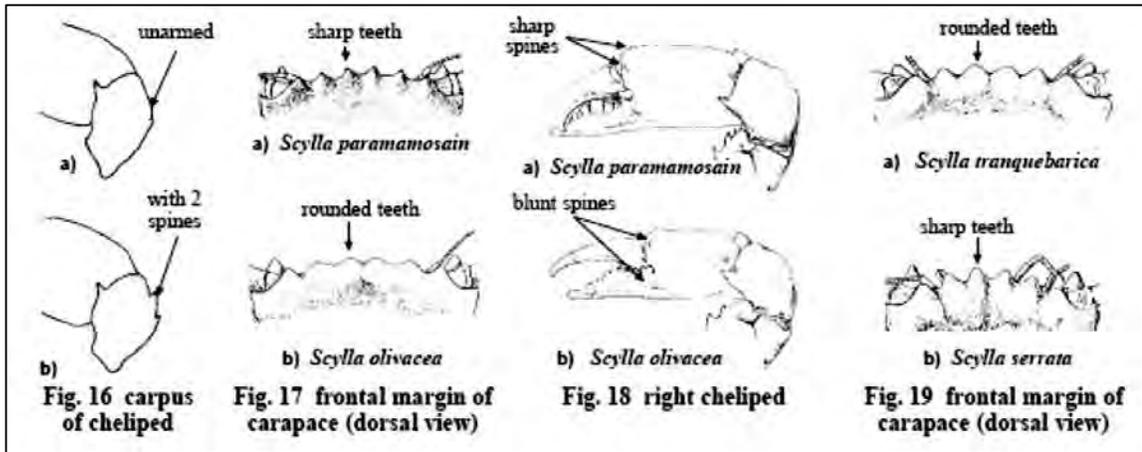
13b. Carpus of cheliped with 2 distinct spiniform or sharp granules or spines on outer surface (Fig. 16b); colour of palm in life green to purple **15**

14a. Frontal margin usually with sharp teeth (Fig. 17a); palm usually with distinct, sharp spines (Fig. 18a) ***Scylla paramamosain***

14b. Frontal margin usually with rounded teeth (Fig. 17b); palm usually with reduced, blunt spines (Fig. 18b) ***Scylla olivacea***

15a. Frontal margin usually with rounded teeth (Fig. 19a); sharp granules on palm and carpus never spiniform; colour in life: carapace usually very dark green to black, outer surface of palm purple and never with marbled pattern, last legs marbled only in males *Scylla tranquebarica*

15b. Frontal margin usually with sharp teeth (Fig. 19b); sharp granules on palm and carpus often spiniform; colour in life: carapace usually green to olive-green, outer surface of palm green and often with marbled pattern, last legs marbled both in males and females *Scylla serrata*

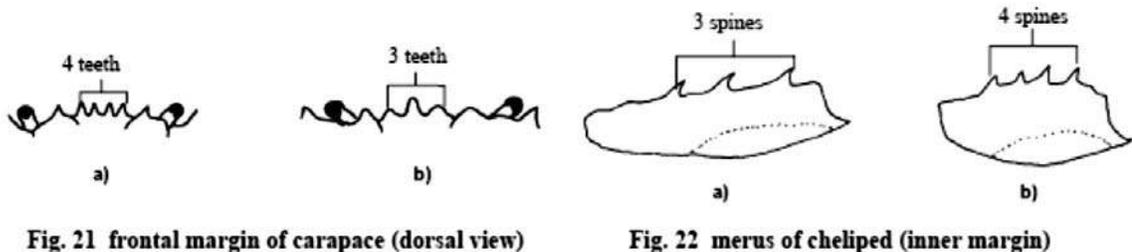


16a. Carapace with 3 purple to red spots on posterior half *Portunus sanguinolentus*

16b. Carapace marbled or with uniform coloration **17**

17a. Front with 4 teeth (Fig. 21a); inner margin of merus of cheliped with 3 spines (Fig. 22a) *Portunus pelagicus*

17b. Front with 3 teeth (Fig. 21b); inner margin of merus of cheliped with 4 spines (Fig. 22b) *Portunus trituberculatus*



Species identification guide for fishery purposes – Crabs –Portunidae

Portunus pelagicus (Linnaeus, 1758) (Flower crab)

Carapace rough to granulose, front with 4 acutely triangular teeth; 9 teeth on each anterolateral margin, the last tooth 2 to 4 times larger than preceding teeth. Chelae elongate in males; larger chela with conical tooth at base of fingers.

Colour: Males with blue markings, females dull green/greenish brown.

Portunus Sanguinolentus (Herbst, 1783)(Three-spot swimming crab)

Carapace finely granulose, regions just discernible; 9 teeth on each anterolateral margin, the last tooth 2 to 3 times larger than preceding teeth. Chelae elongated in males; larger chela with conical tooth at base of fingers; pollex ridged.

Colour: Olive to dark green, with 3 prominent maroon to red spots on posterior 1/3 of carapace.

Charybdis feriatus (Linnaeus, 1758) (Crucifix crab)

Carapace ovate; 5 distinct teeth on each anterolateral margin.

Colour: Distinctive pattern of longitudinal stripes of maroon and white, usually with distinct white cross on median part of gastric region; legs and pincers with numerous scattered white spots.

Charybdis natator (Herbst, 1789) (Ridged swimming crab)

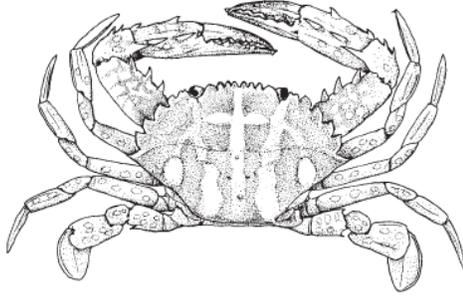
Carapace with densely covered with very short pubescence which is absent on several distinct transverse granulated ridges in anterior half.

Colour: Orangish red overall, with ridges on carapace and legs dark reddish brown.

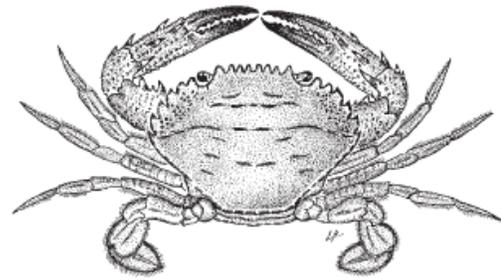
Podophthalmus vigil (Fabricius, 1798)

Carapace distinctly broader than long; anterior margin much broader than posterior margin, with posterolateral margins converging strongly towards narrow posterior carapace margin; orbits very broad. Eyes very long, reaching to or extending beyond edge of carapace.

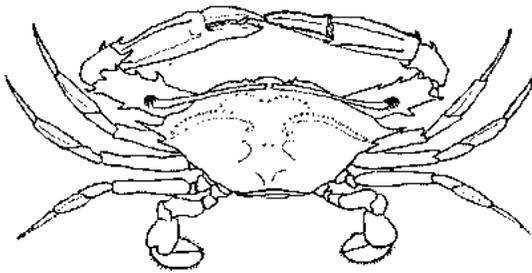
Colour: Carapace green; chelipeds and parts of legs violet to maroon in adults.



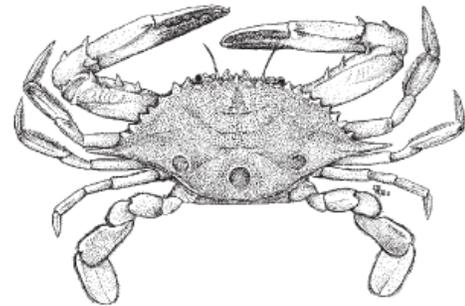
Charybdis feriatus (Linnaeus, 1758)



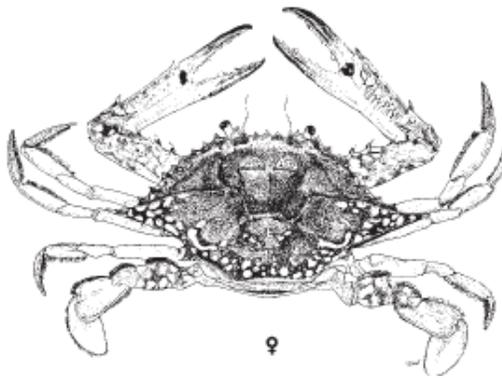
Charybdis natator (Herbst, 1789)



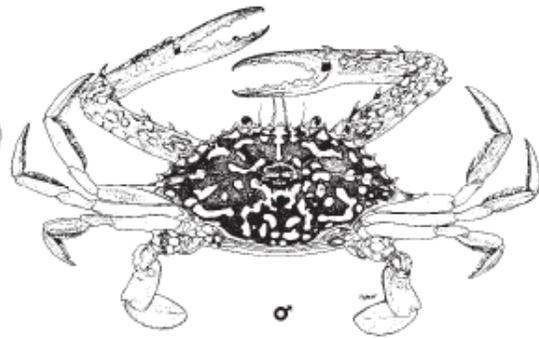
Podophthalmus vigil (Fabricius, 1798)



Portunus Sanguinolentus (Herbst, 1783)



Portunus pelagicus (Linnaeus, 1758)



***Scylla* spp.**

The taxonomy of the genus *Scylla* has been terribly confused and is still difficult. Recent research in Australia (Keenan *et al.*, 1998) has clearly shown, using morphological, DNA, and allozyme data, that there are 4 species of *Scylla*.

Scylla serrata (Forsskål, 1775) (Giant mud crab)

Carapace smooth, with strong transverse ridges; H-shaped gastric groove deep; relatively broad frontal lobes, all more or less in line with each other; broad anterolateral teeth, projecting obliquely outwards, colour green to greenish black; legs may be marbled.

Well-developed spines present on outer surface of chelipedal carpus and anterior and posterior dorsal parts of palm.

Scylla tranquebarica (Fabricius, 1798) (Purple mud crab)

Colour varies from brown to almost black in coloration, and has very well-developed spines on the outer surfaces of the chelipedal carpus and the palm (as seen in *S. serrata*). It differs from *S. serrata*, however, by having the frontal teeth more acutely triangular, the median pair projecting slightly forwards of the lateral pair, and the anterolateral teeth gently curving anteriorly, giving the carapace a less transverse appearance.

Scylla olivacea (Herbst, 1796) (Orange mud crab)

Carapace brownish to brownish green in colour (sometimes orangish), palm orange to yellow. It has a smoother, more evenly convex carapace with very low transverse ridges, a shallow H-shaped gastric groove, the median pair of the frontal lobes more rounded and projecting slightly forwards of the lateral ones, the anterolateral teeth gently curving anteriorly, giving the carapace a less transverse appearance. It also has very low spines on both the outer surface of the chelipedal carpus and the dorsal surface of palm.

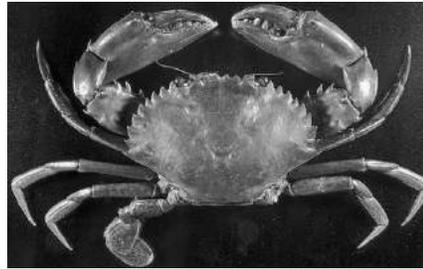
Scylla paramamosain Estampador, 1949 (Green mud crab)

Carapace usually green to light green, palm green to greenish blue with lower surface and base of fingers usually pale yellow to yellowish orange. Frontal margin usually with sharp teeth, palm usually with distinct, sharp spines.

Scylla serrata (Forsskål, 1775)



Scylla tranquebarica (Fabricius, 1798)



Scylla olivacea (Herbst, 1796)



Scylla paramamosain (Estampador, 1949)



Diversity of species along west coast

A total of 226 species of brachyuran crabs belonging to 130 genera and 39 families have been recorded from the different maritime states of the west coast of India. Highest species diversity recorded in Kerala (93 species) followed by Maharashtra (92 species). However, genetic diversity is more in Maharashtra (64 genera) than in Kerala (63 genera). Of the 39 families, Mathildellidae and Geryonidae are found exclusively in Kerala while two families namely, Pseudoziidae and Trapeziidae, known only from Maharashtra and the family Gecarcinidae from Goa. Among the states in the west coast of India, three brachyuran families, viz., Homolodromiidae, Atelecyclidae and Goneplacidae are recorded only from the state of Kerala; their representatives do not occur in the east coast but are found only in the Andaman and Nicobar Islands and Lakshadweep within Indian territorial waters. Among the 39 families, the family Portunidae contains the maximum number of species (28) followed by Xanthidae (23 species) and Leucosiidae (22 species). The genus *Charybdis* supports the maximum number of species (11) in the west coast (Dev Roy, 2013).

Conservation

At present, there is no ban on fishing immature and the berried crabs and the minimum size at capture is not implemented in India. As a conservation measure, only possibility is to educate fishermen to release the juvenile, berried and soft crabs to the sea while they are alive. The governments should take steps to implement ban during peak spawning seasons to prevent indiscriminate fishing. The best method to ensure a sustainable fishery throughout the year as well as to improve the quality of the yield is to ban fishing and marketing of undersized and berried crabs (Josileen, 2007). Recently CMFRI has suggested minimum legal size (MLS) at fishing for important fishery resources for Kerala state (Mohammed *et al.*, 2014).

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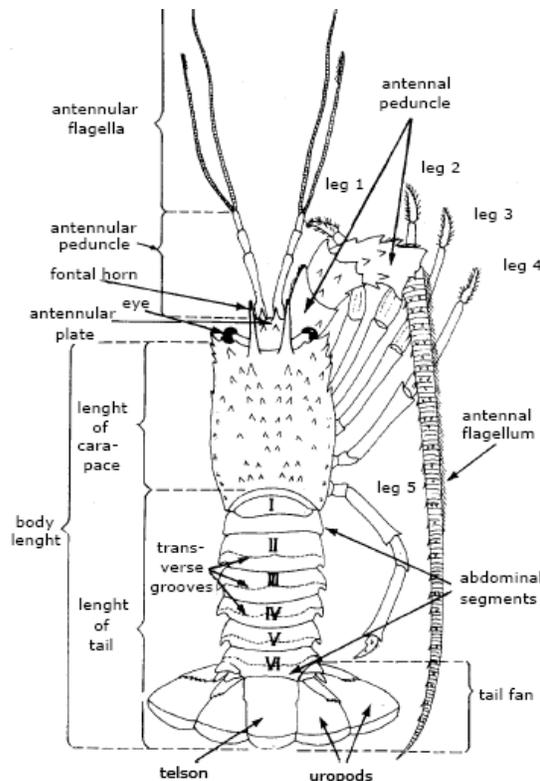
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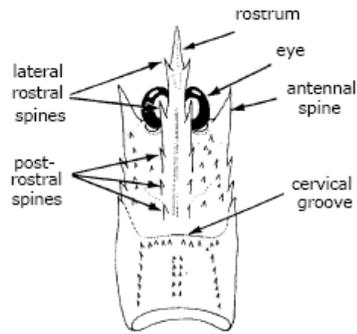
Taxonomy, Biology and Distribution of Lobsters

Dr. Rekha Devi Chakraborty

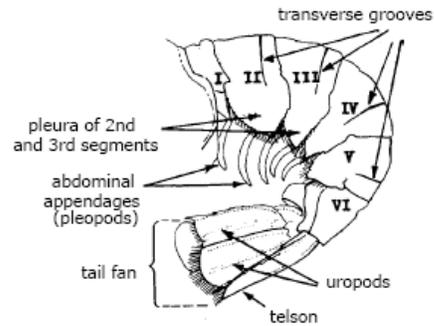
Crustacean Fisheries Division

Lobsters are among the most prized of fisheries resources and of significant commercial interest in many countries. Because of their high value and esteemed culinary worth, much attention has been paid to lobsters in biological, fisheries, and systematic literature. They have a great demand in the domestic market as a delicacy and is a foreign exchange earner for the country.





carapace (dorsal view) of a lobsterette (*Metanephrops* sp.)



tail (abdomen) in lateral view

Taxonomic status

Phylum: Arthropoda

Subphylum: Crustacea

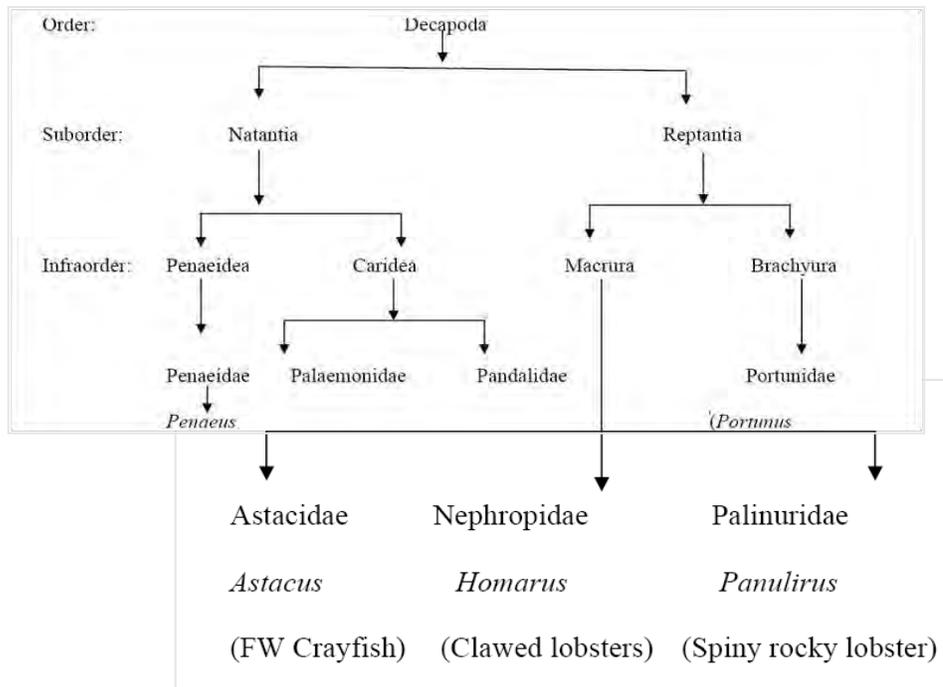
Class: Malacostraca

Subclass: Eumalacostraca

Superorder: Eucarida

Order: Decapoda

Suborder: Macrura Reptantia



The suborder Macrura Reptantia consists of three infraorders: Astacidea (Marine lobsters and freshwater crayfishes), Palinuridea (Spiny lobsters and slipper lobsters) and Thalassinidea (Mud lobsters). The infraorder Astacidea contains three superfamilies of

which only one (Nephropoidea) is considered here. The remaining two superfamilies (Astacoidea and Parastacoidea) contain the freshwater crayfishes. The superfamily Nephropoidea (40 species) consists almost entirely of commercial or potentially commercial species.

The infraorder Palinuridea also contains three superfamilies (Eryonoidea, Glypheoidea and Palinuroidea) all of which are in marine. The Eryonoidea are deepwater species of insignificant commercial interest. The Glypheoidea includes an almost exclusively fossil group. About 120 species are included in the superfamily Palinuroidea.

Third infraorder, Thalassinidea, contains a single superfamily, Thalassinidea which contains around 100 species. Only few representatives of this superfamily are known to be used as food and bait.

Key to the three Infraorders and their Superfamilies

1a. First three pairs of pereiopods with true chelae, the first pair the largest and most robust

2a Fourth pereiopod, and usually also the fifth, without true chelae. Carapace cylindrical not flattened.....Infraorder **Astacidea**, Superfamily **Nephropoidea**

2b All pereiopods, or at least the first four, with true chelae. Carapace flattened. Deep-sea species.....Infraorder **Palinuridea**, Superfamily **Eryonoidea**, Family **Polychelidae**

1b. Third pereiopod never with a true chela, in most groups chelae also absent from first and second pereiopods

3a Antennal flagellum reduced to a single broad and flat segment, similar to the other antennal segments.....Infraorder **Palinuridea**, Superfamily **Palinuroidea**, Family **Scyllaridae**

3b Antennal flagellum long, multi-articulate, flexible, whip-like, or more rigid

4a Epistome long, about 1/3 of carapace length. Eyes on a median elevation of the cephaloninfraorder **Palinuridea**, Superfamily **Glypheoidea**, Family **Glypheidae**

4b Epistome short, far shorter than 1/3 of the carapace. Eyes not placed on an elevation of the cephalon

- 5a Carapace with numerous strong and less strong spines and two frontal horns over the eyes. Rostrum absent or reduced to a single spine. Legs 2 to 4 without chelae or sub chelaeInfraorder **Palinuridea**, Superfamily **Palinuroidea**, Family **Palinuridae**
- 5b Carapace with at most a few spines; no frontal horns. Rostrum present, even though sometimes small. Legs 1 and 1 simple, chelate or subchelate
- 6a First pereopods simple, rostrum flat, broad and triangular or broadly oval.....Infraorder **Palinuridea**, Superfamily **Palinuroidea**, Family **Synaxidae**
- 6b First pereopod chelate or subchelate. Rostrum of diverse shapes.....Infraorder **Thalassinidea**

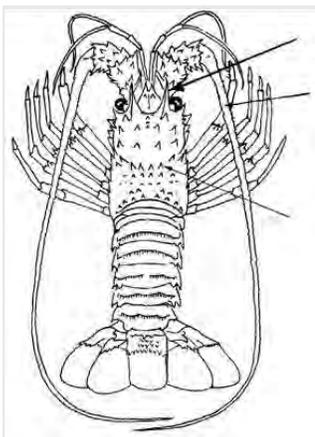
Superfamily Palinuroidea (Latreille, 1802)

Three families make up this superfamily, namely the Palinuridae (Spiny lobsters), Synaxidae (Furry lobsters) and Scyllaridae (Slipper lobsters).

Key to families

1a. Antennal flagellum reduced to a single, flat, plate which forms the sixth and final segment of the antenna. The shovel-like appearance of the antennae is responsible for the names shovel-nose lobster and bulldozer lobster also used for the animals of this group**Scyllaridae**

1b. Antennal flagellum long and consisting of numerous small articles, whip-like or spear-like



Frontal horns

Antennal

Spines on carapace



6th Segment = flagellum

antenna

Family: Palinuridae (Latreille, 1802)

Antennal flagellum long and consisting of numerous small articles, whip-like or spear-like. Rostrum absent or visible as a small on anterior margin of carapace. Carapace with a pair of frontal horns above the eyes, and usually with spines on the dorsal surface; hairs on carapace, if present, few and scattered.....**Palinuridae**

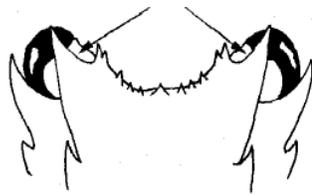
There are 11 genera in this family *Justitia*, *Jasus*, ***Linuparus***, *Nupalirus*, *Palibythus*, *Palinurus*. ***Palinustus***, ***Panulirus***, *Projasus*, ***Puerulus***, *Sagmariasus*, (those in bold letters are represented in India)

Key to genera occurring in the family Palinuridae

Two distinct widely separated tooth-like frontal horns, between which the anterior margin of the carapace is visible; antennal flagella quite flexible; flagella of antennules long, whip-like longer than peduncle of antennules; antennular plate and stridulating organ present.....***Panulirus***

Genus *Panulirus* (White, 1847)

Anterior margin of carapace between frontal horns with about 10 small, sharp teeth; pleura of second to fifth abdominal somites with a strong anterior tooth followed by a lobe denticulated on the posterior margin

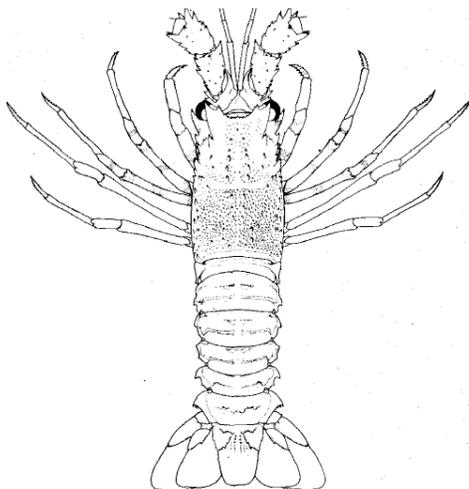


a. anterior part of carapace



tooth denticulated margin

.....***Panulirus***



George and Main (1967) recognized nineteen species within this genus in tropical and subtropical waters of the Indian, Pacific and Atlantic oceans. Six of these occur along the Indian coast. Tooth-like frontal horns; antennal flagella quite flexible; flagella of antennules long, whip-like, longer than peduncle of antennules; antennular plate and stridulating organ present.

The species found in Indian waters are *Panulirus homarus*, *P. polyphagus*, *P. ornatus*, *P. versicolor*, *P. penicillatus*, and *P. longipes longipes*.

There are three subspecies: *Panulirus homarus homarus* (Linnaeus, 1758), *P. homarus rubellus* (Berry, 1974) and *P. homarus megasculpta* (Pesta, 1915).

Key to species of *Panulirus* recorded off the Indian coast and the island groups, Andaman Nicobar Island and the Lakshadweep Islands

1. Abdominal segment 2-5 with the transverse grooves.....2 Abdominal segments 2-5 without transverse grooves or with indistinct grooves in juveniles only.....4
 2. Margin of transverse abdominal grooves with squamae varying from well developed and even in size to minute and irregular in size. Overall colour ranges from brownish-red in specimens with large squamae to olive green in specimens with minute squamae***P. homarus***
 3. Margin of transverse abdominal grooves with squamae varying from well developed and even in size to minute and irregular in size. Overall colour ranges from brownish-red in specimens with large squamae to olive green in specimens with minute squamae***P. homarus***
 4. Antennular plate (between the stridulating organs) with 2 pairs (4) of subequal principle spines, fused at their bases. Supraorbital horns rounded in cross section. Overall colour olive-black.....***P. pencillatus***
Antennular plate with 1 pair (2) of equal principle spines; supraorbital horns flattened bilaterally. Overall colour purplish-red with abdomen covered with conspicuous white spots.....***P. longipes***
Antennular plate with 1 pair of equal spines; white bands on each abdominal segment. Legs with white spots, colour olive green.....***P. polyphagus***
 5. Conspicuous transverse white band posteriorly on each abdominal segment. Legs with longitudinal white stripes, juveniles have white antennae. Overall colour black and green.....***P. versicolor***
- No transverse white band on abdominal segments but above each pleural spur is a conspicuous white spots. Legs with irregular transverse mottling, no longitudinal stripes. Overall colour bluish green.....***P. ornatus***

***Panulirus homarus homarus* (Linnaeus, 1758)**

Diagnosis: Abdominal segments 2-5 with transverse grooves interrupted in the middle; minute squamae on the upper margin of the groove; antennular plate with four spines; exopod of third maxilliped absent; second maxilliped with no flagellum; olive green in specimens with minute squamae.

Distribution: The *P. homarus homarus* subspecies has a broad geographic range extending from East Africa to Japan including Indonesia, Australia, New Caledonia and the Marquesas Archipelago (Holthius, 1991). Northwest, southwest, southeast coast of India, Andaman & Nicobar Islands and Lakshadweep Islands. Forms fishery along southwest and southeast coast; promising species for aquaculture.



Habitat and ecology: The species is commonly found in very shallow water (1-15 m), although can be found to depths of 90 m. It inhabits rocky reefs for shelter (Holthius, 1991).

Biology: Maximum total length 31cm, carapace length 12 cm. Average total length 20 to 25 cm, Major fisheries are on the southeast and southwest coast of India. The commercial fishery at Muttom, Kanyakumari district was found to be largely supported by 1st and 2nd year animals. At a given carapace length females are heavier than males. Females attain functional maturity at a carapace length (CL) of 55 mm. Males attain maturity at 63 mm CL on the basis of allometric growth of III walking leg. Peak breeding season is from November to December.

Panulirus polyphagus (Herbst, 1793)

Diagnosis: Abdominal somites smooth, without transverse groove. Surface of abdominal somites naked and smooth. Exopod of third maxilliped absent; second maxilliped with flagellum present; antennular plate with two strong spines; white transverse bands on the abdomen.



Distribution: This species has abroad range from Pakistan and India to Vietnam, the phillippines, Indonesia, northwest Australia and the Gulf of Papua (Holthius, 1991). In India this species is the most important commercial species contributing to nearly three-fourth of the total lobster catch of the country. Major fisheries are on the northwest coast of India. Exported

in whole-cooked frozen form; promising species for aquaculture.

Habitat and Ecology: The species is commonly found in coastal waters on muddy and rocky substrates to a depth of 40m, although it is occasionally seen at 90m and is often seen near the river mouths (Holthius, 1991).

Biology: The size in the fishery ranged from 75mm to 385mm total length (TL), those between 160mm and 230mm TL forming the mainstay of the fisheries in Maharashtra. Juveniles of both sexes showed identical growth rate and measured 85 mm TL in the first year, 145mm TL in the second year and 205mm TL in the third year. Males demonstrated faster growth rate. Females attained 50% maturity at 175mm TL. Peak breeding is in September. High exploitation ratio of 0.85 and 0.82 in males and females respectively has resulted in recruitment overfishing in Mumbai waters (Radhakrishnan *et al.*, 2007). Exported in whole-cooked frozen form.

Panulirus ornatus (Fabricius, 1798)

Diagnosis: Abdominal somites smooth and naked; colour of abdomen brownish or greenish-grey with utmost minute indistinct speckles. The usually large eyespot in the anterior half near the base of the pleura is accompanied by an oblique pale streak placed somewhat median of the eyespot. Legs not streaked, but with very sharply defined irregular dark spots.

Distribution: Tropical Indo-Pacific; It ranges from Natal in South Africa, along the coast of East Africa and the Red sea to southern Japan, the Solomon island, Papua New Guinea, Australia, New Caledonia and Fiji (Holthius, 1991). Forms fishery along the southeast coast of India.

Habitat and ecology: In shallow, sometimes slightly turbid coastal waters; from 1 to 8m depth, with a few records from depths as great as 50m; on sandy and muddy substrates and sometimes on rocky bottom often near the mouth of rivers, but also on coral reefs. The species has been reported as solitary or as a living in pairs, but has also been found in larger concentrations.

Biology: This is the largest of the *Panulirus* species and can attain a total body length of about 50cm, but usually is much smaller (25-30cm). Mainly form fishery along the southeast coast of India. *P. ornatus* caught both by trawlers and gillnets. *P. ornatus* forms major component of the trawler catch. *P. ornatus* appears throughout the year, but highest catch is in May at Tuticorin. The size of lobsters in the fishery ranges from 113 to 233mm TL in males and 128-452mm TL in females with 41% falling in the size range of 181-190mm TL, which are juveniles. At Tuticorin the inshore fishery for juveniles *P. ornatus* is detrimental to the stock. Occasionally found along the west coast



of Kanyakumari district and form a small fishery at Tikkoti, Calicut. Occurrence of adult and egg bearing population at 40-60m depth indicated that the species breed probably at relatively deeper areas. This is a fast growing spiny lobster among the tropical species. Females mature at 90mm CL. The Fecundity in specimens caught along the Chennai coast (104.4 to 145.1mm CL) ranges from 5,18,181 to 19,79,522 eggs.

Panulirus versicolor (Latreille, 1804)

Diagnosis: Antennular plate with 4 strong spines arranged in a quadrangle. Carapace whitish with well-defined, sharply delimited area of bluish black; antennal peduncles pink; antennal flagella white; abdominal somites 2 to 5 with white transverse bands; legs with streaks of white lines.

Distribution: This species known throughout Indian ocean (east coast of Africa and the Red sea) east to Japan, Micronesia, Melanesia, Polynesia, and northern Australia (Holthius, 1991). Along the Indian coast the species has been reported from southeast, southwest, A & N Islands and Lakshadweep.

Habitat and ecology: This species is found in areas of coral reef, most often on the seaward edge of the reef plateau, where it utilizes the reef and rocks for shelter. It is found in shallow waters to a maximum depth of 15m (Holthius, 1991). Furthermore, they are nocturnal and they only aggregate in very small numbers.

Biology: Fishery of lower magnitude reported along the Chennai, Mandapam, Trivandrum coasts. In A & N Islands, *P. versicolor* formed 26% of total landings (0.12t) in 1999 (Kumar *et al.*, 2010). The fecundity of *P. versicolor* (66.0 to 95mm CL) from Chennai coast was estimated to range from 1.70 to 7.34 lakhs.

Panulirus penicillatus (Olivier, 1791)

Diagnosis: Antennular plate with 4 strong spines which are fused at the base forming a single bunch of 4 diverging points, the anterior pair shorter than the posterior. Transverse grooves over the abdomen uninterrupted.

Distribution: This species has the widest distribution of any of the spiny lobsters. It occurs in Indo-west Pacific and East Pacific regions (Holthius, 1991). South from the Red sea to South and East Africa; Madagascar and surrounding islands, through the Indian Ocean and South China sea to Japan, the Philippines, Indonesia, Hawaii, Samoa, northern and eastern Australia and as far as east as the islands of north west coast of US and Mexico. Along the Indian Coast, the



species is distributed along the southeast and southwest coast. Lakshadweep as well as in Andaman & Nicobar Islands.

Habitat and ecology: This nocturnal species commonly inhabits at depth of 1 to 4m (Maximum 16m), on rocky substrates (Chan, 1988). It is often found in the outer reef slopes, subtidal zone or surge channels, and as such can occur on small islands or near arid coast (Holthius, 1991). In the Western Pacific, females seem to be reproductive all year round (Chan, 1988).

Biology: Little information is available on the biology of the species as there is only occasional capture of the species from Indian coast. The species has been successfully cultured in the laboratory (Nelson *et al.*, 2006). There is little demand for the species in the live lobster export market.

Panulirus longipes (A. Milne Edwards, 1868)

This species is comprised of two subspecies *Panulirus longipes longipes* (A. Milne Edwards, 1868) and *P. longipes bispinosus* Borradaile, 1899. The species found along the Indian coast is *P. longipes longipes*.

P. longipes longipes (A. Milne Edwards, 1868)

Diagnosis: Body or especially the abdomen covered with numerous distinct round spots; legs with light longitudinal streaks; abdomen dark purple. No pubescent area on the

abdominal somites behind the transverse groove; exopod of third maxilliped present.



Distribution: Indo-west pacific, East Africa to Thailand, Taiwan, the Phillipines, Indonesia and India. Along the Indian coast the species was reported from the southeast and southwest coast and A & N Island.

Habitat and ecology: The species lives in clear or slightly turbid water at depths of 1-18 m (also reported from 122m), in rocky area and coral reefs. The animals are nocturnal and not gregarious (Holthius, 1991).

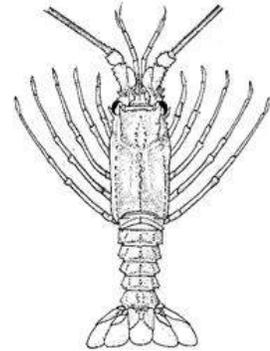
Biology: As this is not a commercial species and occasionally landed as single specimens, not much information is available on the biology of the species from Indian



waters. Maximum total body length 30cm, average length 20 to 25cm. The smallest ovigerous female has a total length of 14cm

Genus *Puerulus* (Ortmann, 1897)

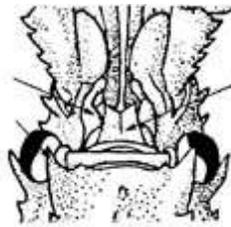
Antennular plate distinct, a stridulating organ present. Carapace with a median ridge behind the cervical groove, often with spines or tubercles, but without submedian rows ***Puerulus***



Pleura of 3rd and 4th abdominal somites

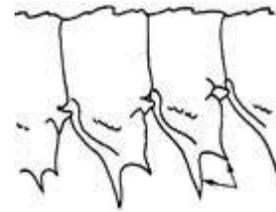
Stridulating organ

Frontal horns



Anterior part of carapace

Antennular plate



Two teeth

Four species have been recognized so far in this genus, all deep waters forms *P. sewelli* forms a commercially important fishery along the southwest and southeast coast of India.

Key to species (after Berry, 1969)

1. Two teeth between frontal horns and the cervical groove

1a. Median keel of carapace with 5 post-cervical and 2 or 3 intestinal teeth. Fifth pereopod of male not chelate ***P. sewelli***

***Puerulus sewelli* (Ramadan, 1938)**

Diagnosis: Median keel of carapace with 5 post-cervical and 2 or 3 intestinal teeth. Fifth pereopod of male not chelate.

Distribution: Western Indian Ocean; Somalia, Gulf of Eden, off Pakistan, southwest (Quilon Bank, Mangalore) and southeast (off Mandapam and Tuticorin, Gulf of Mannar) of India and A & N Islands.

Habitat and ecology: Known from depth between 180 and 300 m on a substrate of coarse sand hard mud and shells (Holthius, 1991).

Biology: Maximum total body length 20cm, maximum carapace length about 8 cm. Average total length about 15cm. The species was commercially exploited along the southwest and southeast coast of India. A catch rate of 200-300 kg/hr was reported from vessels opening off Mandapam. January to April is the peak period of abundance. During 1998-2000, 524t were landed at Sakthikulangara, Kollam, and Kerala. The sizes of *P. sewelli* ranged from 76-80mm to 176-180 TL in Males and from 81-85mm to 176-180mm in females. 26% of females were found in mature/berried stage. Due to coincidence of peak breeding and the fishery, the breeding population has been heavily exploited. The species has been overexploited and the current landing is around 2 tonnes/annum from Quilon Bank.



Due to coincidence of peak breeding and the fishery, the breeding population has been heavily exploited. The species has been overexploited and the current landing is around 2 tonnes/annum from Quilon Bank.

A large single median tooth before the cervical groove. Apart from two submedian and two lateral longitudinal rows of spines the posterior half of the carapace is smooth and without spinules. Abdominal pleura ending in two single sharp teeth ***Projasus***

Genus: *Palinustus* (A. Milne Edwards, 1880)

This genus is characterized by the shape of the frontal horns, that do not end in a sharp point but in a broad, bluntly truncated to that sometimes is crenulated; a strong spine is present on the outer margin of each horn.

Four species have been described of this genus, none has any commercial value as all species seem to be very scarce and all occur at considerable depths. The taxonomic status of some of the species is not yet clear.

From the data in the literature it seems most likely that almost all the specimens, other than the type material, that have been identified as ***Palinustus mossambicus*** do not belong to that species but must be assigned to ***Palinustus waguensis***.

Antennular plate narrow, unarmed; Major supraorbital processes terminating in a blunt crenulated margin; two spines on anterior straight margin of carapace between the supraorbital processes; first peduncular joint of antennae extending beyond and of peduncle of antennules..... ***Palinustus***

Key to species

1a. Anterior margin of carapace between the frontal horns convex, with a single median spine; no other spines on this margin, but a single, small denticle on the inner margin of

each horn. Epistome with 5 to 7 spines on the anterior margin, and small spines in the anterolateral corner (Natal, South Africa) ***P. unicornutus***

1b. Anterior margin of carapace between the frontal horns straight or convex, with two or more spines. Epistome with spinules or tubercles on the anterior margin; anterolateral corners with a single spine or unarmed.

2a. A strong median spine, in addition to several others, on the anterior margin of the carapace between the frontal horns. Inner margin of the horns without spines. Epistome with 5 tubercles on the anteromedian margin; anterolateral corner with a strong spine. Western Atlantic ***P. truncates***

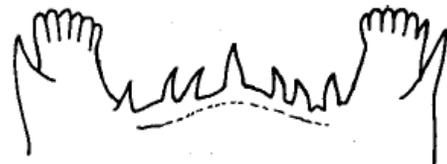
2b. No median spine on anterior margin of carapace. Epistome with tubercles or spinules on anteromedian margin; anterolateral corner with a small spine or unarmed. Indo-West Pacific.

3a. Anterior margin of carapace between frontal horns with a single pair of strong submedian spines; rest of the margin as well as the inner margin of the horns unarmed or with 2 very small spinules. Deep sea (406 m), but also reported from 59 to 61 m. East Africa (Somalia, Mozambique)..... ***P. mossambicus***

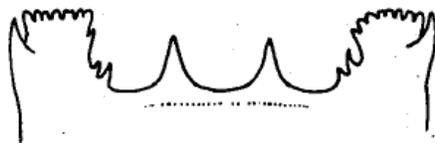
3b. Anterior margin of carapace as well as inner margin of the frontal horns with several distinct spines. Shallow water form, 0 to 180 m. Indo-West Pacific region (India, Thailand, Philippines, Japan)***P. waguensis***



P. unicornutus



P. truncates



P. mossambicus



P. waguensis

Anterior margin of carapace (dorsal view)

Family: Scyllaridae (Latreille, 1825)

Key to Identification of the family

Antennal flagellum reduced to a single, flat plate which forms the sixth and final segment of the antenna. The shovel-like appearance of the antennae is responsible for the name shovel-nosed lobster for the animals of this group.....**Scyllaridae**

The greater part of the lobsters seem to be omnivores and scavengers, but few detailed observations are available on feeding habits. Some species are attracted by dead fish put as bait in lobster traps, but others are hardly ever caught in such traps. The Thalassinidea are mostly detritus feeders. Some lobsters also eat live animals; e.g. *Scyllarides tridacnophaga* has been observed to attack, open and eat specimens of the giant clam *Tridacna*.



The family Scyllaridae includes 19 genera which are distributed in 4 Subfamilies, Arctidinae Holthuis, 1985; Ibacinae Holthuis, 1985; Scyllarinae Latreille, 1825 and Theninae Holthuis, 1985 (Chan, 2010). A single species coming under the subfamily Theninae alone is of commercial importance along Indian coast. The subfamily Arctidinae contains two genera Arctides Holthuis, 1960 and Scyllarides Gill, 1898. Two species under the genus Scyllarides have been reported from Indian coast.

Subfamily Arctidinae (Holthuis, 1985)



Genus *Scyllarides* (Gill, 1898)

***Scyllarides elisabethae* (Ortmann, 1894)**

Diagnosis: Lateral margin of carapace with distinct cervical and postcervical incisions. Anterior margin of the carapace between the eye and the antero-lateral angle evenly concave.

Distribution: Indo-west Pacific region; Known from southeast Africa and Vizhinjam, Southwest coast of India.

Habitat and ecology: Depth range from 37 to 380m (mostly less than 100 m) on substrate of fine sediments mud or fine sand. The animals seem to dig into the mud.

Biology: A single female specimen measuring 120mm CL, 330mm TL and weight 740g was caught off Vizhinjam coast from a depth of 50m by trammel net.

Subfamily: Theninae (Holthuis, 1985)

This monotypic family was recently revised by Burton and Davie (2007). There is only one genus *Thenus* in the subfamily. Five species has been identified using both morphology and molecular methods. The species so far described as *Thenus orientalis* from most part of Indian coast is *T. unimaculatus* (Radhakrishnan *et al.*, 2013). *T. indicus* is also presumed to exist along the southeast coast of India (Jeena, 2013).

Genus *Thenus* (Leach, 1816)

Diagnosis: Orbits on the anterolateral angle of the carapace. Body strongly depressed. Lateral margin of the carapace with only the cervical incision. No teeth on the lateral margin of the carapace, apart from the antero-lateral and postcervical. Fifth leg of female without a chela.

***Thenus unimaculatus* (Burton & Davie, 2007)**

Diagnosis: Purple to black pigmentation blotch on inner surface of merus of second and sometimes third legs, usually large but variable in extent and may be reduced to a narrow streak; purple pigmentation occasionally surrounding eye socket on carapace; outer phase of propodus of p2 having upper-most longitudinal groove bearing obvious



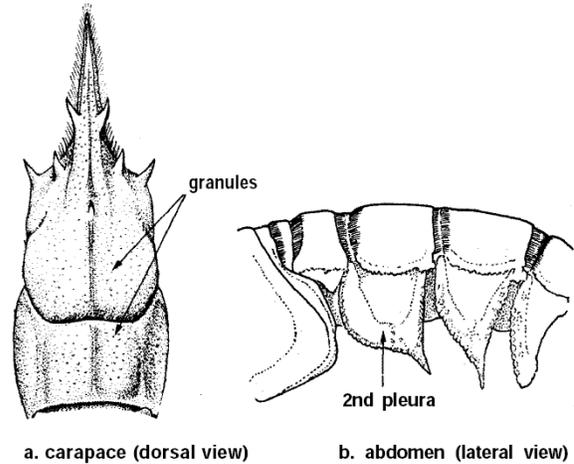
setae over atleast proximal half. Merus of third Maxilliped with a small spine proximally on inner ventral margin; inner margin of ischium prominently dentate along the entire length. No single morphometric ratios that fall outside the following maximum and minimum values; carapace width (CM1) greater than 1.29 times carapace length (CL); length of propodus of pereopod 1 (PL1) less than 0.23 times carapace length (CL); length of propodus of pereopod 2 (PL2) greater than 0.39 times carapace length (CL); width of propodus of pereopod 1 (PW1) greater than 0.35 times length (PL1).

Distribution: Indo-west Pacific region. In India, the species is distributed along the northwest, southwest, southeast and the northeast coasts. Forms commercially fishery in Saurashtra region, Kollam and Chennai.

Habitat and ecology: Depth range from 8 to 70m, usually between 10 and 50m; on soft substrate, sand or mud.

Biology: Maximum total body length about 25cm; often appears as bycatch in trawl; also caught in gillnets. At Kollam, Kerala peak fishery was observed from November to February. Total length varied between 61-230mm in males and 46-250 mm in females. Length at recruitment (Lr) was 48mm. Absolute fecundity varied from 14750 to 33250 mature eggs (Radhakrishnan *et al.*, 2013).

3a Eye not pigmented. Body granular and hairy, but not covered with evenly placed large pearly tubercles. Pleura of second abdominal somite ending in a long sharp point ***Nephropsis***



3b. Eye with pigmented, although small, cornea. Body entirely covered by conspicuous rounded pearly tubercles. Pleura of second abdominal somite broadly trapezoid, distal margin obliquely truncate, ending in a blunt posterior tooth ***Nephropides***

Genus *Nephropsis* (Wood-Mason, 1872)

Five species reported from Indian waters.

***N. carpenteri* (Wood-Mason, 1885);** English name: Ridgeback lobsterette

Distribution range: Bay of Bengal

***N. stewarti* (Wood-Mason, 1872);** English name: Indian Ocean lobsterette

Range distribution: Indo-West Pacific from Eastern Africa to Japan, the Philippines, Indonesia and Northwestern Australia from 170 to 1,060 m depth (Chan, 1998). Southwest coast (Mangalore, Cochin), Southeast coast of India (Chennai), A & N Islands (Ross Island).

Habitat and ecology: Depth 250-500 m; Forms small scale fishery at Mangalore. During 2000-2006, the average annual landing of the species was estimated at 23.3t with the highest landing in 2001 (51t) and the lowest in 2005 (9 t).

Biology: Fishery was constituted by the length range 58-158 mm. Females < 80mm (Total length) were found to be immature. Highest percentage (33%) of immature females was found during November.

***N. sulcate* (MacPherson, 1990)**; English name: Grooved lobsterette

Range distribution: Indo-Pacific; southwest coast of India

***N. ensirostris* (Alcock, 1901)**; English name: Gladiator lobsterette

Range distribution: North of Lakshadweep, Arabian sea

***N. suhmi* (Bate, 1888)**; English name: Red & White lobsterette

Range distribution: Aru Islands, Indonesia, West coast of India

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Molluscan Taxonomy

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The molluscs belong to the large and diverse phylum Mollusca, which includes a variety of familiar animals well-known as decorative shells or as seafood. These range from tiny snails, clams, and abalone to larger organisms such as squid, cuttlefish and the octopus. These molluscs occupy a variety of habitats ranging from mountain forests, freshwater to more than 10 km depth in the sea. They range in size from less than 1 mm to more than 15 m (for example the giant squid) and their population density may exceed 40,000/m² in some areas. In the tropical marine environment, molluscs occupy every trophic level, from primary producers to top carnivores. India has extensive molluscan resources along her coasts. In the numerous bays, brackish waters and estuaries and in the seas around the subcontinent; molluscs belonging to different taxonomic groups, such as, mussels, oysters, clams, pearl-oysters, window-pane oysters, ark-shells, whelks, chanks, cowries, squids and cuttlefish have been exploited since time immemorial for food, pearls and shells.

Three classes of the phylum Mollusca namely, Gastropoda, Bivalvia and Cephalopoda are of fisheries interest. About 3270 species have been reported from India belonging to 220 families and 591 genera. Among these the bivalves are the most diverse (1100 species), followed by cephalopods (210 species), gastropods (190 species), polyplacophores (41 species) and scaphopods (20 species). The first three orders are exploited by Indian fishermen from time immemorial. Presently over 150,000 tonnes of cephalopods, over 100,000 t of bivalves and nearly 20,000 t of gastropods are exploited from Indian waters. The importance of molluscs in the coastal economy of India is often overlooked. For example, the cephalopod fishery is now a US\$ 250 million industry and is one of the mainstays of the Indian trawl fleet in terms of revenue. The bivalve exports amount to US\$ 1.2 million and gastropod exports amount to US\$ 1.8 million per annum.

CEPHALOPOD TAXONOMY

Cephalopods are found to occur in all the oceans of the world from the tropics to the polar seas and at all depths ranging from the surface to below 5000 m. Chambered nautilus, cuttlefishes, squids and octopus are the four major groups of cephalopods, which belong to the highly evolved class of phylum Mollusca. Cephalopods are the third largest molluscan class after bivalves and gastropods and consist of more than 800 species (Lindgren *et al.*, 2004). Of these less than a hundred species are of commercial importance. About 210 species cephalopods have been reported from India. There are about 80 species of cephalopods of commercial and scientific interest distributed in the Indian Seas.

Systematic position of potentially important cephalopods of India

Class	Cephalopoda	
Sub class	Nautiloidea	
Family	Nautilidae	<i>Nautilus pompilius</i>
Subclass	Coleoidea	
Order	Teuthoidea	
Suborder	Myopsida	
Family	Loliginidae	
Genus	<i>Uroteuthis</i>	<i>Uroteuthis (Photololigo) duvaucelii</i>
		<i>U. (P.) sibogae</i>

		<i>U. (P.) singhalensis</i>
		<i>U.(P.) edulis</i>
		<i>U. (P.) chinensis</i>
Genus	<i>Sepioteuthis</i>	<i>Sepioteuthis lessoniana</i>
Genus	<i>Loliolus</i>	<i>Loliolus (Loliolus) hardwickei</i>
		<i>Loliolus (Nipponololigo) uyii</i>
		<i>L.(N.) sumatrensis</i>
Suborder	Oegopsida	
Family	Onychoteuthidae	
Genus	<i>Onchoteuthis</i>	<i>Onchoteuthis banksii</i>
Family	Ommastrephidae	
Subfamily	Ommastrephinae	
Genus	<i>Sthenoteuthis</i>	<i>Sthenoteuthis oualaniensis</i>
Family	Thysanoteuthidae	
Genus	<i>Thysanoteuthis</i>	<i>Thysanoteuthis rhombus</i>
Order	Sepioididae	
Family	Sepiidae	
Genus	<i>Sepia</i>	<i>Sepia pharaonis</i>
		<i>Sepia aculeata</i>
		<i>Sepia prashadi</i>
		<i>Sepia elliptica</i>
		<i>Sepia trygonina</i>
		<i>Sepia brevimana</i>
		<i>Sepia arabica</i>
		<i>Sepia kobiensis</i>
		<i>Sepia prabahari</i>

		<i>Sepia ramani</i>
		<i>Sepia omani</i>
Genus	<i>Sepiella</i>	<i>Sepiella inermis</i>
Family	Sepiolidae	
Genus	<i>Euprymna</i>	<i>Euprymna stenodactyla</i>
Order	Octopoda	
Suborder	Incirrata	
Family	Octopodidae	
Genus	<i>Amphioctopus</i>	<i>Amphioctopus aegina</i>
		<i>Amphioctopus neglectus</i>
		<i>Amphioctopus marginatus</i>
		<i>Amphioctopus rex</i>
Genus	<i>Cistopus</i>	<i>Cistopus indicus</i>
Genus	<i>Haplochlaena</i>	<i>Haplochlaena maculosa</i>
Genus	<i>Callistoctopus</i>	<i>Callistoctopus luteus</i>
Genus	<i>Octopus</i>	<i>Octopus vulgaris</i>
		<i>Octopus lobensis</i>
Genus	<i>Pteroctopus</i>	<i>Pteroctopus keralensis</i>
Family	<i>Argonautidae</i>	
Genus	<i>Argonauta</i>	<i>Argonauta hians</i>
		<i>Argonauta argo</i>

Classification

Cephalopods (Class Cephalopoda) are represented by two extant subclasses, Nautiloidea (Nautilus and Allonautilus) and Coleoidea, and one extinct subclass, Ammonoidea. Members of the subclass Coleoidea includes two subdivisions, the Belemnoidea, which is the primitive form of cephalopods possessing ink sac and ten equally sized arms, became extinct during the cretaceous period and Neocoleoidea (cuttlefish, squid and octopus) where the shell has been internalized and reduced, completely lost. As a

consequence, members of Neocoleoidea rarely fossilize and very few information pertaining to the origin and relationships of living coleoid cephalopods is available from the fossil record. The major division of Coleoidea is based upon the number of arms or tentacles and their structure. Presently, living coleoids can be segregated into two superorders, Decapodiformes and Octopodiformes (Berthold and Engeser, 1987). The Decapodiformes has fourth arm pair modified into long tentacles. The Decapodiformes contains two orders; the order Teuthoidea, which includes two suborders [Myopsida (closed-eye squids) and Oeopsida (open-eye squids)] and the order Sepioidea which includes families like Idiosepiidae (Pygmy squid), Sepiidae (Cuttlefish), Sepiolidae (Bobtail squids), Spirulidae (Ram's horn squid), and Sepiadariidae (Bottletail squids). The Octopodiformes includes the orders Octopoda (pelagic and benthic octopuses) and Vampyromorpha (vampire squid). Octopodiformes has modifications to second arm pair; it is drastically reduced as a sensory filament in the Vampyromorphida, while octopoda species have totally lost that arm pair. The Octopoda contains two suborders; Cirrata (deep-sea finned octopuses) and Incirrata (pelagic and benthic octopuses including the argonautids and blanket octopuses).

Squids possess elongate, cigar-shaped body with posteroexternal fins, and eight circumoral arms, not joined at the base with a web, with two or more rows of stalked suckers bearing chitinous rings (and/or hooks) extend the length of the mantle. They also possess two long tentacles with tentacular club of two or more rows of suckers (and or hooks) at the distal end. The cuttlefish possess a broad sac-like body with lateral fins that are either narrow and running over the entire length (Sepiidae) or are short, round and flap-like (Sepiolidae). In both cases the posterior ends of the fins are free (Sub-terminal) and separated by the posterior end of the mantle; ten circumoral appendages, the longest (fourth) pair of tentacles are retractile into pockets at the ventrolateral sides of head. The eight arms frequently bear four rows of stalked suckers with chitinous rings. Both eyes are covered with a transparent membrane; shell is thick, chalky, calcareous (cuttlebone of sepia) or thin, chitinous (Sepiolidae). Octopus possess a short, sac-like body with either no lateral fins or with separate paddle-like fins in some deep sea forms, and eight circumoral arms with no tentacles, with the bases connected by a web and un-stalked suckers, without chitinous rings, along the length of the arms (Fig.1-4)

Subclass Nautiloidea

Shell complete external, smooth, coiled and chambered, more than 10 (63 - 94) circumoral appendages without suckers, a funnel bilobed, two pairs of gills, and the absence of an ink sac.

Family Nautilidae

The “chambered or pearly nautilus” comprises single family and genus and six species. They have approximately 100 sucker-less tentacles, simple eye without lenses, and thick rigid hood used to protect the animal when retracted within the shell.

Subclass Coleoidea

This subclass includes all living cephalopods – squids, cuttlefish and octopuses, other than chambered nautilus. Key diagnostic characters are shell internal, calcareous, chitinous or cartilaginous, 8-10 circumoral appendages with suckers, only one pair of gills (dibranchiate) and funnel tube-like.

Order Teuthoidea

This order contains the squids, characterized by internal shell (gladius or pen) chitinous feather or rod shaped, eight arms; two contractile but not retractile, pocket absent, tentacles lost secondarily in some, fin on the mantle and stalked suckers with or without chitinous hooks, with horny rings and constricted necks; fin lobes fused posteriorly. Eyes either covered or open and without supplementary eyelid.

Suborder Myopsida

Myopsid squids are characterized by eyes entirely covered by a transparent corneal membrane. Eye cavity communicates with the exterior through a tiny hole. Arms and tentacles have suckers only, no hooks. Mantle locking apparatus is simple (linear) and the gladius is pen-like.

Suborder Oegopsida

Oegopsid squids (Oceanic squid or Open-eyed squids) are characterized by eyes not covered with a corneal membrane and open to the surrounding medium, arms and tentacles bear suckers and / or hooks. Mantle locking apparatus ranges from simple to complex to fused.

Family Loliginidae

***Sepioteuthis lessoniana* (Ferussac in Lesson, 1831)**

Body elongate, cylindrical in outline; fins marginal, wide and muscular, very long almost running along entire length of mantle; elliptical in shape.

***Uroteuthis (Photololigo) duvaucelii* (Orbigny, 1835)**

Body elongate, mid-rib of gladius clearly visible through mantle skin; fin length in adults

upto 60 per cent of mantle length; tentacular clubs large median manal sucker ring with 14 – 17 teeth; Arm sucker rings with broad, large, square teeth (5 to 9) on the distal margin; in males, more than half the length (up to 75 %) of the left ventral arm hectocotylized, papillae not fused (Fig.5).

***U. (P.) sibogae* (Adam, 1954)**

Mantle long, narrow and slender, no ridge but chromatophore concentration ventrally along midline; fins narrow and less than 60 per cent of mantle length; less than half of left ventral arm hectocotylized distally in males; gladius narrow, sharply acumulate posteriorly.

***U. (P.) singhalensis* (Ortmann, 1891)**

Mantle is long, slender, cylindrical, and it tapers posteriorly into as sharply-pointed tip. Mantle bout 4-7 times as long as wide. Mantle with a ridge along midline in males; The tentacles are short and slender. Clubs are rather short. Left ventral arm IV is hectocotylized distally in mature males for 40 - 45% of its length. The chitinous sucker rings are smooth or wavy proximally, while the distal margin bears 6-11 (most commonly 9) plate-like, truncate, squared teeth (Fig. 5).

***U. (P.) edulis* (Hoyle, 1885)**

Mantle more or less stout, elongate and slender. Fins large, rhombic with the anterior margin slightly convex, the posterior margin gently concave and the lateral angles rounded. Fins become slightly longer than wide in adult specimens (up to 70% of mantle length), Gladius long, somewhat narrow, Arms somewhat long (25- 45% of mantle). More than half of left ventral arm hectocotylized distally in males (Fig. 5).

***U. (P.) chinensis* (Gray, 1849)**

Fin length in adults greater than 60% of mantle length. Hectocotylized portion of the left arm IV from 33% to 50% of total arm length. Arm sucker rings with 10-15 stout, pointed, conical teeth distally, the proximal margin smooth; occasionally with rudimentary teeth only. Although the record of this species along the Indian east coast is available in the literature, this species is not recorded in the cephalopod samples of Institute (Fig. 5).

***Loliolus (Loliolus) hardwickei* (Gray, 1849)**

Small squids. Mantle length of adults less than 60 mm; fins heart shaped; vane of gladius conspicuously broad at midlength.

***Loliolus (Nipponololigo) uyii* (Wakiya and Ishikawa, 1921)**

Body short and stout; mid rib of gladius clearly visible through dorsal mantle skin as a median dark line; fins 55-65 per cent of mantle length; Tentacular clubs have median manal suckers with smooth rings; in males left ventral arm hectocotylized almost the entire arm; papillae on ventral margin fused with membrane.

***L. (N.) sumatrensis* (D'Orbigny, 1835)**

Body short, sub-cylindrical, gradually decrease in width posteriorly to blunt point, head small with large eyes; fins 60-65% of mantle length; fin rhomboidal in shape; arm sucker ring with 6-9 broad, squared teeth; in male left ventral arm hectocotylized upto 87%.

Onychoteuthidae

***Onchoteuthis banksii* (Leach, 1817)**

Oceanic squids with muscular body; head with nuchal folds on the dorsal side at posterior end; rachis of gladius visible as a longitudinal ridge middorsally along the entire length of mantle; tentacular clubs with two rows of hooks, marginal suckers lacking.

Thysanoteuthidae

***Thysanoteuthis rhombus* Troschel, 1857**

Funnel locking cartilage shaped consisting of a narrow longitudinal groove and a short transverse groove branching from it medially. Fins broad and rhombus-shaped occupying nearly entire length of mantle.

Ommastrephidae

***Sthenoteuthis oualaniensis* (Lesson, 1830)**

Funnel and mantle cartilages of the locking apparatus fused together. An oval photophoric patch present middorsally near anterior margin of mantle; muscle of mantle ventrally without embedded light organs; two intestinal photophores present.

Order Sepioidea

This order includes the cuttlefishes, characterized by an oval body shape, compressed dorsoventrally and framed along both sides of the body by narrow fins that do not attach at the posterior end. The arms bear 2 to 4 rows of suckers. The tentacles are totally retractile into pockets. The internal shell, cuttlebone (calcareous) lies dorsally in the body below the skin. The shell is oval in shape, thick, containing several gas and water filled chambers for buoyancy control.

Family Sepiidae

Small to medium- sized animals characterized by an oval body; flattened dorsoventrally, calcareous internal shell, head free from dorsal mantle, Fins marginal and narrow, light organ absent.

Family Sepiolidae

Small animals characterized by saccular body, wide, round bottomed; fins circular; internal shell lacking; dorsal mantle and head united by a nuchal commissure; saddle-shaped light organ present on ink sac.

Genus Sepia

Body without a glandular pore at posterior extremity; cuttlebone mostly with a spine (rostrum) at posterior end.

***Sepiella inermis* (Van Hasselt, 1835) (in Ferussac and d' Orbigny, 1834 – 1848)**

Body with a distinct glandular pore at posterior extremity on ventral side; with brownish fluid oozing out; cuttlebone devoid of spine.

***Sepia pharaonis* (Ehrenberg, 1831)**

Body robust, fins broad commencing from edge of anterior mantle margin; tentacular clubs moderately long and well expanded; 5 or 6 suckers in middle row of manus greatly enlarged; cuttlebone broad, thick and with a midventral flattening anteriorly in striated area; striae 'Λ' shaped; inner cone forms a conspicuous yellow flat ledge; a sharp thick spine present; when alive, body brownish, tiger-stripe pattern prominent.

***Sepia aculeata* (Van Hasselt, 1835) (in Ferussac and d' Orbigny, 1834 – 1848)**

Tentacular clubs very long, with 10-14 rows of minute sub-equal suckers. Cuttlebone broad and thick with a median longitudinal edge with a faint groove running medially on striated area; inner cone forms a ledge-like callosity (Fig. 6).

***Sepia prashadi* (Winckworth, 1936)**

Body not robust, fin narrow commencing a few mm behind edge of anterior mantle margin; tentacular clubs short, expanded; not more than 3 suckers in middle row of manus greatly enlarged; cuttlebone narrow, midventral groove narrow and distinct, striae anteriorly broadly truncate with lateral corners slightly produced forward; dorsal surface pinkish in colour, a sharp thin spine present; When alive, dusty brownish, transverse stripes less distinct.

***Sepia elliptica* (Hoyle, 1885)**

Tentacular clubs moderately long, with 10 rows of small suckers of uniform size. Cuttlebone thin, elliptical in shape, dorsal surface smooth; two conspicuous lateral ridges more prominent anteriorly resulting in three longitudinal furrows in striated area; spine thick, sharp, long and well curved.

***Sepia trygonina* (Rochebrune, 1884)**

No fleshy projections on head; fins extend upto end of mantle; tentacles with short clubs, suckers in eight rows, about five in third row enlarged. Cuttlebone lanceolate with acuminate anterior tip with edges of outer cone winged giving an arrow head appearance; spine small.

***Sepia brevimana* (Steenstrup, 1875)**

Tentacular club short with 6-8 small subequal suckers. Cuttlebone flat and distinctly acuminate anteriorly, dorsal surface rugose, a shallow median groove in the striated area, the striae 'Λ' shaped with a median shallow groove broadening anteriorly; inner cone and its limbs pinkish in colour; spine small, sharp and slightly curved.

Onychoteuthidae

***Onchoteuthis banksii* (Leach, 1817)**

Oceanic squids with muscular body; head with nuchal folds on the dorsal side at posterior end; rachis of gladius visible as a longitudinal ridge middorsally along the entire length of mantle; tentacular clubs with two rows of hooks, marginal suckers lacking.

Thysanoteuthidae

***Thysanoteuthis rhombus* (Troschel, 1857)**

Funnel locking cartilage shaped consisting of a narrow longitudinal groove and a short transverse groove branching from it medially. Fins broad and rhombus-shaped occupying nearly entire length of mantle.

Ommastrephidae

***Sthenoteuthis oualaniensis* (Lesson, 1830)**

Funnel and mantle cartilages of the locking apparatus fused together. An oval photophoric patch present middorsally near anterior margin of mantle; muscle of mantle ventrally without embedded light organs; two intestinal photophores present.

Order Octopoda

This order includes all octopuses, described by eight arms with 1 or 2 rows of suckers. Most species have web sectors between the arms.

Sub-order Cirrata

Finned or Cirrate octopods are deep sea octopuses characterized by round to tongue-like fins on the mantle and single rows of suckers interspersed by cirri. Mantle aperture is very narrow. Only the left oviduct is developed

Sub-order Incirrata

Incirrate octopuses are characterized by fins lacking, and have 1 or 2 rows of suckers and no cirri.

Family Argonautidae

This family of pelagic octopuses is known as paper nautilus or Argonauts, the females of which secrete an external shell. This calcareous external shell is brittle and white in colour with fine corrugations. The male is much smaller than the female. Male lacks the external shell and possesses a large modified third left arm which is detached during mating.

Family Octopodidae

This family includes tiny to very large benthic octopuses characterized by eight arms with 1 or 2 rows of sessile suckers and modified third right arm in males, without an external shell; internal shell either vestigial or lacking; no great disparity between males and females in size.

***Amphioctopus aegina* (Gray, 1849)**

Eyes prominent; a single large cirrus posterior to each eye. Ligula small, 5 to 8 per cent of arm; with shallow groove; penis and diverticulum together form U-shaped loop; spermatophores long and unarmed (Fig. 7).

***Amphioctopus neglectus* (Nateewathana and Norman, 1999)**

Medium-sized species characterized by elongate and ovoid body, U-shaped iridescent transverse bar on the head between the eyes, Dark ocellus including blue ring present at base of 2nd and 3rd arm pair, Head relatively wider in males than in female, 1 or 2 papillae present over each eye. Ligula long and slender (Fig. 8).

***Cistopus indicus* (Rapp, 1835 in Ferussac and d' Orbigny, 1834 – 1848)**

Hectocotylized arm only slightly modified, ligula small about 3 per cent of arm. Small water pores leading to embedded pouches between bases of arms (Fig. 9).

***Haplochlaena maculosa* (Hoyle, 1883)**

Body globular smaller in size; skin smooth without reticulate pattern; white fresh dusty brown in colour with prominent bluish rings on mantle, head, web and arms.

BIVALVE TAXONOMY

There are about 10,000 living bivalve species. The bivalve as the name implies, possesses two valves (shells) lying on the right and left sides of the body. Bilateral symmetry is a characteristic feature. The shell is mostly composed of calcium carbonate. Umbo is the first formed part of the valve and is above the hinge. The soft body of the bivalve is covered by the mantle comprising two lobes. The foot is muscular and is ventral. Bysus is a clump of horny thread spun in the foot and helps the sedentary bivalve to attach to hard substrates. In bivalves head is absent. Many bivalves possess a pair of gills, which are respiratory in function and produce water currents from which food is collected (Poutiers, 1998).

Distinctive characters of commercially important species

Mussels

The genus *Perna* (family Mytilidae) is characterized by the absence of anterior adductor muscle, occurrence of one or two well developed hinge teeth, partition of the crystalline sac from the mid-gut, broad partition of the two posterior byssal retractors etc. In India, there are two species of commercially important mussels viz. the green mussel (*Perna viridis*) and the brown mussel (*Perna Indica*) contribute to the fishery (Fig. 10).

Perna indica

The outer surfaces of the shell valve and mantle margin are respectively dark brown and brown in colour. Anterior end of the shell is pointed and straight. Ventral shell margin is more or less straight. Middle dorsal margin has a distinct angle/lump while posterior margin is broadly rounded. One large hinge teeth on the left valve and a corresponding depression on the right valve, foot is tongue shaped with byssal threads.

Perna viridis

The outer shell surfaces and mantle margin are respectively green and yellowish green in colour. Shell is large, elongate sub-trigonal. Anterior end of the shell is pointed with the

beak turned down. Ventral shell margin is slightly concave. Middle dorsal margin is angularly convex while posterior margin is broadly rounded. Two small hinge teeth on the left valve and one on the right valve, foot is tongue shaped with byssal threads.

Commercially important bivalves of India

Resources	Common English name	Local name
Clams and Cockles		
<i>Villorita cyprinoides</i>	Black clam	Karutha kakka,(Ma)
<i>Paphia malabarica, Paphia sp.</i>	Short neck clam, textile clam	Manja kakka (Ma), Chippi kallu (Ka), Tisre (Ko)
<i>Meretrix casta, Meretrix meretrix</i>	Yellow clam	Matti (Ta)
<i>Mercia opima</i>	Baby clam	Njavala kakka (Ma), Vazhukku matti (Ta)
<i>Mesodesma glabaratum</i>		Kakkamatti (Ta)
<i>Sunetta scripta</i>	Marine clam	Kadal kakka (Ma)
<i>Donax sp.</i>	Surf clam	Mural, Vazhi matti (Ta)
<i>Geloina bengalensis</i>	Big black clam	Kandan kakka (Ma)
<i>Anadara granosa</i>	Cockle	Aarippan kakka (Ma)
<i>Placenta placenta</i>	Window pane oyster	
<i>Tridacna sp, Hippopus hippopus</i>	Giant clam	Kakka (Ma)

Mussel		
<i>Perna viridis</i>	Green mussel	Kallumakkai, Kadukka(Ma) Alichippalu (Te)
<i>Perna indica</i>	Brown mussel	Kallumakkai, Chippi (Ma)
Pearl oyster		
<i>Pinctada fucata</i>	Indian pearl oyster	Muthu chippi, (Ma, Ta)
<i>Pinctada margaritifera</i>	Blacklip pearl oyster	Muthu chippi (Ma, Ta)
Edible oysters		
<i>Crassostrea madrasensis</i>	Indian backwater oyster	Kadal muringa (Ma); Ali, Kalungu (Te) ; Patti (Ta)
<i>Saccostrea cucullata</i>	Rock oyster	Kadal muringa (Ma); Ali, Kalungu (Te) ; Patti (Ta)
Ka – Kannada, Ko – Konkani, Ma- Malayalam, Mr – Marati, Ta- Tamil, Te- Telugu		

Pearl oysters

Taxonomy

The pearl oyster belongs to the family Pteriidae. This group is characterized by a straight hinge with 1-2 small tooth-like thickening, a cavity below the anterior angle for the byssus and usually a scaly surface of the outer shell valves. The family comprises two commercially important genera viz. *Pinctada* spp. and *Pteria* spp. (Fig. 11).

In *Pteria* spp., the shell width is much longer than the height and the hinge angle is prominent and pronounced. In *Pinctada* spp., the hinge is rather long and straight, the long axis of the shell is not at right angle at the hinge, the left valve is usually deeper than the right and there is a byssal notch on each valve at the base of the anterior lobe. The colouration of periostracum is changeable and is often brownish with radial markings.

In Indian waters, six species of pearl oysters viz. *Pinctada fucata* (Gould), *P. margaritifera* (Linnaeus), *P. chemnitzii* (Philippi), *P. sugillata* (Reeve), *P. anomioides* (Reeve) and *P. atropurpurea* (Dunken) have been reported.

***Pinctada fucata* (Gould)**

The hinge is nearly as wide as the width of the shell, left valve is deeper than the right, byssal notch slit-like, left valve greatly convex, posterior ear well developed with fairly developed sinus, anterior margin of shell just far in advance in front of anterior ear. Hinge teeth are present in both valves, one each at the anterior and posterior ends of the ligament. The anterior ear is larger than in the other species. The posterior ear is fairly well developed. The outer surface of the shell valves with 6 - 8 radial bands of reddish brown on a pale yellow background. The nacreous layer is thick and has a bright golden, pink or ivory colour with metallic lustre. The non-nacreous margin on the inner surface of valves has reddish or brownish patches.

***Pinctada margaritifera* (Linnaeus)**

The anterior margin of the shell extends in front of the anterior lobe. The anterior ear is well developed whereas the posterior ear and sinus are absent. The byssal notch is broad. The hinge is shorter than the width of the shell and is devoid of teeth. Left valves are moderately convex. The posterior end of the shell meets the hinge almost at a right angle. The outer shell is dark graying-brown with greenish tinge and radially distributed white spots. The nacreous layer is iridescent with a silvery sheen colour and the non-nacreous margin is black colour. Due to the dark marginal colouration of the shell, this pearl oyster is also known as the Black-lip pearl oyster.

***Pinctada chemnitzii* (Philippi)**

The shell is very comparable to that of *P. fucata* with the exception of very less convexity of valves and better developed of posterior ear. The hinge is almost as long as the antero-posterior measurement of the valves. The anterior ear is well developed and the byssal notch is slit-like. Hinge teeth of the anterior and posterior are present, the former is minute and rounded and the latter prominent and ridge-like commencing a little in advance of the posterior area of the hinge ligament. The posterior ear and the posterior sinus are well developed. The outer shells are yellowish externally with about four or more light brownish radial markings. The growth lines of the shell are broad. The nacreous layer is bright and lustrous and the non-nacreous layer is brownish.

***Pinctada sugillata* (Reeve)**

The hinge is noticeably shorter than the antero-posterior axis of the shell. The antero-posterior measurement is approximately equal to the dorso-ventral measurement. The anterior ear is small and the byssal notch is a fairly wide slit-like. The anterior ears are somewhat bent towards the right. The posterior ear and sinus are poorly developed. The

convexity of the valves is not prominent, especially that of the right valve. The anterior hinge teeth are small and roundish and the posterior one is slightly elongated. The shell valves are dark grey with a tinge of brown with six yellowish radial markings. The lower or posterior regions of valves are light yellow and gray.

Pinctada anomioides (Reeve)

The hinge is shorter than the width of the widest region of the antero-posterior axis of the shell. The hinge and dorso-ventral axis have a ratio of 1:1.4. Hinge teeth are absent or poorly developed. The anterior ear is moderately developed and the byssal notch at its base is deep. The posterior ear and sinus are absent. The outer shell valves are yellowish or grayish with faint radial markings. The nacreous layer is well developed.

Pinctada atropurpurea (Dunker)

The shell is roundish with its hinge narrow. The valves are thin, translucent and moderately convex. The nacreous layer is thin and the byssal notch is deep. A poorly developed anterior hinge tooth may be present in some oysters. Externally the shell valves are copper coloured.

Edible oysters

Edible oysters belonging to the family Ostreidae and are found in hard substratum in the bays and creeks near coastal waters. They are attached permanently to the substratum.

Taxonomy

In Indian waters, six species of oysters are reported. They are the Indian backwater oyster *Crassostrea madrasensis* (Preston), Chinese oyster *C. rivularis* (Gould), West coast oyster *C. gryphoides* (Schlotheim), Indian rock oyster *Saccostrea cucullata* (Born), Bombay oyster *Saxostrea cucullata* (Awati and Rai) and the giant oyster *Hyostissa hyotis* (Linnaeus).

Crassostrea madrasensis (Preston)

Shell valves are irregular in shape usually straight/elongate. Shell valves are covered by numerous foliaceous laminae. Left valve is deep while right one slightly concave. Hinge is narrow and elongated. Adductor muscle scar is kidney-shaped and sub central; dark purple in colour. Inner surface of valve is white, glossy and smooth with purplish black colouration on the inner margin.

C. gryphoides (Schlotheim)

Shell valves are elongate and thick. Shell is oblong, narrow in the anterior margin and broader in the posterior margin, laminated, lower valve very thick, especially in the

anterior region below the ligamental area. Adductor muscle scar is broad, more or less oblong or heart shaped and pearly white with striations on the scar are absent or unclear. Upper valve thin flat and opercular, no denticles on the margin. Left valve is cup-like. Hinge region is well developed and has a deep median groove with lateral elevations.

C. rivularis (Gould)

Shell valves large, roughly round, flat, thick and with a shallow shell cavity. Left valve is thick and slightly concave and the right one is about the same size or slightly larger. Adductor muscle scar is oblong and white or smoky white in colour.

Saccostrea cucullata (Born)

Shell more or less trigonal, sometimes oblong, extremely hard and pearshaped. The margins of the valves have well developed angular folds sculptured with laminae. Small tubercles present along the inner margin of the right valve and there are corresponding pits in the left valve. Adductor muscle scar is kidney shaped.

Clam

In Indian waters, a number of species coming under the families viz. Veneridae, Arcidae, Tridacnidae, Corbiculidae, Solenidae, Mesodesmatidae, Donacidae and Tellinidae are exploited from the time immemorial. The cultivable species by and large fit in to the first four aforementioned families (Fig. 14).

Arcidae

Commercially important species under this family is represented by single species, *Anadara granosa*. It is found all along the Indian coast in soft muddy substratum and forms a fishery of some magnitude in the Kakinada Bay (Fig. 15).

Anadara granosa

Shell valves are thick, inflated and dark brown. This species varies from other clams in having taxodont dentition and about 20 prominent ribs with rectangular nodules.

Veneridae

This family is characterized by the hinge with three cardinal teeth, a single anterior tooth on the left valve, and a corresponding depression on the right valve, slightly unequal sized adductor muscle scars (= 2 Nos). This group contains three importance genera, viz. Paphia, Meretrix and Marcia.

Paphia malabarica

Shell is slightly inflated, triangularly ovate and surface is concentrically grooved. The anterior and posterior margins are narrowly rounded. Hinge area is short with narrowly diverging teeth. Pallial sinus is 'U' shaped and very deep. Lunule is relatively short. Shell length is only one and one third times longer than height. The outer shell valves are yellowish brown in colour indistinctly rayed with greyish brown bands or blotched with brownish angular markings.

Villorita cyprinoides

Shell is thick, ovately triangular with strong concentric ridges. Hinge border is very short and thick, always with three oblique cardinal teeth; the anterior in the right valve and posterior in the left valve are less developed. Ridges are more strongly developed in the anterior half. Umbones are prominent and well elevated. Pallial sinus is small. Lunule is narrow and ligament is large. Shell is dark olive brown to blackish brown in colour.

Meretrix casta

Shell is thick, moderately large with a brown horny periostracum. Shell is also smooth and triangularly ovate with devoid of any sculpture. Outer surface of the valves is very faintly rayed with greyish radial lines or pale yellowish brown tinted with dark grey posteriorly.

Meretrix meretrix

Shell varies from *M. casta* in having less elongated lateral tooth, more ovate shell and larger size. Periostracum is thin and of grey or straw colour. Postero-dorsal margin of the outer shell is greyish blue or bluish brown band.

Marcia opima

Shell is thick, inflated, smooth, and triangularly ovate. Pallial line is deeply sinuate. Tip of the pallial sinus is bluntly angular. Lunule is distinct, flattened, and rather broad. Area behind the umbones is clear, flattened and deeply elongated reaching almost upto the hind margin of the shell. Outer surface of shell is pale yellowish brown or straw coloured variously blotched and rayed with purplish grey markings. The inner surface of the valve is white.

Gafrarium tumidum

Shell is thick, strongly inflated and sculptured with thick, nodular radial ribs which tend to bifurcate towards the ventral margin. The interstitial spaces between some of the main

ribs, there are secondary rows of nodules. The pallial line is full and well developed. The outer surface is white with irregular dark spots posteriorly and near the umbo.

Tridacnidae

The tridacnid clams are characterized by large massive shells with broad radial ribs, sometimes having large fluted scales. Border of valves is usually scalloped.

Tridacna crocea

Shell is large, thick, and triangularly ovate with large byssal opening. Shell valves contain 6-10 broad flattened ribs with concentric ridges. Outer shell valves are greyish white flushed with yellow or pinkish orange.

T. maxima

Shell is strongly inequilateral. The shell is similar to that of *T. crocea* except that the 6-12 broad radial ribs have better developed concentric scales. Large byssal gape with distinct plicae is at edges. Ventral border of the valve often deeply scalloped. Shell is greyish white, sometimes tinged with yellow or pinkish orange.

T. squamosa

Shell is large, thick and strongly inflated with small or medium sized byssal gape. Shell valves possess 4-12 strongly convex ribs with riblets in interspaces. Broad, sometime long fluted scales on ribs which may project beyond ventral margin noticeably. Shell is greyish white, sometimes tinged with yellow.

Donacidae

Donax cuneatus

Shell is trigonal, inequilateral. Shell possesses a curved keel extending from the umbo to the postero-ventral corner; there are sharp concentric and fine radiating ones which are conspicuous in the anterior and posterior regions only. The anterior end is broad and rounded while the posterior end is narrow and rounded. Pallial sinus is deep. The outer surface of shell is white covered with pale violet especially towards umbo and the posterior region is darker. The inner surface is of deep violet colour (Fig. 16).

Mesodesmatidae

Mesodesma glabratum

Shell is thick, inequilateral and roughly trigonal. The outer surface of shell has well developed concentric striae. The umbo is small. Hinge has two cardinal teeth and there is an anterior lateral tooth. The pallial sinus is small and angular.

Solenidae

Solen kempi

Shell is small, about six times as long as high. Anterior region is obliquely truncate while posterior region rounded. Cardinal tooth is in right valve with a shallow groove all over its breadth. Dorsal margin of soft body is somewhat concave in the anterior region and convex in the posterior region. Siphon is long and segmented. Foot is long flattened and about half the length of body. Periostracum is yellowish brown and glossy.

GASTROPOD TAXONOMY

Gastropoda is the largest molluscan class with about 35,000 extant species. The gastropods are torped asymmetrical molluscs and usually possess a coiled shell. The soft body normally consists of head, foot, visceral mass and the mantle. Among the marine gastropods, the members belonging to the subclass Prosobranchia, are of major fishery importance (Poutiers, 1998). The shell in this subclass is typically coiled with an opening at the ventral end known as aperture. The aperture is covered by operculum which closes the opening of the shell. The head normally protrudes anteriorly from the shell and bears mouth, eyes and tentacles. The foot is muscular, ventrally located with a flattened base and is used for creeping or burrowing. The visceral mass fills dorsally the spire of the shell and contains most of the organs. The mantle forms mantle cavity which lines and secretes the shell. Asymmetry of the internal anatomy of the gastropods is due to twisting through 180° called the 'torsion' which takes place during the first few hours of larval development (Fig. 17).

Classification

Gastropods classification based on different morphological and anatomical features of their bodies and shells has come across several problems. During the 19th century, researchers were proposed several different classifications of the Gastropoda based on the place of the mantle cavity or on the array of various organs and shape of the shells. By and large, all these classification methods used only a restricted number of distinctive characters. At the start of the 20th century, the German researcher, Johannes Thiele (1929 - 1935), put together earlier classifications and proposed Thiele's system of classifications which was used by zoologists for most of the century. He divided the gastropods into three subclasses: Prosobranchia, Opisthobranchia, and Pulmonata. Besides, the Prosobranchia were divided into three orders: Archaeogastropoda, Mesogastropoda, and Neogastropoda.

During current decades, accumulation of numerous new data on the morphology and anatomy of various gastropod groups due to the application of new methods for instance, transmission electron microscopy etc. and finding of new gastropod groups with strange anatomical features in the deep sea region associated with hydrothermal vents have revealed a need for the revision of existed classification. Recent analyses of these characters of existing gastropods have led to a new classification method, which have been supported by outcome from molecular phylogenetics.

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Suggested reading

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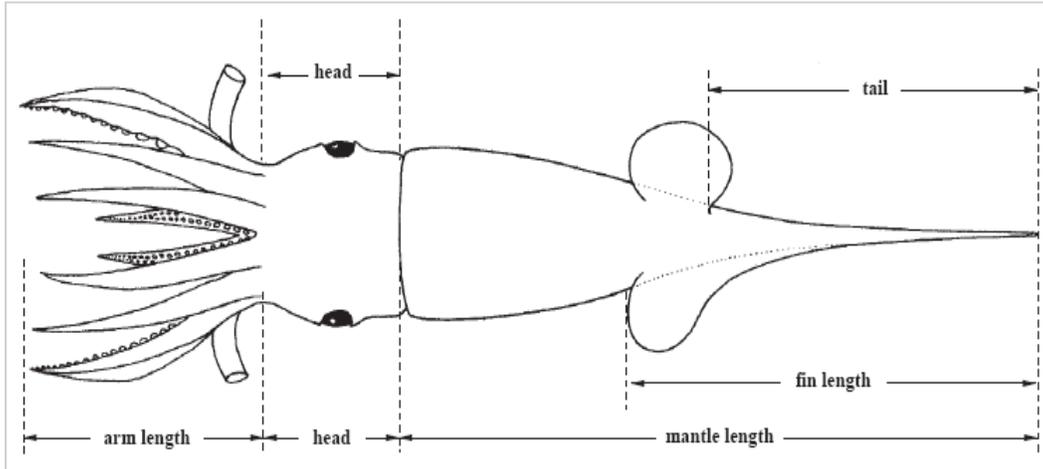


Fig.1. External morphology of squid
(Source: Jereb and Roper, 2010)

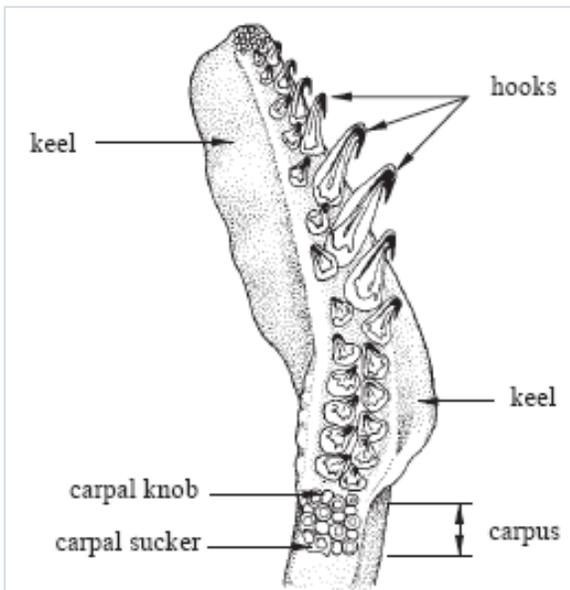


Fig. 2. Tentacular club of squid
(Source: Jereb and Roper, 2010)

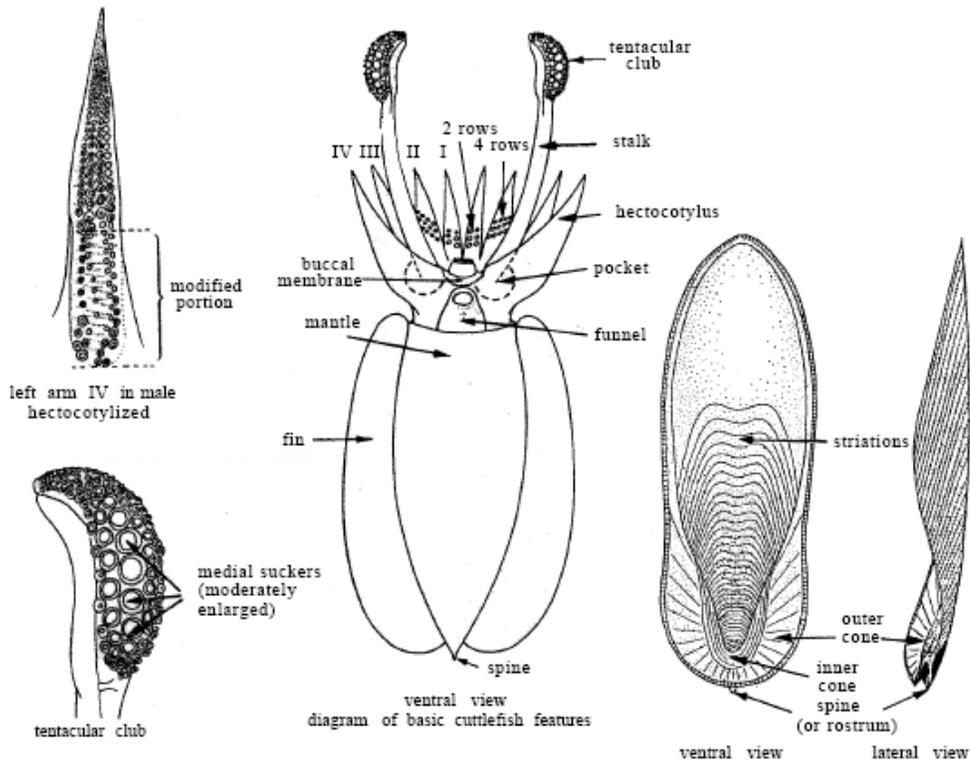


Fig. 3. External features of cuttlefish
(Source: Roper and Nauen, 1984)

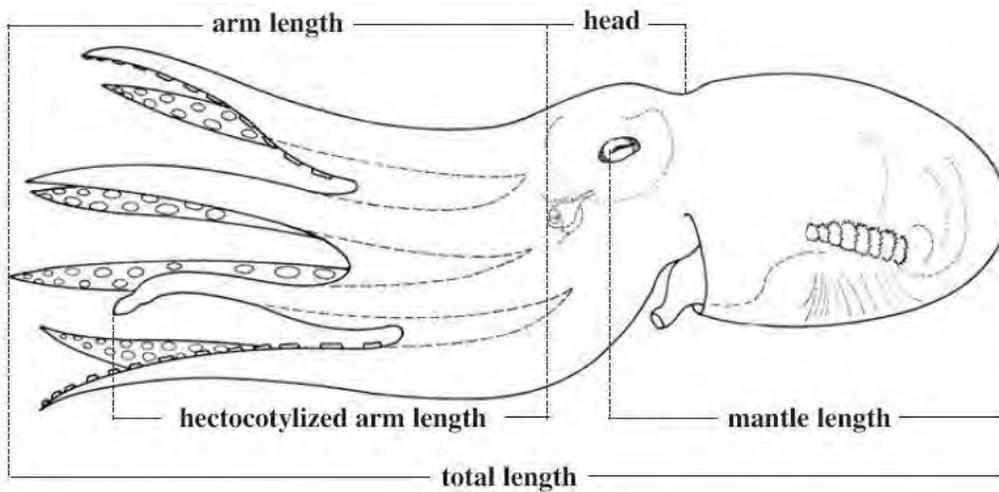
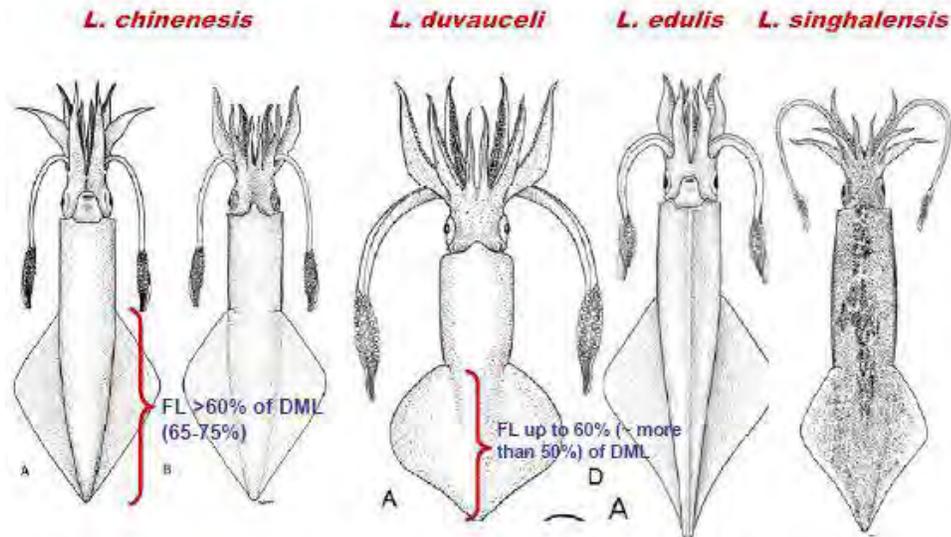


Fig. 4. External morphology of octopus
(Source: Jereb et al., 2014)

Squids



Arm III Sucker Ring

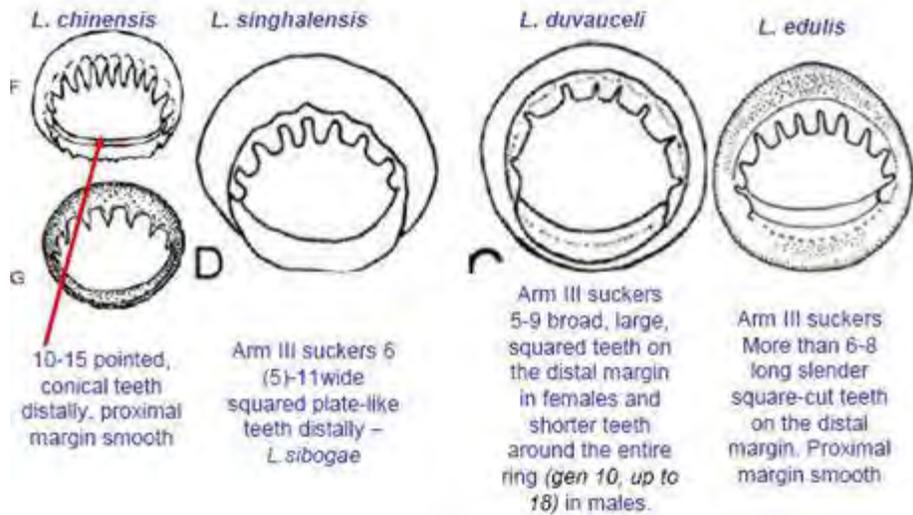


Fig. 5. Keys to identify commercially important squids (Source: Jereb and Roper, 2006)

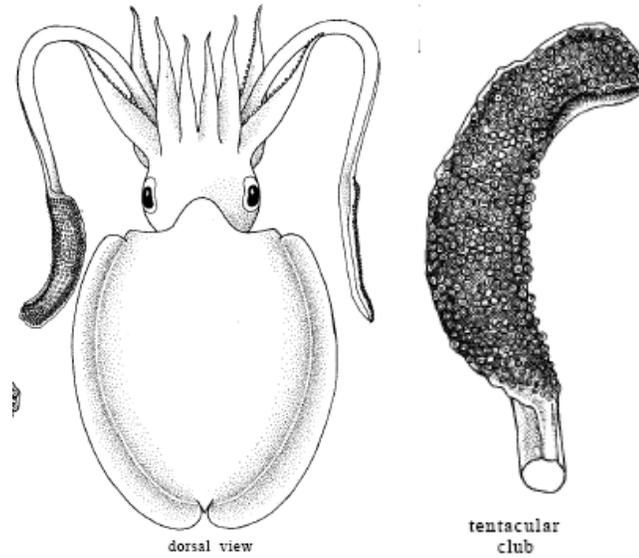


Fig. 6. *Sepia aculeata* (Source: Roper and Nauen, 1984)

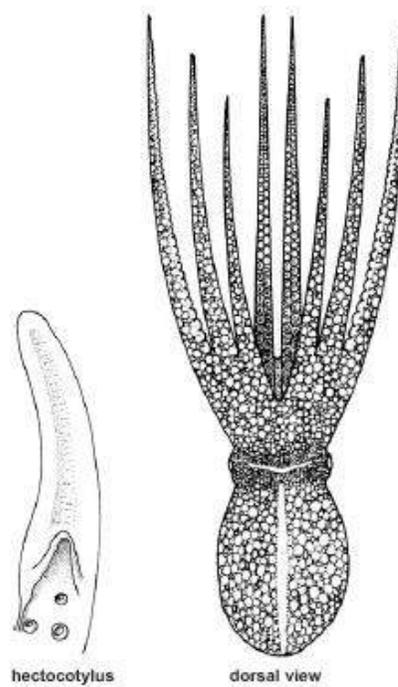


Fig. 7. *Amphioctopus aegina* (Source: Jereb et al., 2014)

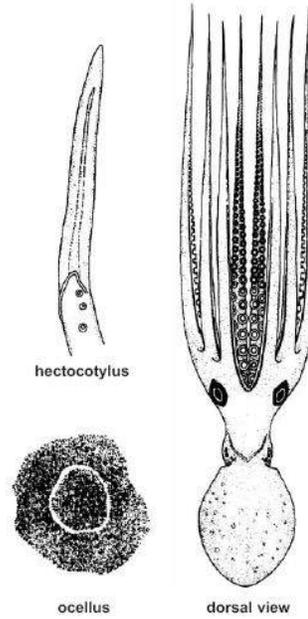


Fig. 8. *Amphioctopus neglectus* (Source: Jereb et al., 2014)

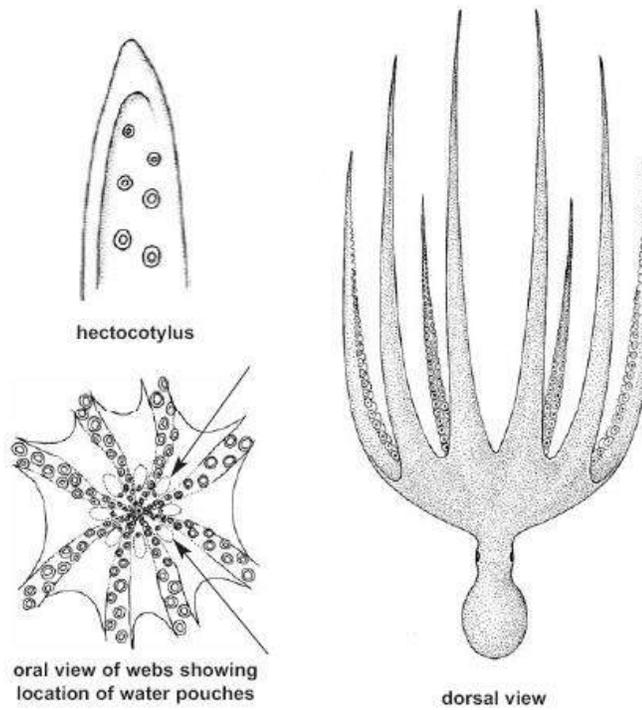


Fig. 9. *Cistopus indicus* (Source: Jereb et al., 2014)

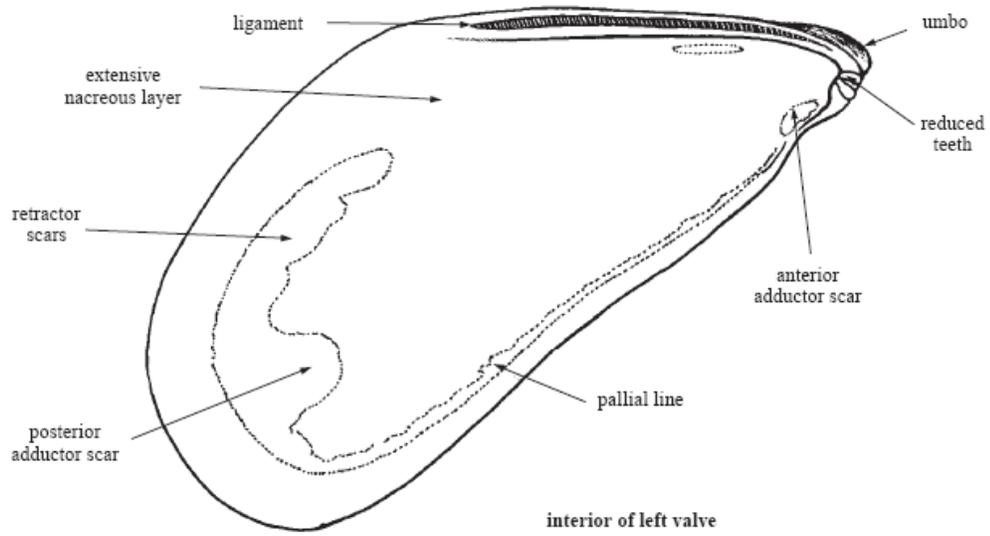


Fig. 10. Interior of left valve of mussel (Source: Leal, 2013)

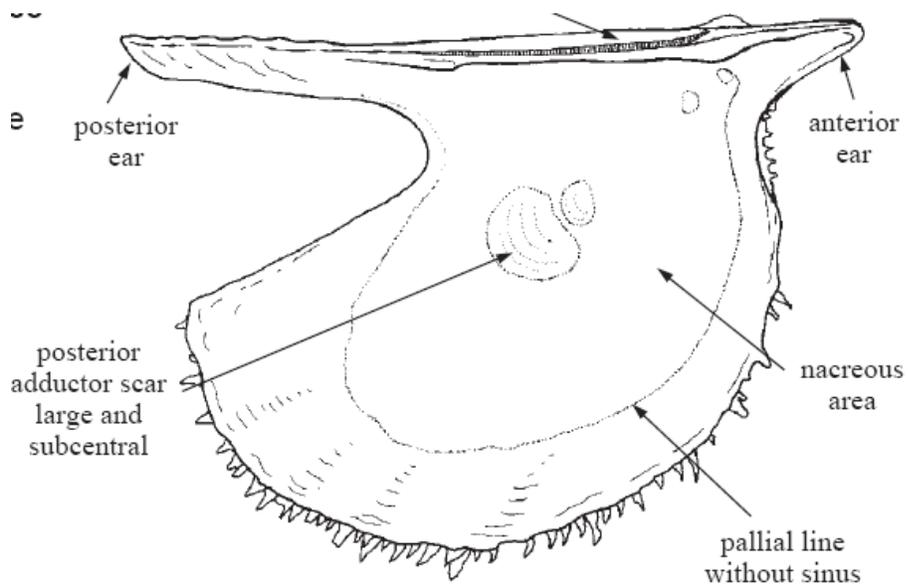


Fig. 11. Interior shell markings of pearl oyster (Source: Leal, 2013)

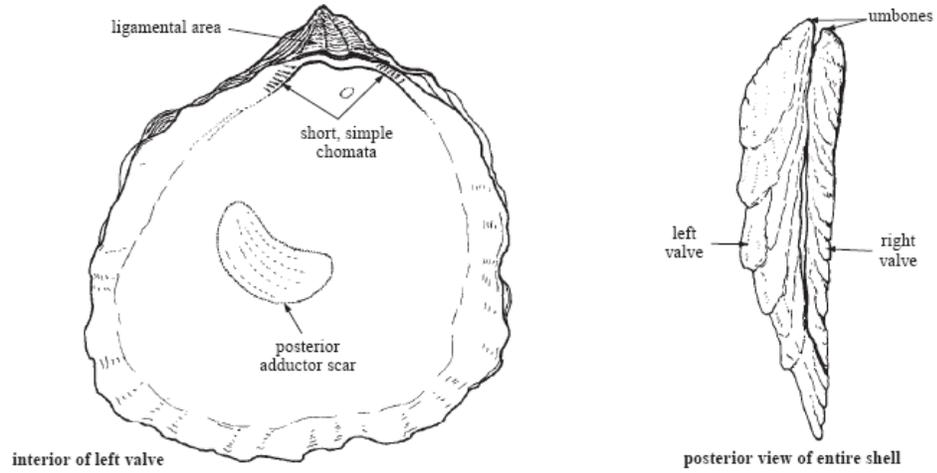


Fig. 12. External morphology of oyster (Source: Leal, 2013)

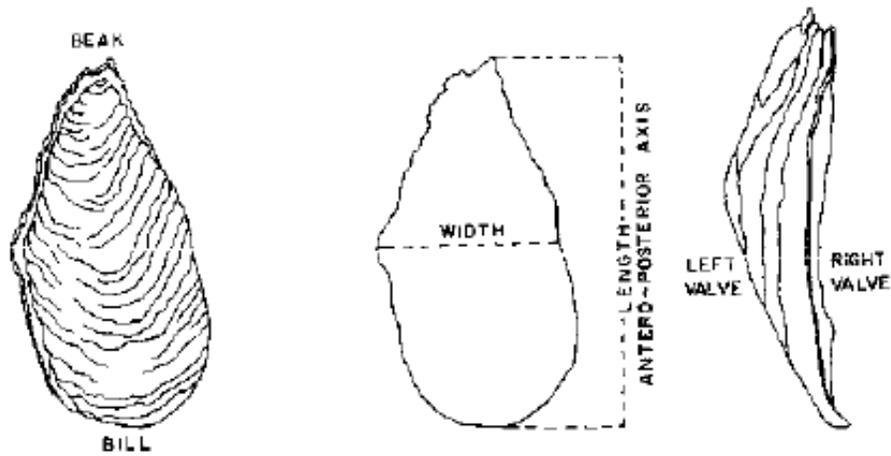


Fig. 13. Shell valves of an edible oyster (Source: James and Rengarajan, 1992)

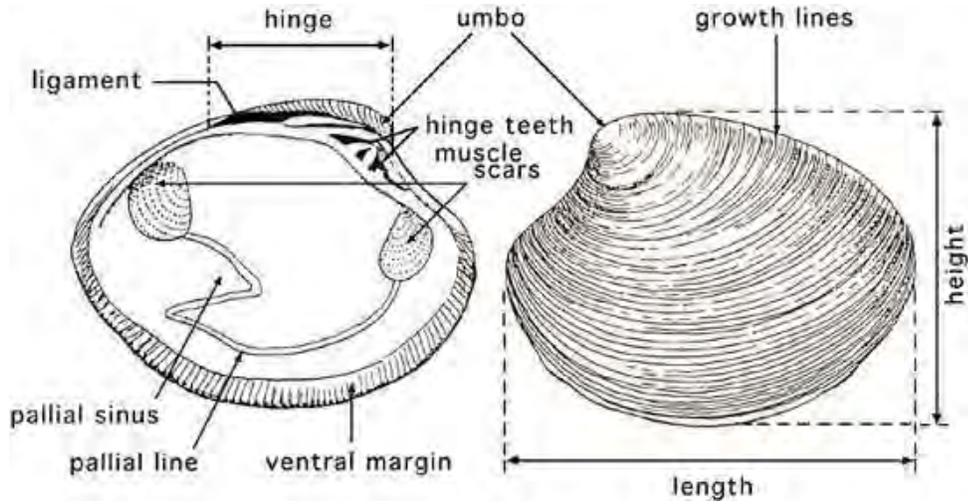


Fig. 14. External shell characteristics of clam (Source: Helm et al., 2004)

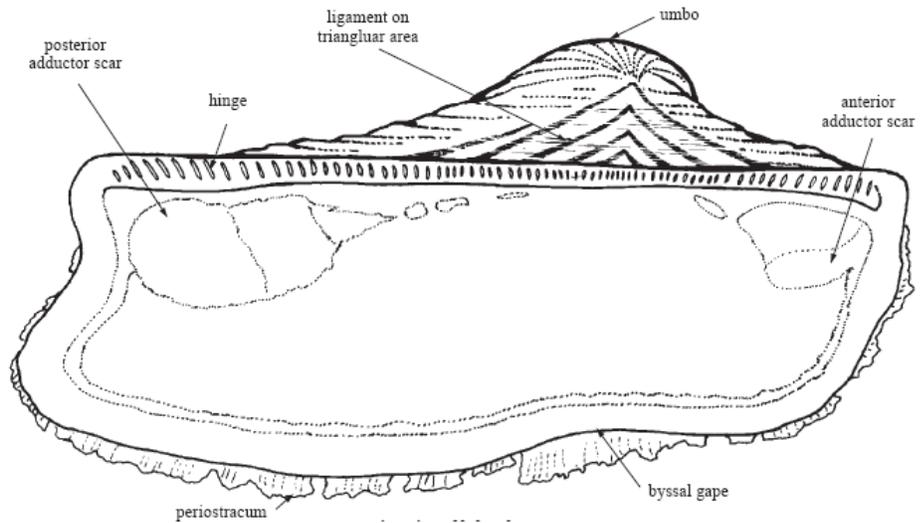


Fig. 15. Interior of left valve of ark shell (Source: Leal, 2013)

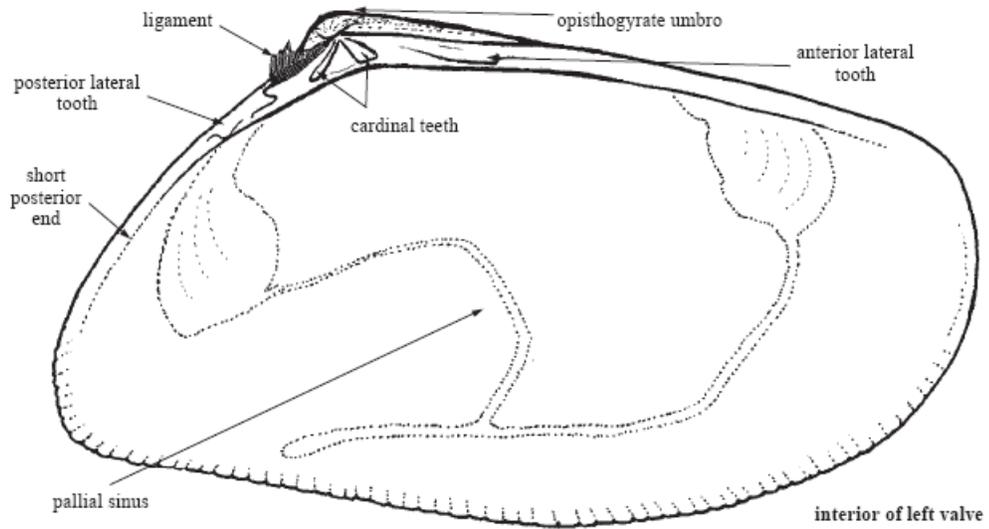


Fig. 16. Interior of left valve of *Donax* shell (Source: Leal, 2013)

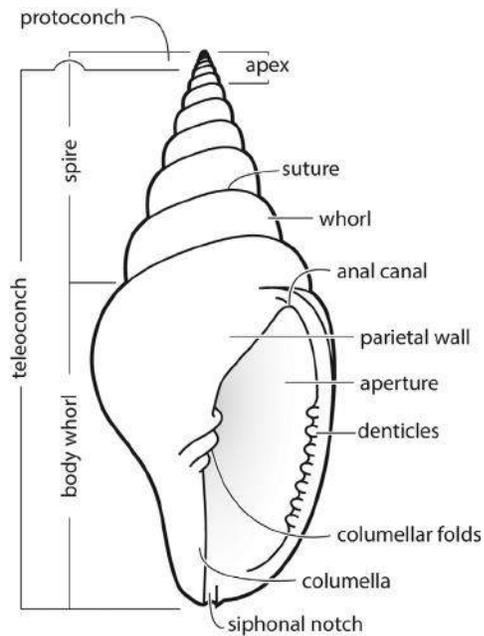


Fig. 17. External morphology of gastropod (Source: Harris et al., 2015)

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