Elasmobranch diversity

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The cartilaginous fish, comprising sharks, rays, skates, guitar fishes and chimaeras have captured the imagination of scientists and enthusiasts alike. From the majestic great white shark to the graceful manta ray, each species contributes to the rich tapestry of marine biodiversity, making elasmobranchs a captivating subject of study and conservation.Elasmobranchs are a subclass under the class Chondrichthyes, which differ from bony fishes (Osteichthyes) in having a cartilaginous skeleton instead of calcified bones. Chondrichthyes is an evolutionary old taxon with the earliest ancestors appearing in the Devonian period about 400million years ago. Chondrichthyes comprises subclass Elasmobranchii (sharks, rays, skates and guitarfishes) and subclass Holocephali (Chimaeras). Elasmobranchs inhabit diverse marine environments worldwide, from shallow coastal waters to deep oceanic trenches, totaling over 869 extant species, including about 400 sharks and the remaining being skates, rays and guitarfishes. These cartilaginous fish occupy various habitats, spanning from nearshore to abyssal depths, from the equator to the poles, and even some in freshwater and hypersaline waters, with a higher concentration in tropical and temperate marine waters.As exploration of deep-sea environments advances, more elasmobranch species are likely to be discovered, enriching our understanding of their biodiversity. Taxonomy undergoes continual revisions, leading to better clarity on the relationships and identities of organisms. In the case of elasmobranchs, species may be reclassified, merged with others, or renamed, contributing to an evolving understanding of their phylogeny and evolutionary history. Such revisions ultimately enhance our comprehension of how these fascinating creatures have evolved over time.

Class :Chondrichthyes

Kingdom Animalia
Phylum Chordata
Class Chondrichthyes
Subclasses Elasmobranchii, Holocephali

Common characteristics of cartilaginous (Chondrichthyes) fishes

- Cartilaginous skeleton which is calcified giving the appearance of bone
- Cranium (or skull) to protect brain and sense organs of the head
- Vertebral column fundamentally structured around a notochord supported by vertebral centra
- Skeleton of the pelvic fins modified into paired claspers in males
- Usuallysnout is pre-oral with the nostrils on the ventral surface
- Teeth usually not fused to jaws and replaced serially
- Lungs/swim bladder absent
- Intestinal spiral valve present
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Subclass Elasmobranchii

Common characteristics of Elasmobranchs

- Upper jaws not fused to the cranium, can be protruded. Lower jaw is a single element on each side
- Gill openings 5-7 pairs, no operculum
- Body covered with placoid scales (dermal denticles), teeth are modified placoid scales
- Teeth arranged in successive rows that continuously replace each other in a conveyor belt-like manner

Living members of the Subclass Elasmobranchiicomes under the division Neoselachii which comprises the subdivisions Selachii (modern sharks) and Batoidea (skates, rays and guitar fishes)

- Selachii include two superorders*viz*., Squalomorphii and Galeomorphii.Squalomorphii includes less derived sharks, such as dogfish sharks,

while Galeomorphii includes most of the living sharks, such as bull sharks, tiger sharks, and hammerhead sharks
- Within Squalomorphii (lack anal fin), there are 3 orders, the Squatiniformes (angel sharks), the Pristiophoriformes (sawsharks) and the Squaliformes (dogfish sharks)
- Galeomorphii, characterized by the presence of an anal fin, encompasses five orders: Heterodontiformes (bullhead sharks), Orectolobiformes (carpet sharks), Lamniformes (mackerel sharks), Carcharhiniformes (ground or requiem sharks), and Hexanchiformes (six- and seven-gilled sharks and frilled sharks)
- Batoidea contains four orders: Rhinopristiformes (saw fishes, wedge fishes and guitar fishes),Myliobatiformes (stingrays, whip rays, eagle rays, devil rays and relatives), Rajiformes (skates) andTorpediniformes (electric rays and numb fishes).

Subdivision Selachii (Modern sharks)

Sharks are perhaps the most well-known members of the subclass Elasmobranchii, ranging in size from small species like the dwarf lanternshark to giants like the whale shark and the great white shark.

Common features of Sharks:

- Upper eyelids that can move freely, gill openings positioned on the sides of head, distinct pectoral fins not attached to sides of the head
- Typically have a streamlined fusiform (bullet-shaped) body, although some species exhibit a flattened ray-like shape
- Five pairs of gill openings, although there are species with six or seven pairs
- Majority possess two dorsal fins, although a few species have only one. Certain groups of sharks have dorsal fins with spines along their leading edges
- Well-developed caudal fin

Subdivision Batoidea (Skates, rays and guitar fishes)

Distinguishing features:

- Flattened in shape and have expanded pectoral fins that give them a wing-like appearance.
- Pectoral fins are connected to both the back of the skull and the body, expanding significantly to create a body disc
- Gill openings are positioned beneath their flattened body
- Majority of species feature diminutive dorsal and caudal fins, with numerous species entirely lacking these fins
- Dorsal fins do not possess spines
- Anal fin absent
- Eyes as well as spiracles typically positioned on top of the head
- In a few blind electric rays, the eyes are obscured by skin and are not easily distinguishable
- Species identification relies on characteristics such as colouration, shape of the body disc and tail, structure of the nasal passages and mouth as well as the arrangement and shape of dermal thorns and denticles

Subclass Holocephali (Chimaeras)
Distinguishing characteristics of chimaeras:

- Upper jaw joined and fused to the underside of skull
- Gills protected by operculum, and only single gill opening
- Skin devoid of denticles
- Teeth glued together into plate-like structures, often resembling a beak
- Tail elongated and slender

Extant Chimaeras are categorized into three families: Callorhinchidae (plough-nose chimaeras), Rhinochimaeridae (long-nose chimaeras), and Chimaeridae (short-nose chimaeras)

Species reported from Indian waters: *Neoharriotta pinnata* (Scklefin chimaera) and *Hydrolagus africanus* (African chimaera).

Classification of Sharks (Selachii) in orders

Squatiniformes (Angel Sharks, Sand devils)
Flat body, mouth at front, no anal fin, ovoviviparous

Pristiophoriformes (Sawsharks)
Long snout, mouth underneath, no anal fin, gill slits on sides of the body, spiracles present; ovoviviparous (litters of 7 to 17 large pups)

Squaliformes (Dogfish and bramble/cookiecutter sharks)
Short snout, no anal fin; ovoviviparous, I or 2 or over 20 young ones in a litter.

Hexanchiformes (Frilled and cow sharks)
Anal fin present, 1 dorsal fin, 6 or 7 gills on each side of the head, ovoviviparous

Heterodontiformes (Bullhead sharks and horn sharks)
Anal fin present, 5 gill slits, 2 dorsal fins, dorsal spines. Only living sharks with dorsal fin spines and anal fins both present, oviparous, producing eggs in unique, large spiral flanged egg cases,

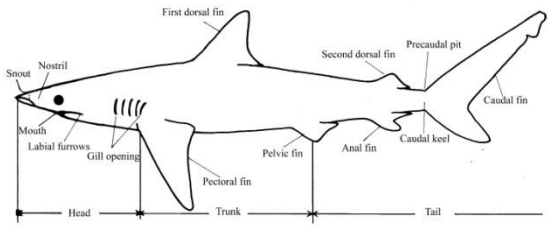
Orectolobiformes (Carpet sharks including the wobbegong, nurse, bambooshark, blind, zebra, and whale shark)
Anal fin, 5 gill slits, 2 dorsal fins, no fin spines, mouth in front of the eyes, oviparous or ovoviviparous

Lamniformes(Mackerel sharks, including the basking, goblin, megamouth, great white, crocodile shark, thresher, porbeagles, sandtiger and mako sharks)
Anal fin, 5 gill slits, 2 dorsal fins, no fin spines, mouth behind the eyes, no nictitating eyelids, ovoviviparous

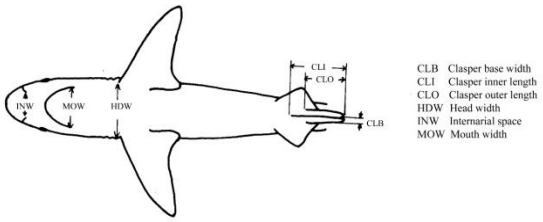
Carcharhiniformes (Ground sharks including catsharks, swellsharks, houndsharks, weasel sharks, requiem, tiger and hammerhead sharks)
Anal fin, 5 gill slits, 2 dorsal fins, no fin spines, mouth behind the eyes, nictitating eyelids, viviparous or ovoviviparous

Morphology and morphometry of sharks

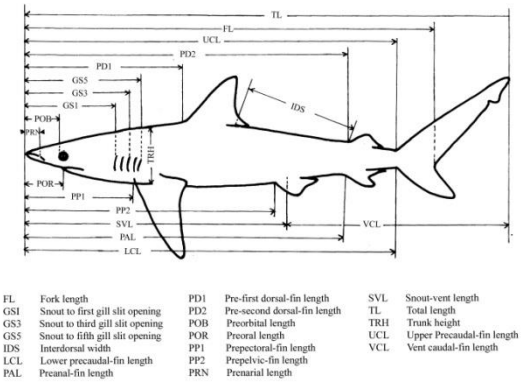
Sharks are categorized according to their external features like body shape, snout length, and fin proportions, as well as internal characteristics such as tooth arrangement and count. Among these, total length (TL) is commonly used in shark taxonomy as it serves as a baseline for measuring other proportional dimensions. Pre-caudal length (PCL) and fork length (FL) are sometimes employed as substitutes for TL in specific cases, providing additional data to analyze shark morphology.



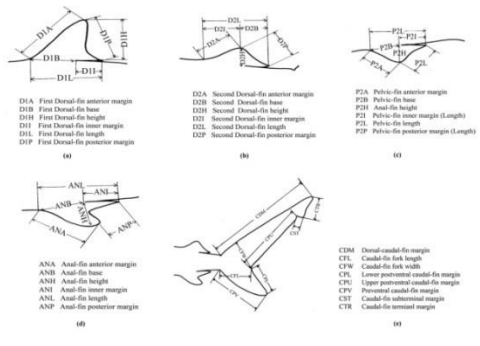
Lateral view of shark illustratingexternal body parts



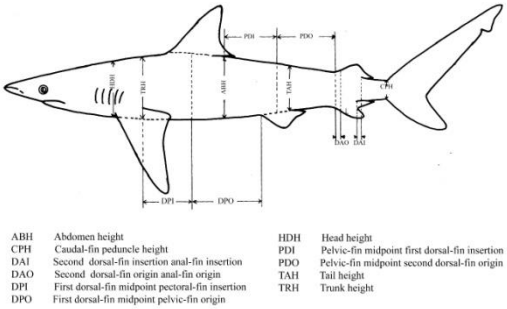
Ventral view and measurements



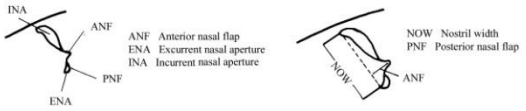
Main longitudinal measurements



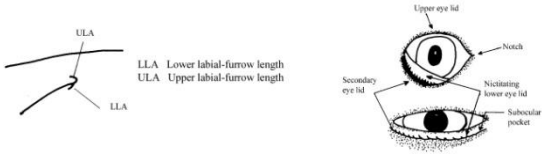
Measurements of (a) first dorsal, (b) second dorsal, (c)pelvic, (d)analand (e)caudalfins



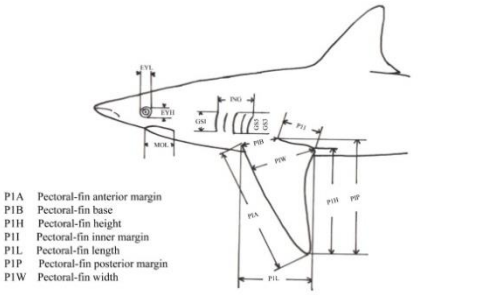
Other common measurements



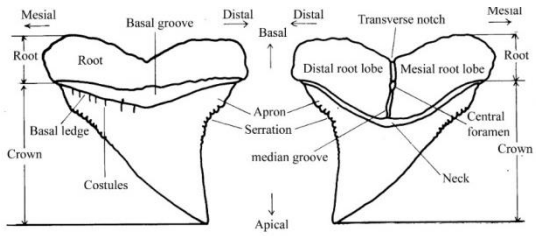
Nostrils



Mouth corner Eye



Head and pectoral fin measurements



Tooth parts of sharks

Taxonomy and diversity of sharks in Indian waters

Order : Carcharhiniformes

Shark species from the families Carcharhinidae, Sphyrnidae, Scyliorhinidae, Pentanchidae, Triakidae, Hemigaleidae, Proscyllidae, and Pseudotriakidae within the Carcharhiniformes order are known to inhabit Indian waters.

Family : Carcharhinidae (Requiem sharks)

The largest and most significant family of sharks in tropical fisheries. They typically lack spiracles (except for *Galeocerdo*); have internal nictitating eyelids and elongated, arched mouths that extend beyond their eyes. Teeth generally blade-like, varying in size from small to large and often broader in the upper jaw, while the lower jaw teeth are more cuspidate and less compressed. Precaudal pit present. Two dorsal fins and an anal fin present, with the first dorsal fin base notably positioned ahead of the pelvic fin bases. Midpoint of the first dorsal fin base always lies in front of the origins of the pelvic fins. They have five gill slits, with the last one to three situated above the pectoral fin, and do not possess gill rakers. Reproduction is typically viviparous, involving a yolk sac placenta, and litter sizes vary from 1 or 2 to as high as 135, although the tiger shark is an ovoviviparous exception to this.

Family : Sphyrnidae (Hammerhead sharks)

These sharks have hammer-like lateral extensions on their heads, with circular eyes positioned at the outer edges. Eyes feature internal nictitating eyelids, and they lack spiracles and labial furrows. Precaudal pit present, have two dorsal fins, with distinctive high and pointed first dorsal fin. Base of the first dorsal fin is shorter than that of the caudal fin and positioned in front of the origins ofpelvic fins. Second dorsal fin and anal fins are notably smaller than the first dorsal fin. Mode of reproduction isby viviparity.

Family : Scyliorhinidae (Catsharks)

These small sharks feature a slender, elongated body with catlike eyes, often elongated and possibly with rudimentary nictitating eyelids. They possess two small dorsal fins without spines, and an anal fin. Base of the first dorsal fin is either opposite or behind the bases of the pelvic fins. These sharks lack pre-caudal pits, and their caudal fin lacks a prominent ventral lobe or dorsal margin undulations. They have five gill slits, with the last two positioned behind the origins of the pectoral fins. Additionally, they

possess spiracles and numerous small teeth, each with a single central cusp and sometimes one or more cusplets on each side near the centre of the mouth. Intestines possess spiral valve, and they do not have lateral keels or precaudal pits on the caudal peduncle.

Family : Pentanchidae (Cat sharks)

Small sharks with slender to moderately stout bodies; eyes horizontal oval; rudimentary lower eyelids; spiracles present; five gill slits last two over the pectoral fin; small, numerous teeth; intestine with spiral valve; origin of first dorsal over or behind pelvics; second dorsal and anal fins relatively large; second dorsalsmaller to larger than first dorsal; tail strongly symmetrical with little or no lower lobe, its top edge straight, sometimes with denticles.

Family:Triakidae(Hound sharks)

Small to medium-sized sharks, characterized by horizontally oval eyes equipped with nictitating eyelids. Their mouths are long, angular, or arched, extending past the front ends of eyes, and they have moderate to very long labial furrows. Their anterior nasal flaps are not typically slender or barbel-like. These sharks have two moderately to large dorsal fins without spines, with the first dorsal fin base located well ahead of the pelvic fin bases. Anal fin is smaller than the second dorsal fin and has a concave rear edge. They lack a precaudal pit, and their caudal fin lacks a prominent ventral lobe or strong undulations on its dorsal margin. They possess spiracles and intestine with a spiral valve.

Family: Hemigaleidae(Weaselsharks)

Margin of the dorsal fin is wavy or undulated, there is a precaudal pit, internal nictitating membrane, small spiracles, moderately long labial furrows, and a spiral valve in the intestine.

Family :Proscyllidae(Finbackcatsharks)

Nictitating eyelids of these sharks are poorly developed, and their spiracles are notably large..Posterior teeth on their dental bands have a comb-like arrangement, and their labial furrows are either very short or entirely absent, only visible at the mouth corners if they are present.

Family: Pseudotriakidae(False catsharks)

Eyes are elongated and slit-like, featuring underdeveloped nictitating eyelids. They also possess large spiracles and an exceptionally high number of tooth rows, with the posterior teeth displaying a comb-like structure. First dorsal fin is elongated, low, and keel-like in appearance.

Species reported from Indian waters: Order Carcharhiniformes

Family	Genus	Species	Common name
Carcharhinidae	*Carcharhinus*	*C. longimanus*	Oceanic whitetip shark
		C. albimarginatus	Silvertip shark
		C. dussumieri	Whitecheek shark
		C. wheeleri	Blacktail reef shark
		C. amblyrhynchos	Grey reef shark
		C. sorrah	Spot-tail shark
		C. falciformis	Silky shark
		C. melanopterus	Black-tip reef shark
		C. leucas	Bull shark
		C. limbatus	Black-tip shark
		C. altimus	Bignose shark

		C. amboinensis	Pigeye shark
		C. brevipinna	Spinner shark
		C. macloti	Hardnose shark
		C. amblyrhynchoides	Graceful shark
		C. obscurus	Dusky shark
		C. hemiodon	Pondicherry shark
	Rhizoprionodon	*R. acutus*	Milk shark
		R. oligolinx	Grey sharpnose shark
	Prionace	*P. glauca*	Blue shark
	Scoliodon	*S. laticaudus*	Spadenose shark
	Galeocerdo	*G. cuvier*	Tiger shark
	Triaenodon	*T. obesus*	Whitetip reef shark
	Loxodon	*L. macrorhinus*	Slit-eye shark
	Lamiopsis	*L. temminckii*	Broadfin shark
	Negaprion	*N. acutidens*	Sicklefin lemon shark
Sphyrnidae	*Sphyrna*	*S. lewini*	Scalloped hammerhead
		S. mokarran	Great hammerhead
		S. zygaena	Round headed hammerhead
	Eusphyra	*E. blochii*	Wing-head shark
Scyliorhinidae	*Cephaloscyllium*	*C. silasi*	Indian swellshark
	Atelomycterus	*A. marmoratus*	Coral catshark
	Bythaelurus	*B. hispidus*	Bristly catshark
Pentanchidae	*Apristurus*	*A. investigatoris*	Broadnose catshark
	Halaelurus	*H. quagga*	Quagga catshark
Triakidae	*Iago*	*I. omanensis*	Bigeye hound shark
		I.mangalorensis	Mangalore hound shark
Hemigaleidae	*Chaenogaleus*	*C. macrostoma*	Hooktooth shark
	Hemigaleus	*H. microstoma*	Sicklefin weasel shark
	Paragaleus	*P. longicaudatus*	Slender weasel shark
	Hemipristis	*H. elongata*	Snaggletooth shark
Proscyllidae	*Eridacnis*	*E. radcliffei*	Pygmyribbontailcatshark
	Proscyllium	*P. magnificum*	-
Pseudotriakidae	*Planonasus*	*P. indicus*	Eastern dwarf false catshark

Order Lamniformes

Shark species belonging to the familiesAlopiidae,Lamnidae, Megachasmidae,Pseudocarchariidaeand Odontaspididae of the orderLamniformesare known to occur in Indian waters

Family Alopiidae (Thresher sharks)
These sharks possess long, curved, asymmetrical caudal fin, dorsal lobe is almost as long as the rest of the body and a short ventral lobe. Pectoral fins are long and narrow. They have large eyes, a small mouth, and short gill openings, with the last two above the base of the pectoral fin. Precaudal pit presentOvoviviparous and exhibits uterine cannibalism

Family Lamnidae (Mako sharks)
These large sharks have pointed snouts and spindle-shaped bodies, with elongated mouths housing large, blade-like teeth. Their gill slits extend widely laterally to the mid-dorsal surface, and they lack gill rakers. They possess long pectoral fins and tall dorsal fins, accompanied by small, pivoting second dorsal and anal fins. Notably, they exhibit large lateral keels and prominent precaudal pits on the caudal peduncle. Caudal finslunate. These sharks follow an ovoviviparous reproductive strategy, lacking a yolk sac placenta, and demonstrate uterine cannibalism.

Family Pseudocarchariidae (Crocodile sharks)
These medium-sized sharks possess a spindle-shaped body, remarkably large eyes without a nictitating membrane. Their gill slits are notably long, extending onto the dorsal surface of the head. Mouth is large and parabolic, positioned ventrally on the head, and holds protrusible teeth

that are large and lanceolate. Anterior teeth are narrow, whereas the lateral teeth are compressed and blade-like. They have small and low dorsal fins, with the second dorsal fin being less than half the size of the first but larger than the anal fin. Their pectoral fins are small, broad, and

rounded, while the pelvic fins are large. A weak lateral keel and precaudal pits are present on the caudal peduncle. Their fins are outlined in white, sometimes with small white spots on the body and a white blotch located between the mouth and gill slits.

Family Megachasmidae (Megamouthsharks)

These sharks have an elongated head, approximately as long as its trunk, with a notably large terminal mouth. Snout is short and broadly rounded, and the gill opening is moderately long but does not extend onto the dorsal surface of the head. Last two gill slits are positioned over the base of the pectoral fin. They have small teeth arranged in numerous rows.

Family Odontaspididae (Sand sharks)

Caudal peduncle without lateral keels, marked by a distinct pit on its upper surface but none on the lower surface. Their teeth are sizable, slender, and characterized by smooth edges. Lower eyelid lacks a nictitating membrane. Their development is ovoviviparous.

Species reported from Indian waters: Order Lamniformes

Family	Genus	Species	Common name
Alopiidae	*Alopias*	*A. uperceliosus*	Big eye thresher
		A.vulpinus	Thin tail thresher
		A. pelagicus	Pelagic thresher
Lamnidae	*Isurus*	*I. oxyrhyncus*	Shortfin mako
		I. paucus	Longfin mako
Pseudocarchariidae	*Pseudocarcharias*	*P. kamoharai*	Crocodile shark
Megachasmidae	*Megachasma*	*M. pelagios*	Megamouthshark
Odontaspididae	*Carcharias*	*C. taurus*	Sand tiger shark
	Odontaspis	*O. ferox*	Smalltooth sand tiger

Order: Squaliformes

Species from the families Echinorhinidae,Squalidae, Centrophoridae, Etmopteridae and Somniosidae within the Squaliformesorder have been recorded in Indian waters.

Family Echinorhinidae (Bramble sharks)
First dorsal fin starts behind the origin of the pelvic fin, and there are no anal fins. Dorsal fins are spineless and positioned far back, situated behind the origins of the pelvic fins. Body and fins have large scattered thorn-like denticles, which vary in size from small to very large. These denticles are widely spaced, with bases that are not star-shaped. Some of these larger denticles are fused in groups. Development is ovoviviparous, and does not possess a yolk sac placenta.

Family Squalidae (Dogfish sharks)
Body relatively low and cylindrical in cross-section, featuring two dorsal fins that may or may not have spines. Origin of the first dorsal fin is located in front of the pelvic fins. Denticles on this species range from small to moderately large. Caudal fin may or may not have a subterminal notch. Reproduction ovoviviparous (aplacental viviparity), and can give birth to anywhere from one or two to over 20 young ones in a litter.

Family Centrophoridae (Gulper sharks)
These sharks have grooved spines on both dorsal fins, with larger teeth on the lower jaw than on

the upper jaw. They lack precaudal pits or lateral keels on the caudal peduncle. Their reproductive strategy is ovoviviparous, where embryos depend solely on yolk for nutrition.

Family Etmopteridae (Lantern sharks)
These bioluminescent sharks are typically small to medium-sized and inhabit deep oceanic waters. Lanternsharks are cylindrical in cross-section and feature elongated snouts, two dorsal fins each with a sharp spine at the front, tiny light organs usually scattered along the belly and lower sides, large spiracles, and a subterminal notch on the caudal fin.

Family Somniosidae (Velvet dogfishes/Sleeper sharks)

Typically, these sharks feature a broad head with a short, flat snout. Their upper teeth are small and needle-like, contrasting with the broader and flatter lower teeth. Five pairs of gill slits and large spiracles. Both the first and second dorsal fins are relatively low and small compared to the shark's body. Fin spines can be found on both dorsal fins across all genera except for *Scymnodalatias* and *Somnosius.*

Species reported from Indian waters: Order Squaliformes

Family	Genus	Species	Common name
Echinorhinidae	*Echinorhinus*	*E. brucus*	Bramble shark
Squalidae	*Squalus*	*Squalus lalannei*	-
Centrophoridae	*Centrophorus*	*C. moluccensis*	Smallfin gulper shark
		C.uyato	Little gulper shark
		C. atromarginatus	Dwarf gulper shark
		C. granulosus	Gulper shark
		C. *squamosus*	Leafscale gulper shark
		C. lusitanicus	Lowfin gulper shark
		C. zeehaani	Southern dogfish
	Denia	*D. profundorum*	Arrowhead dogfish
Etmopteridae	*Etmopterus*	*E. pusillus*	Smooth lantern shark
	Centroscyllium	*C. ornatum*	Ornate dogfish
Somniosidae	*Centroselachus*	*C. crepidater*	Longnose velvet dogfish
	Zameus	*Z. squamulosus*	Velvet dogfish

Order: Orectolobiformes

Sharks representing the families Rhincodontidae, Stegostomatidae, Ginglymostomatidae and Hemiscyllidae of the order Orectolobiformes have been reported from Indian waters.

Family Rhincodontidae
This shark has a wide, flat head with a snub-nosed snout and a large mouth almost at the tip. Teeth are numerous but smaller in size. External gill slits are exceptionally large, while inside the mouth cavity, there are filter screens within the internal gill slits. Gills openings are also very sizable, and the fifth gill slit is notably distinct from the fourth. Gill rakers are elongated. Caudal peduncle features prominent lateral keels, and the caudal fin has a robust ventral lobe, though it lacks a pronounced terminal lobe and subterminal notch. Reproduces through viviparity, giving birth to hundreds of offsprings

Family Stegostomatidae(Zebra sharks)
These sharks are of moderate size, featuring a relatively small and subterminal mouth. External gill slits are small, and the eyes are positioned laterally on the head, lacking movable upper eyelids. Notably, it has large spiracles, and nostrils with short, pointed barbels. One striking characteristic is its unusually long caudal fin, almost equal in length to the rest of the shark's body. Typically, this caudal fin lacks a strong ventral lobe but has a prominent terminal lobe and subterminal notch. On the caudal peduncle, there are no lateral keels or precaudal pits.

Family Ginglymostomatidae (Nurse sharks)
Distinctive characteristics of nurse sharks include a short, wide, and blunt snout; oval-shaped eyes positioned behind the mouth; a pair of large barbels below the snout; a groove between each nasal opening and the corner of the mouth; a small mouth that opens transversely, located slightly below the snout; five gill slits, with the last two situated very close together and positioned above the pectoral fins. They have two relatively close-set dorsal fins of similar size located towards the rear half of the body, and a relatively short, strongly asymmetric tail with a minimal lower lobe and no keels on the tail base.

Famil: Hemiscyllidae(Bamboo sharks)

These small and slender sharks are identifiable by their nasoral grooves and short nasal barbels. Their small transverse mouth is located in front of the eyes, and they have large spiracles positioned below the eyes. No lateral skin flaps on their heads. Possess two dorsal fins without spines, with the second dorsal fin origin well ahead of the first dorsal fin. Anal fin is low, keel-like, and rounded, with its origin situated well behind the origin of the second dorsal fin. A narrow notch separates the anal fin from the lower caudal origin. These sharks have a long precaudal tail and a caudal peduncle lacking lateral keels or precaudal pits. Their reproductive method is oviparous, and they lay their eggs in small oval egg cases.

Species reported from Indian waters: Order Orectolobiformes

Family	Genus	Species	Common name
Rhincodontidae	*Rhincodon*	*R.typus*	Whale shark
Stegostomatidae	*Stegostoma*	*S. fasciatum*	Zebra shark
Ginglymostomatidae	*Nebrius*	*N. ferrugineus*	Tawny nurse shark
Hemiscyllidae	*Chiloscyllium*	*C. griseum*	Grey bamboo shark
		C. indicum	Slender bamboo shark
		C. plagiosum	White spotted bamboo shark
		C. arabicum	Arabian carpet shark
		C. hasselti	Hasselt's bamboo shark
		C. punctatum	Brown banded bamboo shark
		C. burmensis	Burmese bamboo shark
	Hemiscyllium	*H. ocellatum*	Epaulette shark

Order: Hexanchiformes

Sharks representing the family Hexanchidaeunder the OrderHexanchiformes have been reported to occur in Indian waters.

Family Hexanchidae (Six/Seven gill sharks)

Hefty sharks with wide head, mouth situated on the underside and having six rows of blade-like, comb-shaped teeth on each side. Possess a single dorsal fin and a short, sturdy caudal peduncle. Distance from the dorsal fin's insertion to the upper caudal origin is roughly equal to or slightly longer than the length of the dorsal fin base. Ovoviviparous, delivering litters ranging from 22 to 108 pups.

Species reported from Indian waters: Order Hexanchiformes

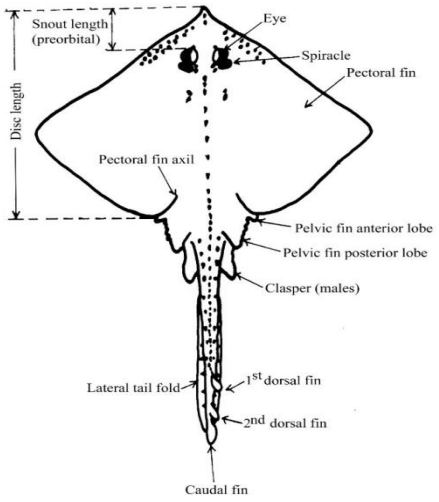
Family	Genus	Species	Common name
Hexanchidae	*Hexanchus*	*H. griseus*	Bluntnose sixgill shark
	Heptranchias	*H. perlo*	Sharpnose seven gill shark

Taxonomy and diversity of Batoids

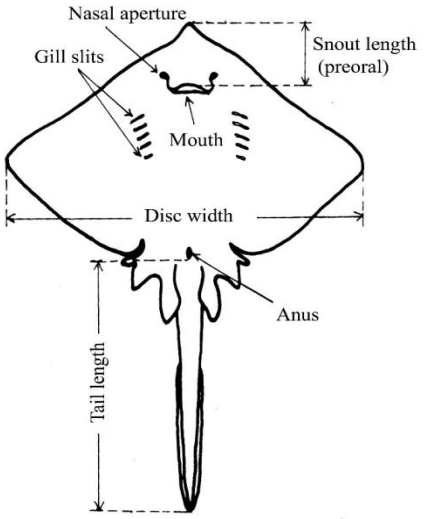
Common characteristics of Batoids:

- Gill openings positioned on the ventral side
- Eyes and spiracles situated on the upper side of the head
- Large pectoral fins that connect to the side of the head
- Absence of anal fin
- Pavement teeth, for crushing prey

Morphology and morphometry of Batoids



Dorsal view illustrating body parts and measurements of skates



Ventral view illustrating body parts and measurements of skates

Classification of Batoids

The classification of Batoids remains debatable, with much yet to be understood about the evolutionary relationships and lineages. Skates, rays, and guitarfishes are commonly acknowledged as a monophyletic group, however, depending on the classification, they can be listed as belonging to four different orders viz., in the division Batoidea under subclass Elasmobranchii, and occasionally they are all listed under one order Rajiformes instead of under separate orders.

Subdivision :Batoidea

OrderRhinopristiformes
OrderMyliobatiformes
Order Rajiformes
OrderTorpediniformes

Order: Rhinopristiformes

Species representing the families Pristidae,Rhinidae and Rhinobatidae of the orderRhinopristiformeshave been documentedin Indian waters.

Family: Pristidae (Saw fishes)
Body is similar to that of a shark, with a depressed head and a snout that extends into a long, flat blade containing teeth on each side. There is one pair of long barbels present. Two distinct dorsal fins and a caudal fin, with no dorsal fin spines and anal fin absent. Spiracles are large.

Family Rhinidae (Bow mouth guitar fishes and Wedge fishes)
Body shape is a blend between that of a shark and a skate, with a large, bilobed caudal fin. Origin of the first dorsal fin is positioned over or in front of the pelvic fins. In bowmouth guitarfish, the snout and anterior part of the head are broadly rounded, whereas in wedge fishes, they are angular and wedge-shaped, often featuring a deep or shallow indentation that separates them from the origin of the pectoral fin.

FamilyRhinobatidae (Guitar fishes)
Body shape intermediate between that of sharks and skates, having a stout tail that is not distinctly separated from the body. Snout wedge-shaped and varies in length but is not elongated into a blade and does not feature lateral teeth.

Possesses two clearly defined dorsal fins and a caudal fin that lacks bilobed structure. First dorsal fin originates behind the pelvic fins. Body covered in denticles, which emerge from a row along the back midline. Notably, the tail doesnot have a spine.

Family Glaucostegidae (Giant guitar fishes)
Flattened, spade-like to wedge-shaped disc and a robust, depressed shark-like trunk. Snout is typically long, with tips that can vary from acute or bluntly rounded to protruding forward as a large, bulbous lobe. Eyes are generally small and widely separated, while the spiracles are small with 1-2 variably developed folds. Skin covered with fine denticles, sometimes with small thorns confined to a row along the mid-line of the body and small patches near the eyes, shoulders, and occasionally on the snout (more pronounced in young ones). Long-based pelvic fins are positioned laterally, behind the disc. Two similarly-shaped, upright dorsal fins that are well separated, with the first positioned well behind the tips of the pelvic fins. Caudal fin is small and directed posteriorly, without a ventral lobe.

Species reported from Indian waters: Order Rhinopristiformes

Family	Genus	Species	Common name
Pristidae	*Anoxypristis*	*A. cuspidata*	Pointed/Narrow sawfish
	Pristis	*P. microdon*	Largetooth sawfish
		P. pristis	Common sawfish
		P. zijsron	Longcomb/Green sawfish
Rhinidae	*Rhina*	*R. ancylostomus*	Bowmouth guitarfish/shark ray
	Rhynchobatus	*R. australiae*	Bottlenose wedge fish/White spotted wedge fish
		R. djiddensis	Giant Guitarfish/Whitespottedwedgefish
	Rhynchobatus	*R. laevis*	Smoothnosewedgefish
	Rhynchobatus	*R. palpebratus*	Eyebrow wedgefish
Rhinobatidae	*Rhinobatos*	*R. lionotus*	Smoothback guitarfish
	Rhinobatos	*R. annandalei*	Annandale's guitarfish/Bengal guitarfish
	Rhinobatos	*R. punctifer*	Spotted guitarfish
	Acroteriobatus	*A. variegatus*	Stripenose Guitarfish
Glaucostegidae	*Glaucostegus*	*G. granulatus*	Granulated/Sharpnose guitarfish
		G. obtusus	Widenose Guitarfish
		G. typus	Giant guitarfish
		G. thouin	Clubnose guitarfish
		G. halavi	Halavi guitarfish

Order:Torpediniformes

Electric rays/numb fishesfrom the families Torpedinidae, Narcinidae and Narkidae within the orderTorpediniformeshave been found to occur in Indian waters.

Family Torpedinidae (Electric rays)

Torpedo rays are characterized by their flat and disc-shaped bodies, featuring caudal fins of varying lengths. They have thick, fleshy margins around their disc and a strongly arched, wide mouth without labial folds or a peripheral groove. Unlike some species, their jaws are not bound by cartilage. Male torpedo rays possess claspers near the base of their tail. They exhibit ovoviviparous mode of reproduction.

Family Narcinidae (Numb fishes)

These small to medium-sized rays exhibit oval, rounded, or shovel-shaped pectoral discs and stout tails that are either equal to or longer than the disc. Mouth transverse with a prominent groove, while the snout is supported by a broad, trough-shaped rostral cartilage. Jaws highly protrusible, and there is a notable groove around the periphery of the mouth. Nasal curtain typically broader and shorter. Their small teeth have a single moderate cusp. Two prominent dorsal fins of roughly equal size and a large caudal fin.

Family Narkidae (Numb rays)

Pectoral disc is rounded anteriorly; mouth is very small and narrow, with upper and lower grooves. Head is flattened, lacking spiracle lamellae except in the genus *Electrolux*. Their teeth are either ridged or unicuspidate.One or two dorsal fins or no dorsal fin at all. Caudal fin is significantly larger than the dorsal fin and is approximately of the same size as the pelvic fin.

Species reported from Indian waters: Order Torpediniformes

Family	Genus	Species	Common name
Torpedinidae	*Torpedo*	*T. panthera*	Panther electric ray
		T. sinuspersici	Variable torpedo ray
		T. marmorata	Marbled electric ray
Narcinidae	*Benthobatis*	*B. moresbyi*	Dark blind ray
	Narcine	*N. timlei*	Spotted numbfish
		N. brunnea	Brown numbfish
		N. lingula	Chinese numbfish
		N. oculifera	Bigeye numbfish
		N. maculata	Darkfinned numbfish
		N. atzi	Oman numbfish
Narkidae	*Heteronarce*	*H. prabhui*	Quilon electricray
	Narke	*N. dipterygia*	Numbray

Order Rajiformes

Skates of the families Gurgesiellidae and Rajidae under the orderRajiformeshave been documented from Indian waters.

Family Gurgesiellidae (Pigmy skates)

The mouth features an exceptionally thin and flexible rostral cartilage; pelvic fin is deeply notched, characterized by finger-like lobes and these lobes are mostly of equal size

Family Rajidae (Skates)

The snout is slender and pointed, while its mouth is wide, sometimes covered by a fleshy nasal flap. The rostral cartilage is mostly firm. Its pelvic fin usually has two lobes, with a deep or weak incision, and the anterior lobe tends to be shorter than the posterior lobe. May have up to two dorsal fins but lacks an anal fin.

Species reported from Indian waters: Order Rajiformes

Family	**Genus**	**Species**	**Common name**
Gurgesiellidae	*Cruriraja*	*C. andamanica*	Andaman skate/Andaman pygmy
	Fenestraja	*F. mamillidens*	Prickly pygmy skate/Prickly skate
Rajidae	*Dipturus*	*D. johannisdavesi*	Travancore skate
	Orbiraja	*O. powelli*	Indian ring skate
	Cruriraja	*C. andamanica*	Andaman leg skate

Order: Myliobatiformes

Rays representing the families Gymnuridae,Dasyatidae, Plesiobatidae, Myliobatidae, Aetobatidae, Rhinopteridae, Hexatrygonidae andMobulidae falling under the orderMyliobatiformes have been recorded from Indian waters.

FamilyGymnuridae (Butterfly rays)

Disc considerably broader than it is long, taking on a lozenge shape that is 1.6 times wider than it is long. Possesses five pairs of gill slits and a very thin, short tail.

Family Dasyatidae (Whiprays)

Disc oval, circular, or rhomboidal in shape, paired with moderately stout to slender, and often elongated whip-like tails that are usually longer than the disc itself. There are no ridge-like skin folds on their tails.

Family Plesiobatidae (Stingrays)

Snout elongated, measuring over six times the diameter of its orbit. Body is broadly angular and fleshy, with a dorsal surface uniformly covered in fine denticles. Tail is short.

FamilyMyliobatidae (Eagle rays)

These rays exhibit a clear distinction between the head and the rest of the disc, with a notable separation. Their internasal curtain lacks notches or indentations, presenting a smooth and continuous structure.

FamilyAetobatidae (Eagle rays)

The snout of these rays features a single convex rostral lobe, providing a distinctive shape. Their internasal flap is deeply notched, forming a noticeable "V" shape

Family Rhinopteridae (Cow nose rays)

Snout characterized by a pair of low, rounded, and broad lobes that are deeply notched in the middle, creating a distinct and recognizable shape.

Family Hexatrygonidae (Stingrays)

Greatly elongated and thick snout that is quite prominent. Their body is notably soft and flabby in texture. Has six pairs of gill openings, and the spiracles are positioned widely apart and located behind the eyes.

Family Mobulidae (Devil rays/Manta rays)

These rays possess a distinct snout structure that is formed into paired elongated lobes, giving them a unique appearance. Their mouth is broad, lacking a nasal curtain, which adds to their characteristic features.

Species reported from Indian waters: Order Myliobatiformes

Family	Genus	Species	Common name
Gymnuridae	*Gymnura*	*G. poecilura*	Longtail butterfly ray
		G. micrura	Smooth butterfly ray
		G. zonura	Zone tail butterfly ray
Dasyatidae	*Brevitrygon*	*B.imbricata*	Bengal whipray/Scaly whipray
		B.walga	Dwarf whipray
	Hemitrygon	*H. bennettii*	Bennett's sting ray
	Telatrygon	*T. crozieri*	Indian sharpnose ray
	Himantura	*H. leoparda*	Leopard whipray
		H. uarnak	Coach whipray/Reticulate whipray
		H. undulata	Leopard whipray
		H. alcockii	Pale-spot whip ray
		H. fava	Honeycomb whipray
		H. marginata	Black edge whip ray
	Maculabatis	*M. arabica*	Pakistan whipray
		M. bineeshi	Shorttail whipray
		M. gerrardi	Whitespotted whipray
		M. pastinacoides	Round whipray
		M. microps	Smalleye stingray
	Neotrygon	*N. kuhlii*	Blue-spotted stingray
		N. indica	Indian ocean blue-spotted maskray
	Telatrygon	*T. zugei*	Pale edged stingray
	Pastinachus	*P. ater*	Broad cowtail ray
		P. gracilicaudus	Narrow cowtail ray
		P. sephen	Cowtail ray
	Pateobatis	*P. bleekeri*	Bleeker's whipray
		P. fai	Pink whipray
		P. jenkinsii	Jenkins' whipray
		P. uarnacoides	Whitenose whipray
	Pteroplatytrygon	*P. violacea*	Pelagic stingray

	Taeniura	*T. lymma*	Blue-spotted fantail ray
	Taeniurops	*T. meyeni*	Blotched stingray
	Urogymnus	*U. asperrimus*	Porcupine whipray
		U. granulatus	Mangrove whipray
Plesiobatidae	*Plesiobatis*	*P. daviesi*	Giant stingray
Myliobatidae	*Aetomylaeus*	*A. maculatus*	Mottled eagle ray
		A. milvus	Brown eagle ray
		A. nichofii	Banded eagle ray
		A. vespertilio	Ornate eagle ray
Aetobatidae	*Aetobatus*	*A. flagellum*	Longheaded eagle ray
		A. ocellatus	Spotted eagle ray
Rhinopteridae	*Rhinoptera*	*R. javanica*	Javanese cownose ray/Flapnose ray
		R. jayakari	Short tail cownose ray
Hexatrygonidae	*Hexatrygon*	*H. bickelli*	Sixgill stingray
Mobulidae	*Mobula*	*M. alfredi*	Reef manta ray
		M. birostris	Giant manta ray
		M. kuhlii	Shortfin devilray/Kuhl's devilray
		M. mobular	Giant devilray/Devil fish
		M. tarapacana	Chilean devilray
		M. thurstoni	Bentfindevilray/Smoothtailmobula
		M. eregoodootenkee	Longhornedmobula

Further reading

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