5. Elasmobranchs: Classification, and Key Characteristics of Cartilaginous Fishes

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Cartilaginous fish (sharks, rays, skates, guitarfishes, and chimaeras) are a captivating group contributing to marine biodiversity. Elasmobranchs, a subclass of Chondrichtheys, possess a cartilaginous skeleton, unlike bony fishes (Osteichthyes). Chondrichtheys, an ancient taxon dating back to 400 million years, comprises Elasmobranchii and Holocephali. Elasmobranchs inhabit diverse marine environments globally, from shallow coastal waters to deep trenches, with over 869 extant species (around 400 sharks). They occupy habitats from nearshore to abyssal depths, from the equator to the poles, including some freshwater and hypersaline waters, primarily in tropical and temperate marine regions. Deep-sea exploration will likely uncover more species. Taxonomic revisions, including reclassification and renaming, contribute to our understanding of elasmobranch phylogeny and evolutionary history.

Class: Chondrichthyes

Classification



Common characteristics of cartilaginous (Chondrichtheys) 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
- Usually snout 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

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 Elasmobranchii comes 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) and Torpediniformes (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

Classification	Characteristics
Squatiniformes (Angel Sharks, Sand devils)	• Flat body
	• Mouth at front
	• No anal fin
	 Ovoviviparous
Pristiophoriformes (Saw sharks)	Long snout
	• Mouth underneath

	No anal fin
	• Gill silts on sides of body
	• Spiracles present
	• Ovoviviparous (litters of 7
	to 17 large pups)
Squaliformes (Dogfish and bramble/cookie cutter	• Short snout
sharks)	• No anal fin
	• Ovoviviparous (1, 2, or
	over 20 young)
Hexanchiformes (Frilled and cow sharks)	• Anal fin present
	• One dorsal fin
	• 6 or 7 gills on each side
	 Ovoviviparous
Heterodontiformes (Bullhead sharks and horn sharks)	• Anal fin present
	• 5 gill slits
	• 2 dorsal fins
	• Dorsal spines present
	• Only living sharks with
	dorsal fin spines and anal
	fin
	 Ovinarous (unique spiral
	flanged egg cases)
Orectalohiformes (Carpet sharks including the	• Anal fin present
wobbegong nurse bamboosbarks blind zebra and	• 5 gill slits
whole shark)	 J gill slits 2 dorsal fins
	 2 dorsar mis No fin grings
	 No fill spines Mouth in front of ever
	Mouth in none of eyes
	• Oviparous or ovoviviparous
Lamiltormes (Mackerel sharks, including the basking,	• Anal fin present
goblin, megamouth, great white, crocodile shark,	• 5 gill slits
thresher, porbeagles, sandtiger and mako sharks)	• 2 dorsal fins
	• No fin spines
	• Mouth behind eyes
	 No nictitating eyelids
	Ovoviviparous
Carcharhiniformes (Ground sharks including catsharks,	• Anal fin present
swellsharks, houndsharks, weasel sharks, requiem, tiger	• 5 gill slits
and hammerhead sharks)	• 2 dorsal fins
	• No fin spines
	• Mouth behind eyes
	• Nictitating eyelids present
	• Viviparous or
	ovoviviparous

Morphology and morphometry of sharks

Sharks are classified based on external features such as body shape, snout length, and fin proportions, as well as internal traits like tooth arrangement and count. Among these, total length (TL) is a primary metric used in shark taxonomy, serving as a reference for measuring other proportional dimensions. In certain instances, pre-caudal length (PCL) and fork length (FL) are used as alternatives to TL, offering supplementary data to examine shark morphology more thoroughly.



Lateral view of shark illustrating external body parts



Ventral view and measurements



- GS5
- IDS Interdorsal width
- Lower precaudal-fin length LCL
- PAL Preanal-fin length
- Preoral length PP1 Prepectoral-fin length PP2 Prepelvic-fin length

VCL

Vent caudal-fin length

- PRN Prenarial length

Main longitudinal measurements





Head and pectoral fin measurements



Measurements of (a) first dorsal, (b) second dorsal, (c) pelvic, (d) anal and (e) caudal fins



DAI	Second dorsal-ini insertion anai-ini insertion
DAO	Second dorsal-fin origin anal-fin origin

- DPI First dorsal-fin midpoint pectoral-fin insertion
- DPO First dorsal-fin midpoint pelvic-fin origin

Other common measurements

TAH

TRH

Tail height

Trunk height



Tooth parts of sharks

Taxonomy and diversity of sharks in Indian water

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	Characteristics	
Carcharhinidae (Requiem	Largest tropical shark family.	
sharks)	• No spiracles (except Galeocerdo).	
	• Internal nictitating eyelids.	
	• Elongated, arched mouth past eyes.	
	• Blade-like teeth, upper broader.	
	• Precaudal pit present.	
	• Two dorsal fins, anal fin.	
	• First dorsal base ahead of pelvic fins.	
	• Five gill slits, last 1-3 over pectoral fin.	
	• No gill rakers.	
	• Viviparous (yolk sac placenta).	
	• Litter size varies (1-2 to 135).	
	• Tiger shark is ovoviviparous.	
Sphyrnidae (Hammerhead	Hammer-like head extensions.	
sharks)	• Circular eyes on outer edges.	
	• Internal nictitating eyelids.	
	• No spiracles, labial furrows.	
	• Precaudal pit present.	
	• Two dorsal fins, high pointed first dorsal.	
	• First dorsal base shorter than caudal, ahead of pelvic	
	fins.	
	• Smaller second dorsal and anal fins.	
	• Viviparous.	
Scyliorhinidae (Cat sharks)	• Small, slender, elongated body.	
	• Cat-like eyes, elongated, maybe rudimentary	
	nictitating eyelids.	
	• Two small dorsal fins (no spines), anal fin.	
	• First dorsal base opposite/behind pelvic fins.	
	• No precaudal pit.	
	• Caudal fin without ventral lobe or dorsal undulations.	
	• Five gill slits, last two behind pectoral fins.	
	• Spiracles present.	
	• Numerous small teeth, single cusp, maybe cusplets.	
	• Spiral valve intestine.	
	• No lateral keels or precaudal pits on caudal peduncle.	
Pentanchidae (Cat sharks)	• Small, slender to moderately stout.	
	• Horizontal oval eyes.	
	• Rudimentary lower eyelids.	
	• Spiracles present.	
	• Five gill slits, last two over pectoral fin.	
	• Small, numerous teeth.	
	• Spiral valve intestine.	

	First dorsal over/behind pelvics.
	• Large second dorsal and anal fins.
	• Symmetrical tail, little/no lower lobe.
Triakidae (Hound sharks)	• Small to medium-sized.
	• Horizontal oval eyes, nictitating eyelids.
	• Long, angular/arched mouth, past eyes.
	• Moderate to long labial furrows.
	• Two moderate/large dorsal fins (no spines).
	• First dorsal base well ahead of pelvic fins.
	• Anal fin smaller than second dorsal, concave rear
	edge.
	• No precaudal pit.
	• Caudal fin without ventral lobe or dorsal undulations.
	• Spiracles present.
	• Spiral valve intestine.
Hemigaleidae	• Wavy/undulated dorsal fin margin.
(Weasel sharks)	• Precaudal pit present.
	• Internal nictitating membrane.
	• Small spiracles.
	 Moderately long labial furrows.
	• Spiral valve intestine.
Proscyllidae (Finback cat	 Poorly developed nictitating eyelids.
sharks)	• Large spiracles.
	• Comb-like posterior teeth.
	• Very short/absent labial furrows.
Pseudotriakidae (False cat	• Elongated, slit-like eyes.
sharks)	 Underdeveloped nictitating eyelids.
	• Large spiracles.
	• Many tooth rows, comb-like posterior teeth.
	• Elongated, low, keel-like first dorsal fin.

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
	<u>Paragaleus</u>	P. <u>longicaudatus</u>	Slender weasel shark
	Hemipristis	H. elongata	Snaggletooth shark
Proscyllidae	Eridacnis	E. radcliffei	Pygmy ribbontail catshark
	Proscyllium	P. magnificum	-
Pseudotriakidae	Planonasus	P. indicus	Eastern dwarf false catshark

Order : Lamniformes

Shark species belonging to the families Alopiidae, Lamnidae, Megachasmidae, Pseudocarchariidae and Odontaspididae of the order Lamniformes are known to occur in Indian waters

Family	Characteristics
Alopiidae (Thresher sharks)	 Long, curved, asymmetrical caudal fin (dorsal lobe almost as long as body). Short ventral caudal lobe. Long, narrow pectoral fins. Large eyes. Small mouth. Short gill openings (last two above pectoral fin base). Precaudal pit present. Ovoviviparous. Uterine cannibalism.
Lamnidae (Mako sharks)	 Pointed snout. Spindle-shaped body. Elongated mouth, large, blade-like teeth. Gill slits extend widely laterally to mid-dorsal surface. No gill rakers. Long pectoral fins. Tall dorsal fins. Small second dorsal and anal fins. Large lateral keels. Prominent precaudal pits. Lunate caudal fin. Ovoviviparous. Uterine cannibalism.
Pseudocarchariidae (Crocodile sharks)	 Medium-sized. Spindle-shaped body. Very large eyes (no nictitating membrane). Long gill slits (onto dorsal surface). Large, parabolic, ventral mouth. Protrusible, large, lanceolate teeth (narrow anterior, blade-like lateral). Small, low dorsal fins (second < half first, > anal). Small, broad, rounded pectoral fins. Large pelvic fins. Weak lateral keel. Precaudal pits present.

	• Fins outlined in white, maybe white spots, white blotch between mouth and gills.
Megachasmidae	• Elongated head (\approx trunk length).
(Megamouth sharks)	 Very large, terminal mouth. Short, broadly rounded snout. Moderately long gill opening (not onto dorsal surface). Last two gill slits over pectoral fin base. Small teeth, many rows.
Odontaspididae (Sand sharks)	 Caudal peduncle without lateral keels. Pit on upper caudal peduncle, none on lower. Large, slender teeth, smooth edges. No nictitating membrane. 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	<u>Pseudocarcharias</u>	P. <u>kamoharai</u>	Crocodile shark
Megachasmidae	Megachasma	M. pelagios	Megamouth shark
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 Squaliformes order have been recorded in Indian waters.

Family	Characteristics
Echinorhinidae (Bramble sharks)	 First dorsal fin behind pelvic fin origin. No anal fin.
	 Spineless dorsal fins, far back. Large contrared therm like dentiales (some
	• Large, scattered, morn-like denticies (some fused).

	 Ovoviviparous (no yolk sac placenta).
Squalidae (Dogfish sharks)	• Low, cylindrical body.
	• Two dorsal fins (may or may not have spines).
	• First dorsal fin origin in front of pelvic fins.
	• Small to moderately large denticles.
	• Caudal fin with or without subterminal notch.
	• Ovoviviparous (aplacental viviparity).
	• Litter size 1-2 to over 20.
Centrophoridae (Gulper sharks)	• Grooved spines on both dorsal fins.
	• Larger lower jaw teeth.
	• No precaudal pits or lateral keels on caudal
	peduncle.
	• Ovoviviparous (embryos depend on yolk).
Etmopteridae (Lantern sharks)	• Small to medium-sized.
	• Deep oceanic.
	• Bioluminescent.
	• Cylindrical body.
	• Elongated snout.
	• Two dorsal fins, sharp spine on each.
	• Small light organs (photophores) on belly and
	sides.
	• Large spiracles.
	• Subterminal notch on caudal fin.
Somniosidae (Velvet	• Broad head, short, flat snout.
dogfishes/Sleeper sharks)	• Small, needle-like upper teeth.
	• Broad, flat lower teeth.
	• Five gill slits.
	• Large spiracles.
	• Low, small dorsal fins.
	• Fin spines on dorsal fins (except
	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	<u>C. crepidater</u>	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	Characteristics
Rhincodontidae	• Wide, flat head, snub-nosed snout.
	• Large, near-terminal mouth.
	• Numerous, small teeth.
	• Large external gill slits.
	• Filter screens in internal gill slits.
	• Large gill openings, fifth distinct from fourth.
	• Elongated gill rakers.
	• Lateral keels on caudal peduncle.
	• Robust ventral lobe on caudal fin.
	• No prominent terminal lobe or subterminal
	notch.
	• Viviparous, large litters.
Stegostomatidae (Zebra sharks)	• Moderate size.
	• Small, subterminal mouth.
	• Small external gill slits.
	• Lateral eyes, no movable upper eyelids.
	• Large spiracles.
	• Short, pointed nasal barbels.
	• Very long caudal fin (almost body length).
	• Caudal fin usually without strong ventral lobe.
	• Prominent terminal lobe and subterminal notch
	on caudal fin.
	• No lateral keels or precaudal pits.
Ginglymostomatidae	• Short, wide, blunt snout.
(Nurse sharks)	• Oval eyes behind mouth.
	• Large barbels below snout.
	• Groove between nasal opening and mouth
	corner.
	• Small, transverse mouth below snout.
	• Five gill slits, last two close together, above
	pectoral fins.

	• Two close-set dorsal fins (similar size), rear half
	of body.
	• Short, asymmetrical tail, minimal lower lobe.
	• No keels on tail base.
Hemiscyllidae (Bamboo sharks)	• Small, slender.
	• Nasoral grooves.
	• Short nasal barbels.
	• Small, transverse mouth in front of eyes.
	• Large spiracles below eyes.
	• No lateral skin flaps on head.
	• Two dorsal fins (no spines).
	• Second dorsal origin ahead of first.
	• Low, keel-like, rounded anal fin, origin behind
	second dorsal origin.
	• Narrow notch between anal fin and lower
	caudal origin.
	• Long precaudal tail.
	• No lateral keels or precaudal pits.
	• Oviparous, 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 Hexanchidae under the Order Hexanchiformes have been reported to occur in Indian waters.

Family : Hexanchidae (Six/Seven gill sharks)

- Hefty sharks with a wide head.
- Mouth on underside.
- Six rows of blade-like, comb-shaped teeth on each side.
- Single dorsal fin.

- Short, sturdy caudal peduncle.
- Dorsal fin insertion to caudal origin distance \approx dorsal fin base length.
- Ovoviviparous reproduction.
- Large litters (22-108 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

Order	: Rhinopristiformes (Saw fishes, wedge fishes and guitar fishes)
Order	: Myliobatiformes (Sting rays and relatives)
Order	: Rajiformes (Skates)
Order	: Torpediniformes (Electric rays and numb fishes)

Order: Rhinopristiformes

Species representing the families Pristidae, Rhinidae and Rhinobatidae of the order Rhinopristiformes have been documented in Indian waters.

Family	Characteristics
Pristidae (Saw fishes)	• Shark-like body, depressed head.
	• Long, flat, toothed snout (saw).
	• One pair of long barbels.

- Two dorsal fins, caudal fin.
- No dorsal fin spines, no anal fin.
- Large spiracles.
- Body between shark and skate-like.
- Large, bilobed caudal fin.
- First dorsal fin origin over/in front of pelvic fins.
- Bowmouth: Rounded snout and head.
- Wedgefish: Angular, wedge-shaped snout, indentation before pectoral fin origin.
- Body between shark and skate-like.
- Stout tail, not distinctly separate from body.
- Wedge-shaped snout (not a blade), no lateral teeth.
- Two dorsal fins, caudal fin (not bilobed).
- First dorsal fin origin behind pelvic fins.
- Denticles, row along back midline.
- No tail spine.
- Flattened, spade/wedge-shaped disc.
- Robust, depressed, shark-like trunk.
- Long snout, tip varies (acute, rounded, bulbous).
- Small, widely separated eyes.
- Small spiracles, 1-2 folds.
- Fine denticles, sometimes small thorns (back midline, eyes, shoulders, snout).
- Long-based pelvic fins, lateral, behind disc.
- Two separated, similar dorsal fins (first behind pelvic fin tips).
- Small, posterior caudal fin, no 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

Glaucostegidae (Giant guitar

fishes)

Rhinidae (Bow mouth guitar

Rhinobatidae (Guitar fishes)

fishes and Wedge fishes)

		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/Whitespotted wedgefish
	Rhynchobatus	R. laevis	Smoothnose wedgefish
	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 fishes from the families Torpedinidae, Narcinidae and Narkidae within the order Torpediniformes have been found to occur in Indian waters.

Family	Characteristics
Torpedinidae (Electric Rays)	• Flat, disc-shaped body
	• Caudal fin varies in length
	• Thick, fleshy disc margins
	• Arched, wide mouth (no labial folds or peripheral groove)
	• Jaws not bound by cartilage
	• Males have claspers
	Ovoviviparous
Narcinidae (Numb Fishes)	• Small to medium size

- Tail stout, equal to or longer than disc
- Transverse mouth with prominent groove
- Snout with broad, trough-shaped rostral cartilage
- Highly protrusible jaws
- Prominent groove around mouth periphery
- Nasal curtain typically broader and shorter
- Small, single-cusped teeth
- Two dorsal fins (roughly equal size)
- Large caudal fin

• Pectoral disc rounded anteriorly

- Very small, narrow mouth (upper and lower grooves)
- Flattened head (no spiracle lamellae, except *Electrolux*)
- Teeth ridged or unicuspidate
- One or two dorsal fins, or absent
- Caudal fin large (same size as or larger than pelvic fin)

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

Species reported from Indian waters: Order Torpediniformes

Narkidae (Numb Rays)

Order: Rajiformes

Skates of the families Gurgesiellidae and Rajidae under the order Rajiformes have been documented from Indian waters.

Family	Characteristics
Gurgesiellidae (Pigmy skates)	• Exceptionally thin and flexible rostral cartilage in the mouth.
	• Deeply notched pelvic fin with finger-like lobes.
	• Lobes of pelvic fin mostly equal in size.
Rajidae (Skates)	• Slender and pointed snout.
	• Wide mouth, sometimes covered by fleshy nasal flap.
	• Mostly firm rostral cartilage.
	• Pelvic fin usually with two lobes (deep or weak incision).
	• Anterior lobe of pelvic fin shorter than posterior lobe.
	• May have up to two dorsal fins.
	• 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 and Mobulidae falling under the order Myliobatiformes have been recorded from Indian waters.

Family	Characteristics
Gymnuridae (Butterfly rays)	• Disc much broader than long (lozenge-shaped).
	• 1.6 times wider than long.

• Five pairs of gill slits.

	• Very thin, short tail.
Dasyatidae (Whiprays)	• Disc oval, circular, or rhomboidal.
	• Moderately stout to slender, often elongated whip-like tails.
	• Tails usually longer than the disc.
	• No ridge-like skin folds on tails.
Plesiobatidae (Stingrays)	• Elongated snout (over 6x orbit diameter).
	• Broadly angular, fleshy body.
	• Dorsal surface covered in fine denticles.
	• Short tail.
Myliobatidae (Eagle rays)	• Distinct separation between head and disc.
	• Internasal curtain without notches or indentations.
Aetobatidae (Eagle rays)	• Snout with single convex rostral lobe.
	• Internasal flap deeply notched ("V" shaped).
Rhinopteridae (Cow nose rays)	• Snout with two low, rounded, broad lobes.
	• Deeply notched between lobes.
Hexatrygonidae (Stingrays)	• Greatly elongated, thick snout.
	• Soft, flabby body.
	• Six pairs of gill openings.
	• Spiracles widely spaced, behind eyes.
Mobulidae (Devil rays/Manta rays)	• Snout formed into paired elongated lobes.
	• Broad mouth, no nasal curtain.

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

	<u>Telatrygon</u>	T. <u>crozieri</u>	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	Bentfin devilray/Smoothtail mobula
		M. eregoodootenkee	Longhorned mobula

Further reading

- Compagno, L. J. V. 1984. FAO Species catalogue, Vol. 4, Sharks of the world, An annotated and illustrated catalogue of sharks species known to date, Part 1, Hexanchiformes to Lamniformes, *FAO Fisheries Synopsis*, No. 125, Vol. 4, Part 1, Food and Agriculture Organisation of the United Nations, Rome, Italy, 249 p.
- Compagno, L. J. V. 1984. FAO Species catalogue, Vol. 4, Sharks of the world, An annotated and illustrated catalogue of sharks species known to date, Part 2, Carcharhiniformes, *FAO Fisheries Synopsis*, No. 125, Vol. 4, Part 2, Food and Agriculture Organisation of the United Nations, Rome, Italy, pp. 251-655.
- 3. Hamlett, W. C. 1999. *Sharks, skates and rays: The biology of elasmobranch fishes.* The Johns Hopkins University Press, Baltimore, USA, 515 p.
- 4. Ebert, D. A. and Stehmann, M. F. W. 2013. Sharks, batoids and chimaeras of the North Atlantic. *FAO Species Catalogue for Fishery Purposes* No. 7. Food and Agriculture Organisation of the United Nations, Rome, Italy, 523 p.
- 5. Last, P., White, W., Carvalho, M. Seret, B., Stehmann, M. and Naylor, G. 2016. *Rays of the world*. CSIRO Publishing, Australia, 800 p.
- 6. Nelson, J. S., Grande, T. C., Wilson, M. V. H 2016. *Fishes of the world*, 5th edn. John Wiley and Sons, Hoboken, NJ, USA.