

I. Introduction to Fish and Fisheries

About Indian Fisheries

India is the third largest fish producing country and the second largest aquaculture fish producer in the world. India contributes about 7% to the global fish production. The country is also home to more than 10% of the global fish biodiversity and is one of the 17-mega biodiversity rich countries. Around 14 million people are engaged in fisheries and its allied activities. Andhra Pradesh is the largest fish producer in the country followed by West Bengal and Gujarat. The total fish production during 2017-18 is estimated to be 12.60 million metric tonnes, of which nearly 70% is from inland sector and about 50% of the total production is from culture fisheries. More than 50 different types of fish and shellfish products are being exported to 75 countries around the world. Fish and fish products have presently emerged as the largest group in agricultural exports from India, with 13.77 lakh tonnes in terms of quantity and Rs. 45,106.89 crore in value. This accounts for around 10% of the total exports and nearly 20% of the agricultural exports, and contribute to about 0.91% of the GDP and 5.23% to the Agricultural GVA of the country.

Fisheries is an economic activity that involves harvesting fish or any aquatic organism from the wild (Capture Fisheries) or raising them in confinement (Culture Fisheries/ Aquaculture). It may be Traditional/ Small Scale Fisheries (SSF) for sustenance, or Large-Scale/ Commercial Fisheries for profit.

Fish (in general) is a cold-blooded aquatic organism that breathes with gills and swims with fins; they are categorized as Finfish and Shellfish.

Finfish are cold-blooded aquatic vertebrates that have gills, fins with rays, and scales covering the body.

Shellfish are cold-blooded aquatic invertebrate that have gills, various types of locomotory organs and a shell/ exoskeleton covering the body. They include crustaceans and mollusc.

Biodiversity: India has a large number of finfish species. As per the database of the National Bureau of Fish Genetic Resources (NBFGR), Lucknow, 2,508 species of native finfish have

been recorded, of which 1,518 species are from the marine environment, 113 from brackish waters and 877 are from freshwater habitats. In addition, 291 exotic fish species also occur in India.

Fish Diversity of India*

<i>Native Fishes</i>	<i>Number of Species</i>
Marine Ecosystem	1518
Brackishwater Ecosystem	113
Freshwater Ecosystem	877
Sub-total	2508
<i>Exotic Fishes</i>	291
Total	2799

*Uttam K Sarkar, JK Jena, Shri Prakash Singh, AK Singh and SC Rebello (2012). *Documenting Coastal Fish Biodiversity of India: Status, Issues and Challenges*. Conference Paper, International Day for Biological Diversity, Marine Biodiversity, 22 May 2012, Uttar Pradesh State Biodiversity Board, Lucknow, pp. 22-28.

Categorization of Fish by their habitat:

- **Freshwater Fish:** Fish that spend most or all of their life in freshwaters, such as rivers and lakes, having a salinity of less than 0.5 ppt. Around 40% of all known species of fish are found in freshwater.

They may be divided into **Coldwater Fish** (5 – 20 °C); examples: Mahseer, Trout, etc., and **Warmwater Fish** (25 – 35 °C); example: Carps, Catfish, Snakeheads, Featherbacks, etc.

- **Brackishwater Fish:** Fish that can tolerate a wide range of salinity (0.5 – 30.0 ppt) and live in backwaters, estuaries and coastal waters.

Example: Mullet, Milkfish, Seabass, Pearlsport, Mudskipper, etc.

- **Marine Fish:** Fish that spend most or all of their life in seawater, such as Seas and Oceans, having salinity above 30 ppt. There are about 240 species contributing to the marine fisheries.

Example: Sardines, Mackerel, Ribbonfish, Anchovies, Grouper, Cobia, Tuna, etc.

II. Finfish Fisheries

1. Freshwater Fisheries

Around 70% of India's fish production comes from inland waters, of which nearly 65% comes from aquaculture. Out of the total inland aquaculture production, Indian Major Carps are the most cultured freshwater fish followed by Exotic Carps, Minor Carps, Catfish and Trout. There are around 1300 Carp Hatcheries in India that produced seed and supply to fish farmers. The inland water resources of India can be categorised as follows:

Inland Water Resources of India

Warmwater Resources	Extent
Rivers & Canals (km)	1,95,210
Tanks & Ponds (lakh ha)	24.14
Reservoirs (lakh ha)	31.50
Floodplain / Derelict Water Bodies (lakh ha)	8-12
Brackishwater (lakh ha)	12.40
Saline / Alkaline affected areas (lakh ha)	12.00
Coldwater Resources	
Rivers (km)	8,253
Natural Lakes (ha)	21,900
Reservoirs (ha)	29,700

The Inland Fisheries of India may be classified as:






- i. Lacustrine Fisheries (Lakes and Reservoirs)
- ii. Riverine Fisheries (Rivers and Streams)
- iii. Estuarine Fisheries (Estuaries and Backwaters)
- iv. Floodplain and Wetland Fisheries
- v. Coldwater Fisheries
- vi. Ornamental Fisheries
- vii. Sport Fisheries
- viii. Culture Fisheries (Aquaculture)





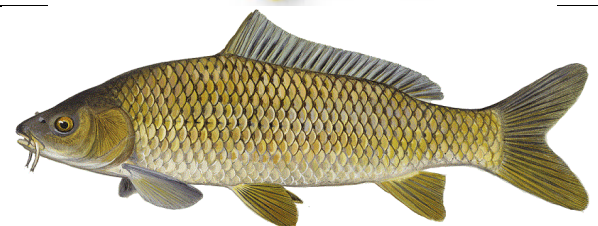

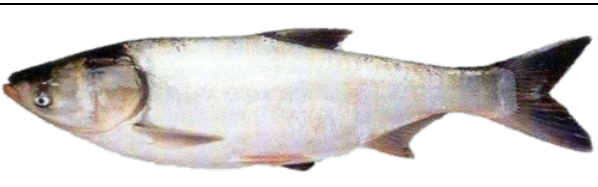
1.1. Carps

Carps form the mainstay of aquaculture practices in India, contributing over 85% of the total aquaculture production. Out of 266 carp species available in the Indian region, about 34 carp species are economical and are produced mainly from capture fishery, while less than 10 carp species are produced from both the culture and capture fisheries in the country. India is called the "Carp Country" since carps have been cultured since ancient times and been a relished delicacy in the country.

The carps which are native to the Indus-Ganges River Systems/ Indo-Gangetic Plains of India are referred to as the **Gangetic Carps / Indian Major Carps (IMC)**, comprising of Catla, Rohu and Mrigal that contribute 60% of total Carps production. The carps that were introduced from other countries are referred to as Exotic Carps such as Silver Carp, Grass Carp and Common Carp.

Besides the Major Carps, there are also smaller carps often referred to as Minor Carps such as Reba (*Cirrhinus reba*), Bata (*Labeo bata*), Fringe-lipped carp (*Labeo fimbriatus*), Calbasu (*Labeo calbasu*), white carp (*Cirrhinus cirrhosus*) and Cauvery carp (*Labeo kontius*).







Fish Name	Picture
Indian Major Carps	
Catla <i>Catla catla</i>	
Rohu <i>Labeo rohita</i>	
Mrigal <i>Cirrhinus mrigala</i>	
Minor Carps	
Reba <i>Cirrhinus reba</i>	
Bata <i>Labeo bata</i>	

<p>Fringe-lipped Carp <i>Labeo fimbriatus</i></p>	
<p>Calbasu <i>Labeo calbasu</i></p>	
<p>Pengba <i>Osteobrama belangeri</i></p>	
<p>Exotic Carps</p>	
<p>Common Carp <i>Cyprinus carpio</i></p>	
<p>Amur Common Carp <i>Cyprinus carpio</i></p>	
<p>Grass Carp <i>Ctenopharyngodon idella</i></p>	
<p>Silver Carp <i>Hypophthalmichthys molitrix</i></p>	

1.2. Catfish


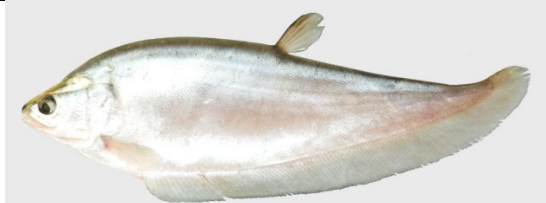
Catfishes are a diverse group of ray-finned fish named for their prominent barbels, which resemble a cat's whiskers (but not all catfish have prominent barbell). Although catfish can generally be found in faster-flowing rivers and streams, some catfish species have adapted

to living in shallow salt-water environments while other catfish species live their lives in caves underground. Most catfish are bottom feeders as they are negatively buoyant (which means that they usually sink rather than float due to a reduced gas bladder and a heavy, bony head). The air-breathing catfishes such as Magur and Singhi inhabit shallow waters, withstand low oxygen conditions and are referred to as "live fishes"; they are marketed live and fetch higher price.

Fish Name	Picture
Magur/ Walking Catfish <i>Clarias magur</i> [formerly known as <i>C. batrachus</i>]	
Singhi/ Stinging Catfish <i>Heteropneustes fossilis</i>	
Giant River-Catfish, <i>Sperata seenghala</i> [formerly <i>Mystus seenghala</i> / <i>Aorichthys seenghala</i>]	
Freshwater Shark <i>Wallago attu</i>	
Pabda Catfish <i>Ompok pabda</i>	
Sutchi/ Striped Catfish (Exotic) <i>Pangasianodon hypophthalmus</i>	


1.3. Featherbacks





Featherbacks are adapted to flowing conditions and widely distributed in deep and clear waters in the rivers, beels, reservoirs and ponds. The Bronze Featherback is reported to enter brackishwater. They are carnivorous and predatory fish and feed on aquatic insects, mollusks, shrimps and small fishes and take insects and tender roots of aquatic plants during early stages of life. They are rich in nutritive value and commands higher market price despite the presence of a large number of intramuscular spines.

Fish Name	Picture
Chital <i>Chitala chitala</i>	
Bronze Featherback <i>Notopterus notopterus</i>	

1. 4. Small Indigenous Fish Species (SIFS)

They are defined as fish that grow to a maximum size of 25-30 cm in mature or adult stage of their life cycle. They inhabit rivers and tributaries, floodplains, ponds and tanks, lakes, beels, streams, lowland areas, wetlands and paddy fields. In India, out of 877 native freshwater fish species, about 450 are Small Indigenous Fish Species (SIFS). The maximum diversity of SIFS in freshwaters has been recorded from the North East Region followed by Western Ghats and Central India. About 62 SIFS have been categorized as food fish while 42 species as ornamental fish. Some cultivable SIFS are Mola, Climbing Perch, Barbs, Bata, etc.





Small Indigenous Freshwater Fish Species (SIFS)	
Fish Name	Picture
Mola Carplet <i>Amblypharyngodon mola</i>	

<p>Climbing Perch <i>Anabas testudineus</i></p>	
<p>Ticto Barb <i>Puntius ticto</i></p>	
<p>Pool Barb <i>Puntius sophore</i></p>	 <p style="text-align: right; font-size: small;">Photo credit: Balam Mahalder www.bdfish.org</p>
<p>Silver Hatchet Chela <i>Chela cachius</i></p>	

1.5. Snakeheads


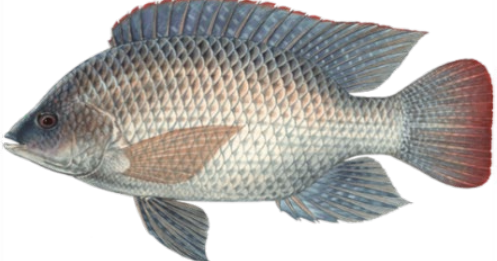


The snakeheads are members of the freshwater Perciformes fish family Channidae, native to parts of Africa and Asia. They inhabit swampy waters and their gills are adapted to breathe air. They can survive out of water for up to four days, provided they are wet, and are known to migrate up to 400 metres on wet land to other bodies of water by wriggling with their body and fins. They have a pair of air-chambers (suprabranchial cavity), developing from the pharynx, lined by vascular epithelium, take in air and function like lungs.

Snakeheads consume plankton, aquatic insects, and mollusks during early life stages and become predatory and cannibalistic as they grow. The snakehead meat has good taste, high nutrient and also has high pharmaceutical values. Snakehead also has all the essential amino acids for wound healing, especially glycine, which is important for the formation of human skin collagen.

Snakeheads	
Fish Name	Picture
Striped Murrel / Snakehead <i>Channa striata</i>	
Spotted Murrel / Snakehead <i>Channa punctata</i>	
Flower Murrel / Bullseye Snakehead <i>Channa marulius</i>	
Dwarf Murrel / Snakehead <i>Channa gachua</i>	

1.6. Tilapias







Tilapias are a group of “Cichlid” fish native to the African Continent. In the Central African Countries, farming of Tilapias in ponds was introduced after Second World War and then soon spread to most of the tropical and sub-tropical countries of the world and hence they are referred to as international fish. Although most of the natural resources of Tilapias are found mainly in Africa, nearly 80% of the global Aquaculture production of Tilapias of about 5.0 million metric tonnes comes from Asia. Tilapias are considered the most important aquaculture species of the 21st century and they are being cultured in 100 countries of the world commercially, ranging from extensive to super-intensive scale.

Fish Name	Picture
Nile Tilapia <i>Oreochromis niloticus</i>	
GIFT Strain <i>Oreochromis niloticus</i>	
Red Tilapia <i>Oreochromis niloticus</i>	
Mozambique Tilapia <i>Oreochromis mozambicus</i>	

1.7. Coldwater Fishes

Coldwater fishes occupy an important place amongst the freshwater fishes of India. The coldwater fisheries deal with fisheries activity in water where temperature of water ranges from 5 to 20 degrees centigrade. The gills of cold water fish are greatly reduced and the gill opening are smaller in size for adaptation to cold temperatures. Important coldwater fishes of India are Mahseers such as *Tor putitora*, *T. tor*, *T. khudree*, *T. mosal*, Snow Trout such as *Schizothorax richardsonii* and *Schizothoraichthys esocinus*, Mountain Trout such as *Barilius vagra*, *B. bendelisis*, other fish such as *Glyptothorax sp.*, *Garra sp.*, etc.

Mahseers

Fish Name	Picture
Golden Mahseer <i>Tor putitora</i>	 A side view of a Golden Mahseer fish, showing its elongated body, scales, and fins. The fish has a yellowish-gold hue.
Tor Mahseer <i>Tor tor</i>	 A side view of a Tor Mahseer fish, showing its elongated body, scales, and fins. The fish has a silvery-gold hue.
Deccan Mahseer <i>Tor khudree</i>	 A side view of a Deccan Mahseer fish, showing its elongated body, scales, and fins. The fish has a brownish-gold hue.
Chocolate Mahseer <i>Neolissocheilus hexagonolepis</i>	 A side view of a Chocolate Mahseer fish, showing its elongated body, scales, and fins. The fish has a brownish-gold hue.
Trout	
Common Snow Trout <i>Schizothorax richardsonii</i>	 A side view of a Common Snow Trout fish, showing its elongated body, scales, and fins. The fish has a brownish-gold hue.
Rainbow Trout <i>Oncorhynchus mykiss</i>	 A side view of a Rainbow Trout fish, showing its elongated body, scales, and fins. The fish has a brownish-gold hue with a prominent pinkish-red lateral stripe.

Brown Trout
Salmo trutta



Brook Trout
Salvelinus fontinalis



Others

Mountain Trout
Barilius vagra



Gheur
Barilius bendelisis



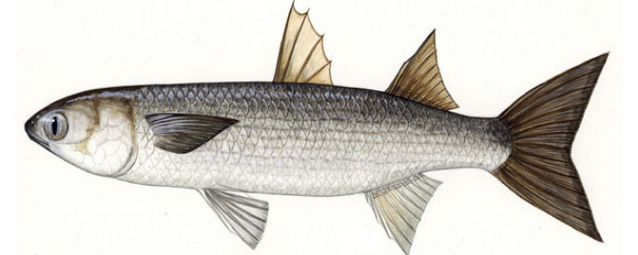

2. Brackishwater Fisheries

India has around 1.2 million ha brackishwater resources comprising of estuaries (deltaic river mouths), coastal lagoons, lakes, backwaters, tidal creeks, canals, mudflats, mangrove plants, etc. These water bodies lying between the freshwater and marine regimes have certain characteristics: (i) fluctuating water level synchronizing with the tides, (ii) wide salinity range of 0-35 ppt, (iii) higher nutrient content and productivity, (iv) serve as nursery grounds for numerous marine organisms, (v) harbour a rich diversity of flora and fauna, and (vi) support artisanal capture fisheries and provide livelihood to the coastal fishers.

The tidal currents carrying with them the juvenile fish and shrimp, and the rising and falling water level formed the basis of traditional brackishwater fish and shrimp farming practices in the *Bheries* of West Bengal and *Pokalli* paddy fields of Kerala. Scientific brackishwater aquaculture started around 1980s, wherein shrimp were cultured in well designed and managed ponds as there was high demand for them in the export market. At present around 0.16 million ha are under shrimp culture. Andhra Pradesh and West Bengal States are the chief producers of shrimp accounting for about 80% of the total country's production. However, of late, culture of high-value euryhaline marine fish species is being undertaken in brackishwater ponds and cages to meet the demand in domestic market. The most commonly cultured fish are Mulletts, Milkfish, Seabass, Pompano, Grouper, etc.

2.1. Mulletts

Thirteen species of Mulletts are found in India of which eight species contribute to the commercial catches. *Mugil cephalus* and *M. parsia* are the two cultivable species. They are euryhaline species that tolerate salinity from 0-35 ppt. They are omnivorous in feeding habit. They feed at the lowest trophic levels on plant detritus and algae. Mulletts are known for the high protein and vitamins contained in the muscle tissue. The Roe (ripe ovaries) from mature females are a delicacy, high-valued and sought after in many countries.

Fish Name	Picture
Grey Mullet <i>Mugil cephalus</i>	
Goldspot Mullet <i>Mugil parsia</i>	

2.2. Milkfish



The Milkfish, *Chanos chanos*, is the sole living representative of the family Chanidae and is widely distributed in the whole of tropical and subtropical regions of the Indian and the Pacific Oceans. The distribution coincides with coral reef areas where the water is warm, clear and shallow. It is one of the most important species cultured in South-East Asia.



Milkfish, *Chanos chanos*

2. 3. Bass

Asian Seabass, *Lates calcarifer*, commonly called the Giant Sea Perch is an economically important food fish in the tropical and subtropical regions of Asia and the Pacific. Because of its relatively high market value, it has become an attractive commodity of both large and small-scale aquaculture enterprises. The major constraint to rapid expansion of Seabass culture has been the inconsistent supply of fry collected from the wild. The Crescent Bass or Tiger Bass, *Terapon jarbua*, is common species in the Indo-Pacific; it occasionally makes its way into the aquarium trade.

Fish Name	Picture
Asian Seabass <i>Lates calcarifer</i>	
Tiger Bass <i>Terapon jarbua</i>	

2.4. Pearlspot

The Green Chromide Pearlspot, *Etroplus suratensis*, is the state fish of Kerala and locally (in Malayalam) it is called “*Karimeen*”. It being an euryhaline species is compatible for polyculture with other brackishwater / freshwater fish. It breeds naturally in confined conditions, sexes are separate and fertilization is external.


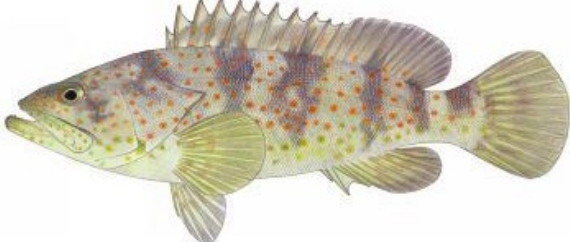



Pearlspot, *Etroplus suratensis*

2. 5. Grouper

There are more than 64 species of groupers found in the Indian waters. Groupers are important and economically valuable aquaculture species in Southeast Asian countries. Though groupers are sea fish, juveniles of some groupers are found in coastal waters, mangroves, estuaries and sandy bottoms. Groupers are ideal candidate species for intensive aquaculture particularly in the Asia-Pacific Region because of high consumer demand, desirable taste, hardiness in a crowded environment, efficient feed conversion, and rapid growth. Commonly found species in Indian waters are Greasy Grouper (*Epinephelus*

tauvina), Orange-spotted Grouper (*E. coioides*), Brown-lined Reef Cod (*E. undulosus*) and Brown-spotted Reef Cod (*E. chlorostigma*).

Fish Name	Picture
Greasy Grouper <i>Epinephelus tauvina</i>	
Orange-spotted Grouper <i>Epinephelus coioides</i>	
Brown-lined Reef Cod <i>Epinephelus undulosus</i>	

2.6. Scat



Spotted Scat, *Scatophagus argus*, is a euryhaline subtropical fish widely distributed in Indian-Pacific waters. It occurs in two basic colour morphs which are called Green Scat and Ruby or Red Scat and lives in coastal muddy areas, including estuaries, mangroves, harbours, and the lower courses of rivers. It is an important aquaculture food fish with high economic value and is also a popular aquarium species due to its colourful appearance, hardiness, slow growth, and calm behaviour.



Spotted Scat, *Scatophagus argus*

2. 7. Catfish

Nuna Tenggara or the Long Whiskers Catfish, *Mystus gulio*, is a common and popular fish because of its nutritional value and taste. Primarily a brackish water fish that enters and lives in freshwater. In freshwater, adults occur mainly in larger water bodies (rivers and streams) with mud or clay substratum, and rarely found in smaller streams. It forms schools of 10 to 25 individuals. *Mystus vittatus*, the Striped Dwarf Catfish is found in brackishwater systems with marginal vegetation in lakes and swamps with a mud substratum.

Fish Name	Picture
Long Whiskers Catfish <i>Mystus gulio</i>	
Striped Dwarf Catfish <i>Mystus vittatus</i>	

2. 8. Pompano

The Silver Pompano, *Trachinotus blochii* belongs to the family Carangidae; it resembles the much sought after Silver Pomfret (*Pampus argenteus*). It is a tropical species, distributed in the Indo-Pacific Region, inhabits shallow coastal waters. It is one of the most promising species for coastal aquaculture as its growth rate is high, meat quality is good and fetches high price in the market.



Silver Pompano, *Trachinotus blochii*

3. Marine Fisheries

India has a 8,118 km long coastline stretching along 9 Maritime States and 4 Union Territories. The nine Maritime States are Gujarat, Tamil Nadu, Kerala, West Bengal, Maharashtra, Odisha, Andhra Pradesh, Karnataka and Goa. The 4 Maritime Union Territories are Daman & Diu, Puducherry, Lakshadweep Islands and the Andaman & Nicobar Islands. The country has also a 0.53 million km² Continental Shelf and 2.02 million km² of Exclusive Economic Zone (EEZ). The annual potential yield from the EEZ is estimated as 3.93 million tonnes of fish. The Marine Fisheries has been playing a pivotal role in the Indian Fisheries Sector. The major marine catches comes from the coast of Gujarat, Tamil Nadu, Kerala, West Bengal and Maharashtra.

Marine Fisheries Resources of India

Length of Coastline (km)	8,118
Exclusive Economic Zone (EEZ) (sq. km)	2,020,000
Continental Shelf (sq. km)	530,000
Territorial Sea (up to 12 nautical miles) sq.km	193,834
Number of Fish Landing Centres	1,537
Number of Fishing Villages	3,432
Number of Fishermen Families	874,749
Fisher-folk Population	4,056,213

The important Marine Fisheries can be grouped into the following categories:




1. **Surface-water Fish (Pelagic):** Sardines, Anchovies, Ribbonfish, Mackerel, Seerfish, Tuna, etc.
2. **Mid-water Fish (Pelagic):** Bombay Duck, Cobia, Silver Bellies, Horse Mackerel, etc.
3. **Bottom-water Fish (Demersal):** Perches, Catfish, Pomfrets, Flatfish, Eels, etc.

3.1. Sardines

Sardines are one of the two most important commercial pelagic schooling fishes in India (the other being Mackerel). Fourteen species of Sardines are found in the Indian waters. Out of the 14 species, the Oil Sardine *Sardinella longiceps* alone contributes to the largest single-species fishery in the country, comprising about 15% of the total marine fish catches. The Indian Oil Sardine is one of the most regionally limited species of *Sardinella* and can be

found in the northern regions of the Indian Ocean. Oil Sardine landing is maximum during post-monsoon season followed by monsoon and pre-monsoon.




The other 13 species are termed as “Lesser Sardines”, comprise all the species of Sardines (*Sardinella spp.*) other than the Indian Oil Sardine, and contribute about 3-7% to the total marine fish catch. They are known to inhabit mostly the near-shore waters up to 25-30 m depth zone. Nine species of Lesser Sardines occurring in Indian waters, in the order of abundance, are *Sardinella gibbosa*, *S. fimbriata*, *S. sirm*, *S. albella*, *S. dayi*, *S. sindensis*, *S. clupeoides*, *S.melanura* and *S. jonesi*. Four regions of Lesser Sardine concentrations are noticed along the Indian coasts, viz., Goa, Karnataka, Kerala, Tamil Nadu, Pondicherry, Andhra Pradesh and Orissa.

Sardines	
Fish Name	Picture
Indian Oil Sardine <i>Sardinella longiceps</i>	
Goldstripe Sardine <i>Sardinella gibbosa</i>	
Fringescale Sardine <i>Sardinella fimbriata</i>	

3. 2. Anchovies



Anchovies are small fish having greenish-blue reflections due to a silver-coloured longitudinal stripe that runs from the head to base of caudal (tail) fin. They are found in scattered areas throughout the world's oceans, but are concentrated in temperate waters, and are rare or absent in very cold or very warm seas. Anchovies contributes around 6% to

the total pelagic fish landings of India. 28 species of Anchovies are recorded in the Indian waters. Anchovies mostly feed on zooplankton. Andhra Pradesh and Tamil Nadu along east coast and Kerala along west coast are the three coastal states of India which support 95% of the average annual catch of anchovies in the country. There are two fishing seasons: January to May and September to November, the latter period being the peak season for anchovy catches. Major contribution to the fishery is by the genera: *Stolephorus*, *Engraulis*, *Thryssa*, *Setipinna* and *Coilia*.

Anchovies	
Fish Name	Picture
Indian Anchovy <i>Stolephorus indicus</i>	
Goldspotted Grenadier Anchovy <i>Coilia dussumieri</i>	
Malbar Anchovy <i>Thryssa malabarica</i>	

3. 3. Mackerels

Mackerel is a common name applied to a number of different species of schooling epipelagic fish of the family Scombridae. They are found in both temperate and tropical seas, mostly living along the coast or offshore in the oceanic environment. Mackerels typically have: rows of longitudinal bands or spots along upper half of body, dorsal and anal finlets, keels on caudal peduncle and a deeply forked caudal fin. Mackerels found in Indian waters are the Indian Mackerel (*Rastrelliger kanagartha*) and the Indian Chub Mackerel (*Scomber indicus*).

Mackerels	
Fish Name	Picture
Indian Mackerel <i>Rastrelliger kanagurta</i>	
Indian Chub Mackerel <i>Scomber indicus</i>	

3.4. Seerfishes

Another group of commercially important fishes, belonging to the family Scombridae, are the Seerfishes represented in Indian coastal waters by Narrow-barred Spanish Mackerel *Scomberomorus commerson* and Indo-Pacific King Mackerel *Scomberomorus guttatus*.






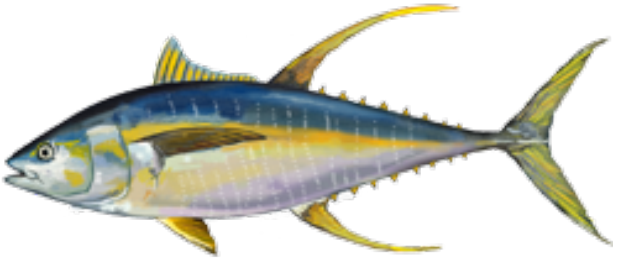


Seerfish, *Scomberomorus commerson*

3.5. Tunas

Tunas (family Scombridae) are among the largest, most specialized and commercially important of all fishes. They are found in temperate and tropical oceans around the world and account for a major proportion of the world fishery production. Tunas are unique among fishes because they possess body temperature several degrees higher than the ambient waters and have high metabolic rate that enables them to exhibit extraordinary growth rate. They have streamlined bodies and vary widely in size, colour and fin length.

Around 19% of the global tuna catches are from the Indian Ocean. The waters of Andaman Islands are known to have the world's richest stocks of Tunas with 100,000 tonnes of Coastal Tunas and 82,000 tonnes of Oceanic Tunas available for exploitation. In Lakshadweep the stocks of Tunas are estimated to be around 50,000-90,000 tonnes, and Tunas contribute around 85% of the total marine fish landings in Lakshadweep Islands. Tunas commonly found in Indian waters are Little Tunny (*Euthynnus affinis*), Frigate Tuna

(*Auxis thazard*), Oriental Bonito (*Sarda orientalis*), Yellowfin Tuna (*Thunnus albacares*), Bigeye Tuna (*Thunnus obesus*), Skipjack Tuna (*Katsuwonus pelamis*), etc.

Tunas	
Fish Name	Picture
Little Tunny <i>Euthynnus affinis</i>	
Frigate Tuna <i>Auxis thazard</i>	
Oriental Bonito <i>Sarda orientalis</i>	
Yellowfin Tuna <i>Thunnus albacares</i>	
Bigeye Tuna <i>Thunnus obesus</i>	
Skipjack Tuna <i>Katsuwonus pelamis</i>	

3. 6. Bombay-duck

Bombay-duck *Harpodon nehereus*, found in the mid-water column, distributed in the Indo-West Pacific, is a white, soft and delicate fish, predatory in habit; it contributes to a major fishery along the Maharashtra and Gujarat coasts and occurs sporadically along the east coast. It is captured using a characteristic bag-net known as 'dol' that is operated against tidal currents. It is a popular food-fish along the north-west coast of India; it is marketed fresh, dried or salted.



Bombay-duck, *Harpodon nehereus*

3.7. Cobia




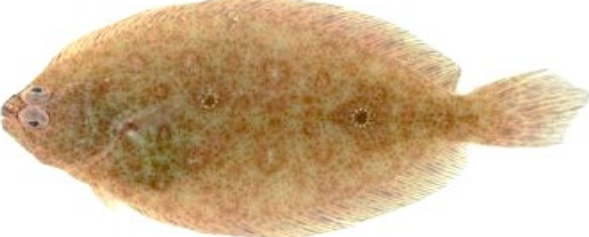
Cobia, *Rachycentron canadum*, is found throughout the water column and occurs in warm-temperate to tropical waters of the West and East Atlantic, throughout the Caribbean and in similar zones in the Indo-West Pacific region of India, Australia and Japan. The fish is a carnivore and congregates at reefs, ship wrecks, harbour-buoys and other submerged structures in search of food. Juveniles may enter estuaries and mangroves in search of prey. It is dark brown in colour, young ones have alternate black and white horizontal stripes, it grows up to 2 m length and 50 kg weight. It is one of the fast-growing and high-value marine fish that is being farmed in Sea Cages, in India.



Cobia, *Rachycentron canadum*

3.8. Flatfishes

Flatfishes (Order Pleuronectiformes) are bottom dwelling deep sea bony fishes with oval-shaped and flattened bodies having both eyes on one side of the body. Flatfish can camouflage themselves by imitating the colour of the sea floor. They include Halibut, Flounder, Sole, Turbot, Plaice, Dab, etc. Among the marine fishery resources of India, the flatfishes occupy a place of importance along the West Coast especially the North Kerala and South Kannada coasts. Although, about 91 species of flatfish are reported in the Indian waters, it is only a very small number that contributes to any large catches and in fact only Malabar Tongue Sole (*Cynoglossus macrostomus*) contributes to a regular fishery of significance. Other species such as Large Scale Tongue Sole (*C. macrolepidotus*), Indian Halibut (*Psettodes erumei*), Large Tooth Founder (*Pseudorhombus arsius*), etc., are also found in small quantities.

Flatfish	
Fish Name	Picture
Malabar Tongue Sole <i>Cynoglossus macrostomus</i>	
Large Scale Tongue Sole <i>Cynoglossus macrolepidotus</i>	
Indian Halibut <i>Psettodes erumei</i>	
Large Tooth Founder <i>Pseudorhombus arsius</i>	

III. Shellfish Fisheries

Shellfish are aquatic invertebrates having an exoskeleton/shell. They can be grouped into two general categories: Crustaceans and Molluscs. Crustaceans refers to those organisms that have segmented bodies covered with armour-like sections of thick or thin shell and bear jointed appendages: e.g., crabs, shrimps, lobsters and crayfish. Molluscs are of three types: (i) Bivalves that include clams, oysters, mussels and scallops; (ii) Univalves that include abalone, periwinkle and other snails like conch and whelk; and (iii) Cephalopods that have a soft pliable body with an internal shell, a beaked head bearing tentacles, include squids and octopus.

Types of Shellfish

- Crustaceans: Prawns, Shrimps, Crabs, Lobsters, Crayfishes, etc.
- Molluscs: Gastropods (snails), Pelecypods or Bivalves (clams, mussels, oysters) and Cephalopods (squids, cuttlefish, octopus).

1. Crustaceans

Crustaceans are a large and diverse group of Arthropods (bearing jointed appendages) that thrive in a wide range of habitats; majority are marine while relatively few inhabit inland waters. More than 117 species of shrimps, 17 species of lobsters and around 700 species of crabs are found to inhabit mostly marine and estuarine areas in the country, of which around 150 species contribute to commercial catches. Around 80% of the Crustacean landings are from the West Coast while only about 20% are from the East Coast. Maharashtra followed by Gujarat top in Crustacean fisheries production. India is one of the major contributors to the global marine Crustacean production.

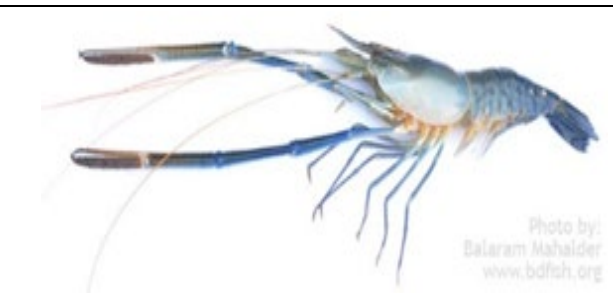

1.1. Shrimps and Prawns

Shrimps and Prawns belong to the Order Decapoda (having 10 pairs of legs: 5 pairs of walking legs and 5 pairs of swimming legs). Generally the smaller forms are termed Shrimp while the larger ones are known as Prawns. In seafood trade, the marine forms are referred to as Shrimp (Family Penaeidae) while the freshwater forms are referred to as Prawns (Family Palaemonidae). However, quite often, these two terms are used interchangeably.

a. Freshwater Prawns:

The Giant Freshwater Prawn, *Macrobrachium rosenbergii*, popularly known as SCAMPI, is the most important species. It is native to the Indo-West Pacific region, from India through Southeast Asia to Northern Australia. It has been introduced to several countries across the globe for aquaculture purpose. Males and females have different growth rates; the males exhibit heterogenous individual growth. Among males there are three different morphotypes (Small Males, Orange Claws and Blue Claws) which display social hierarchy. All three types of males are sexually active, and females that have undergone pre-mating moult will pair with any type male to reproduce. A Blue Claw male protects the female until their shells have hardened but the other two show no such behaviour.




The second largest freshwater palaemonid prawn, *Macrobrachium malcolmsonii*, also called the Indian River Prawn/Monsoon River Prawn/Godavari Prawn, has great potential for aquaculture development in the inland waters of the country. Freshwater prawn farming in India developed during 1999, after marine shrimp culture encountered disease problems.

Freshwater Prawns	
Name	Picture
Giant Freshwater Prawn (SCAMPI) <i>Macrobrachium rosenbergii</i>	 <small>Photo by: Balaram Mahalder www.bdfish.org</small>
Indian River Prawn <i>Macrobrachium malcolmsonii</i>	

b. Marine Shrimp:

Some of the commercially important marine shrimps are Tiger Prawn (*Penaeus monodon*), Indian White Prawn (*Penaeus indicus*), Pink Shrimp (*Metapenaeus dobsoni*), Brown Shrimp (*Metapenaeus monoceros*), etc. For Aquaculture purpose, the exotic Pacific White Shrimp (*Litopenaeus vannamei*) has been introduced into India and is being farmed extensively on a

commercial-scale in low-saline or brackishwater ponds in Gujarat, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Odisha, West Bengal etc. With the availability of Specific Pathogen Free (SPF) quality brooders and seed and adoption of improved culture techniques, mortality of juvenile and young shrimp due to disease reduced and thereby yields of shrimp increased significantly in the country.

Marine Prawns/ Shrimps	
Name	Picture
Tiger Prawn/ Black Tiger Shrimp <i>Penaeus monodon</i>	
Indian White Prawn/Shrimp <i>Penaeus indicus</i>	
Pacific White Shrimp <i>Litopenaeus vannamei</i>	




1.2. Crabs

Crabs are decapods in which the abdomen is vestigial; the five pairs of thoracic legs are well developed and used for capturing prey, walking and swimming. Crabs inhabit a wide variety of habitats like mud flats, rock crevices, under stones, in gravel and sand and constructed burrows etc. They are primarily nocturnal and prefer hiding places for shelter during the day time.

a. Freshwater Crabs:




Freshwater crabs are adapted to semi-terrestrial or terrestrial mode of life and known for their ability to complete the life-cycle independent of marine environment. They are

generally omnivorous, feeding on plant material, live or dead animals such as fish, prawns, molluscs, etc., and sometimes cannibalism is also seen. Over 1300 species are known from the world, of which 96 species are found in India. Some of the commonly found freshwater crabs of India are listed below:

Freshwater Crabs	
Name	Picture
Indian Freshwater Crab <i>Barytelphusa cunicularis</i>	
<i>Maydelliathelphusa lugubris</i>	
<i>Maydelliathelphusa falcidigitis</i>	




b. Brackishwater/Marine Crab:

Marine crabs are one of the valuable seafood items that are in great demand both in the domestic and export markets. There are about 600 species of marine crabs recorded from Indian waters. The crab fishery in India is dominated by a few species such as *Scylla serrata*, *S. tranquebarica*, *Portunus pelagicus*, *P. sanguinolentus*, *Charybdis feriata*, *C. lucifera* and *C. truncata*. Commercial-scale crab culture is undertaken along the coastal areas of Andhra Pradesh, Tamil Nadu, Kerala and Karnataka. Grow-out culture ('Crab Fattening') is generally pond based wherein crabs juveniles are held in pens or cages. Production of 'Soft-Shellled Crabs' is done using floating boxes held in tidal ponds.

Marine Crabs	
Name	Picture
Mud Crab <i>Scylla serrata</i>	 A photograph of a mud crab, showing its dark green and brown carapace, large claws, and legs.
Three-spot Swimming Crab <i>Portunus sanguinolentus</i>	 A photograph of a three-spot swimming crab, characterized by its light green and brown coloration and three distinct dark spots on its carapace.
Blue Swimming Crab <i>Portunus pelagicus</i>	 A photograph of a blue swimming crab, showing its dark blue and brown carapace and long, powerful legs.

1.3. Lobsters

Lobsters are one of the most valuable and highly priced crustaceans as well as an important export commodity. The massive head bears five pairs of walking legs; the abdomen is well developed, muscular and bears five pairs of swimmerets. Lobsters are solitary animals that crawl on the sea floor and hide under rocks. Among the 12 species recorded from Indian coastal waters, only four species of Spiny Lobsters (*Panulirus homarus*, *P. ornatus*, *P. polyphagus*, *P. versicolor*) and one species of Slipper Lobster (*Thenus orinetalis*) are commercially important. Growth is slow, most lobsters take more than 3 years to attain maturation and they have a prolonged life-cycle. Grow-out and fattening of lobsters is commonly done in indoor tanks and cages to fetch better price in market.

Lobsters	
Name	Picture
Scalloped Spiny Lobster <i>Panulirus homarus</i>	 A photograph of a Scalloped Spiny Lobster (Panulirus homarus) from a dorsal perspective. It has a dark, segmented body with a prominent, fan-shaped tail fan at the posterior end. The legs are long and thin, with some showing spines.
Ornate Spiny Lobster <i>Panulirus ornatus</i>	 A photograph of an Ornate Spiny Lobster (Panulirus ornatus) from a dorsal perspective. It has a more colorful and patterned body compared to the Scalloped Spiny Lobster, with blue and white markings. The tail fan is also fan-shaped but appears more delicate.
Slipper Lobster <i>Thenus orientalis</i>	 A photograph of a Slipper Lobster (Thenus orientalis) from a dorsal perspective. It has a very large, broad, and flattened body, giving it a slipper-like appearance. The tail fan is also broad and fan-shaped.

2. Molluscs




Molluscs are invertebrates, belonging to one of the largest phylum, inhabiting the marine, freshwater and terrestrial ecosystems. Their body structure, form, colour and size vary widely. In India, molluscs are captured for food, pharmaceuticals and ornamental purpose and dead shells are collected for making shell-lime. Molluscs include forms such as bivalves, univalves and cephalopods, and some of them support both capture and culture fisheries.

2.1. Bivalves

Bivalves as the name suggest are bilaterally symmetrical, laterally compressed molluscs, with extensive mantle lobes, which secrete the shell having two valves. Majority of bivalves are marine and a few species are found in freshwater habitats. Nearly 652 species of marine bivalves are reported from India, of which 88 species are endemic to Indian waters. Clams are the most important group among bivalves forming 85.8%, followed by Mussels 9.6% and Oysters 4.6%.



a. Clams:

Commercially exploited Clams are the *Villorita cyprinoides*, *Paphia malabarica*, *Meretrix casta*, *Sunetta scripa*, *Anadara granosa*, *Anadara rhombia*, *Meretrix meretrix*, *Marcia opima*, *Giloina bengalensis*, *Gafrarium diverticulum* and *G. lumidum*. Nearly 93.3% of the contribution to the average annual clam production is by three species, namely *Villorita cyprinoides*, *Paphia malabarica* and *Meretrix casta*.

Name	Picture
Blood Calm <i>Anadara granosa</i>	
Asiatic Hard Clam <i>Meretrix meretrix</i>	
Black Clam <i>Villorita cyprinoides</i>	
Short-neck Clam <i>Paphia malabarica</i>	
Backwater Clam <i>Meretrix casta</i>	



b. Mussels:


Commercial fishery of Mussels along the Indian coast is mainly for the Green Mussel *Perna viridis*, contributing 83.7% on an average, and the remaining by the Brown Mussel *Perna indica* which is limited to the fishery along southern tip of Indian peninsula.

Name	Picture
Green Mussel <i>Perna viridis</i>	
Brown Mussel <i>Perna indica</i>	

c. Oyster:

The Indian Backwater Oyster *Crassostrea madrasensis* is the most important edible oyster exploited (90.1%), followed by the Rock Oyster *Saccostrea cucullata* (5.9%) and Windowpane Oyster *Placuna placuna* (3.6%) along the Indian Coast. The Pearl Oyster *Pinctata fucata*, which produces Natural Pearls in the sea, is utilized for production of Cultured Pearls.

Name	Picture
Indian Backwater Oyster <i>Crassostrea madrasensis</i>	
Rock Oyster <i>Saccostrea cucullata</i>	

<p>Pearl Oyster <i>Pinctata fucata</i></p>	
<p>Windowpane Oyster <i>Placuna placuna</i></p>	

2.2. Gastropods/ Snails/ Slugs

Gastropods are the largest group of Phylum Mollusca that inhabit marine, freshwater and terrestrial environments. The marine gastropods are an important fauna of Rocky Shores. Some of the common genera include: *Turritella*, *Natica*, *Bursa*, *Tonna*, *Murex*, *Babylonia*, *Oliva*, *Conus*, *Umbonium*, *Cellana*, *Turbinella pyrum* (Sacred Chank), etc.




Sacred Chank, *Turbinella pyrum*

2.3. Cephalopods

Cephalopods are a small group of highly advanced and organized molluscans, exclusively marine animals. The best-known feature of the Cephalopods is the possession of arms and tentacles, eight or ten in most forms, surrounding the head. The Octopus, Squid, Cuttlefish, and Nautilus are the familiar representatives. Cephalopods occur in large numbers and form a major food resource of the seas and oceans. India's squid fishing fleet accounted for 3% of the global squid production and makes up approximately 5–7% of U.S. squid imports.


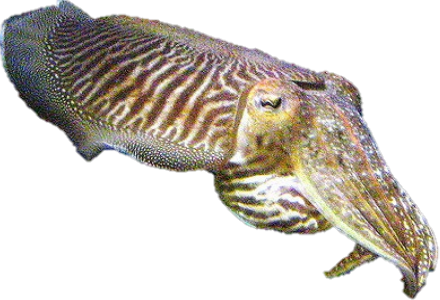
a. Squids:

Squids are economically important Cephalopods represented in India mainly by *Loligo duvauceli*, *Sepioteuthis lessoniana* and *Doryteuthis* species. The Indian squid *Loligo duvauceli* is the dominant species, contributing about 97% of the total Squid catches annually in the country.

Name	Picture
Indian Squid <i>Loligo duvauceli</i>	

b. Cuttlefish:

Cuttlefish especially Needle Cuttlefish, *Sepia aculeata*, is one of the commercially important marine fishery resources of Indian waters by virtue of its export demand, and is optimally exploited from East Coast and under-exploited from West Coast. Needle Cuttlefish is a bottom-living species that occurs down to 60 m depth.

Name	Picture
Needle Cuttlefish <i>Sepia aculeata</i>	
Pharaoh Cuttlefish <i>Sepia pharaonis</i>	

c. Octopus:

As many as 200 species of Octopodidae are known to occur in the world Oceans of which about 60 are reported from the Indian Ocean. Catches of octopus in Indian waters mostly occurs along the coast of Lakshadweep, Kerala, Tamil Nadu and Maharashtra. Thirty eight commercially important species of Octopus have been reported from the Indian seas. *Cistopus indicus* which is called the Old-Woman Octopus is the most commonly occurring species.

Name	Picture
Old-Woman Octopus <i>Cistopus indicus</i>	

IV. Fish and Health Benefits

Fisheries and Aquaculture have been considered as an important means of poverty elevation and food security besides promoting health and well being. Fish continue to be one of the most traded food commodities worldwide. It contributes to around 17% of the global population's animal protein intake. Around 125-210 million tonnes of fish is projected to be required by 2050 to meet the annual per capita requirement of 15-20 kg.

Fish is often referred to as "**Rich Food for Poor People**" as it provides essential nourishment with both macronutrients and micronutrients. Fish contain low-fat high quality protein with omega-3 fatty acids and vitamins. Fish is rich in calcium and phosphorus and a great source of minerals, such as iron, zinc, iodine, magnesium, and potassium. On a fresh-weight basis, fish contains a good quantity of protein, about 18-20%, and all the eight essential amino acids including the sulphur-containing lysine, methionine, and cysteine. In general, fish have less fat than red meats and the fat content ranges from 0.2% to 25%. However, fats from

fatty fish species contain the polyunsaturated fatty acids (PUFAs) namely EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid) which are essential for proper growth of children, proper brain development in unborn babies, reduced risk of preterm delivery and low birth weight. The fat also contributes to energy supplies and assists in the proper absorption of fat soluble vitamins namely A, D, E, and K. Fish is a rich source of vitamins, particularly vitamins A and D from fatty species, as well as thiamine, riboflavin and niacin (vitamins B₁, B₂ and B₃). Vitamin D present in fish liver and oils is crucial for bone growth since it is essential for the absorption and metabolism of calcium.

Fish is also called "**Brain Food**" as it helps in development and function of brain, and "**Heart Food**" as it contributes to lower risks of heart attacks and strokes. Consumption of fish reduces risk of autoimmune diseases, including Type-1 Diabetes, prevents and treats depression, protect from age-related brain deterioration, help prevent asthma in children, protect vision in old age by lowering risk of muscular degeneration, improves sleep quality, lowers risk of cancer, blood pressure, Alzheimer's disease etc. Fish is soft, easy to cook and more easily digested than meat so even young children can be fed fish, contributing to improved nutrient intake.
