

India is endowed with a wide diversity of water resources, which sustain a large fisheries sector in the country. India has a coastline of 8,118 km with an Exclusive Economic Zone (EEZ) stretching over 2.02 million sq. km, and a continental shelf covering 0.53 million sq.km. Fisheries have a very important role for food supply, nutritional security and livelihood in India. The sector is one of the important revenue-earning and employment-opportunity sectors, contributing significantly to the economy of the country. Marine fisheries in India are a shared responsibility between the national and state governments. In a legal and constitutional sense, state governments are responsible for waters inside the 12 nautical mile territorial limit (22 km) while the Government of India (GOI) is responsible for waters between 12 nautical miles and the country's 200 nautical mile (370 km) EEZ.

## What is Ichthyology?

Ichthyology is simply the science of studying fishes. Ichthyology has the word ichthy, deriving from the Greek word *ixthu*, combining form of *ixthus*, meaning "fish". This includes bony fish, cartilaginous fish and jawless fish. Historically, ichthyologists were naturalists who described fishes they collected. Fish are the most diverse group of vertebrates, with more than one-half of the total vertebrate species. Approximately 33000 living species of fishes were described so far.

## Ichthyological diversity in India

Indian fisheries has a long history dating back to Kautilya's Arthashastra, in which fish is described as a food source, and fishing is shown as a well-established industry in India as early as 300 B.C. The ancient Hindus were well-versed in fish habits, and the ancient Hindus acquired significant knowledge on the habit of fishes and the epic on the second pillar of Emperor Ashoka enacting the prohibition of consumption of fish during a certain lunar period which can be

interpreted as a conservation point of view. The early research conducted by Linnaeus, Bloch and

Schneider, Lacepède, Russell, and Hamilton can be linked to the current scientific investigations on Indian fishes. Modern scientific studies on Indian fishes could be traced to the first works by Linnaeus, Bloch and Schneider, Lacepède, Russell and Hamilton. Cuvier and Valenciennes (1828-1849) reported 70 nominal species off Puducherry, Skyes (1839), Gunther (1860, 1872, 1880) and The Fishes of India by Francis' day (1865-1877) and another book Fauna of British India Series in two volumes (1889) describing 1,418 species are the two most fundamental works on Indian fish taxonomy to date. Alcock (1889, 1890) reported 162 species new to science from Indian waters. In the 20th century, the basis of comprehensive investigations on the various families and groups of freshwater fishes was made by Chaudhuri along with Hora and his co-workers. Misra published An Aid to Identification of the Commercial Fishes of India and Pakistan and The Fauna of India and Adjacent Countries (Pisces) in 1976. Jones and Kumaran described about 600 species of fishes in the work Fishes of Laccadive Archipelago. Talwar and Kacker presented a precise description of 548 species under 89 families in his work Commercial Sea Fishes of India. The FAO Species Identification Sheets for Fishery-Western Indian Ocean (Fischer and Bianchi) is yet a valuable guide for researchers. Recently, Talwar and Jhingran published report on 930 inland species of India recognized till date.

## Species richness

Of the 33,059 all fish species from the world, India supports of about 2443 marine fishes owing to 7.4% of the total marine fish resources. Of the overall fish diversity known from India, the marine fishes make up 75.6 percent, containing 2443 species belonging to 927 genera, under 230 families of 40 orders. By revising the new descriptions and additions, the overall number of fish species of India was of the tune of 2492 species belonging to 941 orders, 240 families. Among the fish diversity-rich areas in the marine waters of India, the Andaman and Nicobar archipelago exhibits the highest number of species, 1431, followed by the east coast of India with 1121 species and the west coast with 1071. A list of 1785 species is prepared based on the data of FishBase, FAO species identification

sheets of Western Indian Ocean Area 51 and Eastern Indian Ocean Area 57 (Table 1). We recognize since 91 species of endemic marine fishes to exist in the coastal waters of India. As of now, about 50 marine fishes known from India fall into the vulnerable category as per the IUCN Red List, and about 45 species are Near-Threatened and on the track to vulnerability. But, hardly this species (10 elasmobranchs, 10 seahorses and one grouper) are listed in Schedule I of the Wildlife (Protection) Act, 1972 of the Government of India.

In the global context, approximately 36088 valid marine and freshwater species under 515 families and 5213 genera (Nelson, 2006; Fricke et al. 2021). A stable naming and indexing system is essential for global communication about organisms and this system is maintained by the International Code of Zoological Nomenclature. The species are named according to the protocol set by Linnaeus' binomial nomenclature system (Engelhoff, 2009). The identification and description of fish species is important not only for taxonomy and systematics but also for natural history and ecology studies, fishery management, tracking the dispersal patterns of eggs and larvae, estimations of recruitment and spawn areas, and food product authentication (Anderson et al. 2007; Fischer, 2013).

### **Fish Taxonomy. -what is it? Is everyone a Taxonomist?**

Taxonomy is basically the science of correctly naming species. The term has often been confused with fish identification, which basically refers to the use of the latest taxonomic information to identify fishes. The job of the Fish Taxonomist is to name and classify species in a way that makes it easier for fisheries scientists, and other "users", to correctly identify fish species during their work. In other words, fish taxonomy is practiced by very few, whereas fish identification is practised daily by many people.

### **Why do we need fish collections in fish taxonomy?**

Any researcher who wishes to make an in depth study of the taxonomy, anatomy of fishes, reproductive biology or feeding habits of a particular species, needs to learn the details of the fish and its skeleton. This saves the time, expense, and conservation issues associated with capturing fresh specimens. For many species, capturing fresh specimens is often difficult or impossible, such as those which migrate, are found in the deep sea or are endangered. The

collection serves much as a library, with specimens being loaned and returned. Unlike a library however, the collection becomes more valuable after specimens have been studied and returned.

### **Fish biodiversity**

The Indian fish fauna is divided into two classes, viz., Chondrichthyes and Osteichthyes. The Chondrichthyes are represented by 131 species under 67 genera, 28 families and 10 Orders in the Indian region. The Indian Osteichthyes are represented by 2,415 species belonging to 902 genera, 226 families and 30 orders

### **Classification and Diversity** **([eprints.cmfri.org.in/12911/](http://eprints.cmfri.org.in/12911/))**

#### **Class Actinopterygii-the ray finned fishes**

Numerically, actinopterygians are the dominant class of vertebrates, comprising nearly 99% of the over 30,000 species of fish. Traditionally actinopterygians have been divided into the subclasses Chondrostei and Neopterygii. Neopterygii, in turn, have been divided into the infraclasses Holostei and Teleostei.

Important characters of the class are:

- Scales ganoid, cycloid, or ctenoid
- Spiracles usually absent
- Pectoral radials attached to the scapulo-coracoid complex except in Polypteriformes
- Interopercle and branchiostegal rays usually present.

**Infraclass Teleostei** Teleost are the most species rich and diversified group of all the vertebrates.

#### **Class: Pisces**

**Elasmobranchs:** The elasmobranchs consists of sharks, sawfishes, rays, skates and guitar fishes. Many elasmobranchs have been included in the WLP list as per those included in CITES List. (dealt in detail elsewhere).

Some major Orders are given here

**Order Atheriniformes:** Commonly called silversides, the order includes at least 354 species in six families in 2 suborders. They are found worldwide in tropical and temperate marine and freshwater environments; they often live in dense schools and is pelagic in coastal and off shore environments, entering turtle grass beds in the evening.

## **Order: Anguilliformes (Apodes)**

The Order Anguilliformes, or true eels, contains 20 families and about 820 species. Species are usually elongate and slender, with single dorsal and anal fins that are continuous with the caudal fin (if present) in most species. All species lack pectoral fins and skeleton while some groups lack pectoral fins. Scales are usually absent, or if present, are cycloid and embedded in skin. All have leptocephalus larvae. Most true eels are predators and belong to one of three families Congridae (Conger eels), Muraenidae (Moray Eels) and Ophichthidae (snake eels and worm eels). Some species are excellent food fish and form the basis of very important commercial fisheries.

### **Order Aulopiformes**

Includes includes 5 families; commercially important Lizard fishes and green eyes

#### **Family Chlorophthalmidae-Greeneyes**

Large eye with teardrop-shaped pupil and distinctive lensless space anteriorly. A hermaphroditic species.

#### **Family Synodontidae-Lizardfishes**

These are generally small with a slender cylindrical body and head that superficially resemble those of lizards. They have a dioecious mode of reproduction. Worldwide, four genera with about 57 species have been recorded. In India 22 species have been reported in three genera *Harpadon*, *Saurida*, *Trachinocephalus* and *Synodus*.

### **Order Batrachoidiformes**

#### **Family Batrachoididae (Toadfishes)**

Two species recorded from India

### **Order Beloniformes**

Four families with with nine species infive genera are recorded from India. Some major families are

#### **Family Belonidae (Needlefishes)**

Needlefishes have slender, stream-lined bodies, and very long jaws filled with very sharp teeth. They are voracious predators and feed mostly on small fishes. In most species, the upper jaw only reaches its full length in adulthood, so the juveniles have a half-beak appearance, with an elongated lower jaw, but a much smaller upper one. During this stage of their lifecycle, they eat plankton, switching to fish once the beak fully develops. Needlefish reproduce through mating and lay eggs. The male usually rides the female on the waves as they mate

#### **Family Exocoetidae (Flyingfishes)**

Elongate bodied fishes with cylindrical shape, flattened ventrally in some species. Head short. Snout blunt. Worldwide, five subfamilies with 52 species in 8 genera has been reported. Represented in Indian waters by 18 species in 6 genera.

#### **Family Hemiramphidae (Halfbeaks)**

Elongate fishes with a prolonged lower jaw and a short triangular upper jaw. Spines absent in fins. Represented in Indian waters by 17 species in 7 genera.

### **Order Beryciformes**

The Order has 7 families with 29 genera and 144 species. All species are marine. Four families represented in Indian waters. Family Berycidae (Alfonsinos) Dorsal fin without notch, with 4-7 spines increasing in length from first to last, and 12-20 soft rays. 2 genera with about 9 species.

#### **Family Holocentridae (Squirrelfishes, soldierfishes)**

Species with a long dorsal fin with spiny portion and soft rayed portion divided by a notch. Holocentrids (squirrelfish and soldierfish) are vocal reef fishes whose calls and sound-producing mechanisms have been studied in some species only. Worldwide, eight genera with 78 species has been reported. In India, 18 species in 4 genera have been recorded.

### **Order Clupeiformes**

Herrings are certainly among the most valuable commercial fishes in the world, being important food fishes in many countries and serving as a chief source of fish meal for animal feeds. The Order Clupeiformes include anchovies, herrings, sardines, shads, gizzard shads, wolf herrings and their relatives. The current classification by Nelson (2006), divided the Clupeoidei into four families: the Engraulidae with two subfamilies with 139 species in 16 genera, the Pristigasteridae with two subfamilies and 37 species in 9 genera, the Chirocentridae with 2 species in one genus and the Clupeidae with five subfamilies with 216 species in 66 genera.

#### **Clupeoids**

This is a large group consisting mostly small to moderate sized fishes belonging to several families, genera and species and accounts for more than quarter of the fish catch. The clupeid fishes are grouped under four families (Clupeidae, Engraulidae, Pristigasteridae and Chirocentridae) and seven subfamilies. The main

groups included under these families include the sardines, anchovies, herrings, shads and sprats.

Clupeoid's species have a complete covering of easily shed cycloid scales on the body (except Chirocentridae) and can be easily identified in the field with the absence of spines in the fins, single short dorsal fin (11 to 23 finrays), situated usually near the midpoint of the body (except in *Chirocentrus*), small pelvic fins, short or moderate anal fins and a forked caudal fin (except rhomboid in *Coilia*). The body is usually fusiform, sometimes almost round in cross-section (*Dussumieria*, *Etrumeus*, also *Engraulis*), but more often compressed, sometimes highly compressed (Chirocentridae, some Pristigasteridae). Typically, there is a pelvic scute with ascending arms just in front of the pelvic fins (absent in Chirocentridae, W-shaped in the Dussumieriinae, and a series of similar scutes in front of the pelvic fins and behind them, but absent in the Dussumieriinae, some Pellonulinae, *Engraulis*). Mouth is either terminal or superior. Small conical teeth are typically present in the jaws and on the vomer, palatines and endo- and ectopterygoids but some or all may be absent, or the jaws may bear canine teeth (Chirocentridae).

#### **Order Elopiformes**

The order Elopiformes includes two small families of medium to large-sized fishes found in coastal marine, estuarine and freshwater environments. Fishes have well-developed gular plates, i.e. extra bones in the throat between the lower jaws, found only in some primitive bony fishes. Elopomorphs all have ribbon-shaped leptocephalus ("pointed head") larvae. The Atlantic Tarpon is a highly prized gamefish that reaches a length of 2.5 m and a mass of 150 kg. Albuliform bonefishes are also popular gamefishes that occupy sandy flats in shallow tropical waters. Two families with two species are recorded from India.

#### **Order Lampriformes**

These oceanic fishes are pelagic feeders that stay well above the sea floor, and normally occur in waters 100–1000 m deep. They are typically brightly coloured as adults, often with brilliant crimson fins. Lampriforms have highly variable body forms, but they are generally laterally compressed. Some are rounded in lateral view, while others are very elongated. Two families and 4 species from India

#### **Order Lophiiformes**

The order Lophiiformes is a group of marine fish that includes anglerfish and frogfish. The order contains about 322 species in 16 families in three

suborders and includes Anglerfish, Handfish, Frogfish

#### **Order Myctophiformes**

Myctophiformes consists of two families of deep-sea marine fish, including the highly abundant lanternfishes (Myctophidae) with over 30 genera and some 252 species and the blackchins (Neoscopelidae) which contain six species in three genera. Large adults of *Neoscopelus* are usually benthopelagic below 1 000 m, but subadults mostly in midwater between 500 and 1 000 m in tropical and subtropical areas.

#### **Order Notacanthiformes**

The word Notacanthiformes comes from the Greek words *noton* meaning back and *akantha* meaning thorn, and the Latin word *forma* (shape). This is an order of deep-sea ray-finned fish and includes the families Halosauridae and Notacanthidae with 27 species in 6 genera and 2 families. They are elongated and eel-like, but are not related to true eels. They are found in deep waters on the continental slope, typically in depths greater than 500 m.

#### **Order Ophidiiformes**

Ophidiiformes is an order of ray-finned fish that includes the cusk-eels, pearlfishes, viviparous brotulas, and others. Members of this order have small heads and long slender bodies. They have smooth scales or no scales, a long dorsal fin and an anal fin that typically runs into the caudal fin. Three families with 93 genera have been recognised.

#### **Order Osmeriformes**

The Osmeriformes belong to the superorder Protacanthopterygii, which also includes pike and salmon. They are one of the three major subdivisions of the class Actinopterygii, which is the most advanced of the bony fishes. The Osmeriformes spawn in freshwater, except for the Argentinoidei, Osmeruseperlanus, and perhaps one or two salangids. Osmeriformes are small to mid-sized slender fish, their maxilla is usually included in the mouth's gape, and most of them have an adipose fin. Order Osmeriformes contains two suborders, six families, some 20 genera, and about 93 species.

#### **Order Perciformes**

The Perciformes are the largest order of percomorphs, with 148 families and 9300 species, including most marine and freshwater fishes inshore and shallow-water zones. The order Perciformes includes a large proportion of the total species of fish. These fishes usually have

two dorsal fins, of which the first is spiny. Their pelvic fins are usually located under or in front of the pectoral fins. This morphologically diverse order is divided among about 20 suborders.

**Family Acanthuridae** (Surgeonfishes, tangs, unicornfishes)

Includes two subfamilies with 19 species from India

#### **Family Serranidae**

The sea basses and groupers are the most important of the more than 400 species of the family Serranidae. They are usually robust with large mouths, small teeth, ctenoid scales, and either a round or a truncate caudal fin. Most species live in shallow tropical or subtropical seas, but a few occur along temperate shores or in fresh water. Most are predatory on other fishes or invertebrates. 52 species of groupers are recorded from Indian waters.

#### **Family Lutjanidae**

The snappers of the family Lutjanidae include about 250 species. Most are large, voracious, and brightly colored fish of shallow tropical or subtropical seas. They have large mouths with canine teeth, robust bodies, ctenoid scales, and usually truncate or forked caudal fins. Most are highly valued for either food or sport, and some for both. Around 42 species are recorded from India.

**Family Lethrinidae** Commonly called pigface breams, they are benthic feeders, consuming invertebrates and small fishes. Some species have molariform teeth which they use to eat shelled invertebrates, such as molluscs and crabs. Lethrinids are an important component of some commercial, artisanal and recreational fisheries and

#### **Family Leiognathidae**

Commonly called slipmouths, they are common in shallow coastal waters and tidal creeks. They feed on benthic invertebrates. They can be used in the preparation of soups rich in calcium.

#### **Order Carangiformes**

Around 158 species are recorded in Carangiformes, in 36 genera and 5 families. The order includes Coryphaenidae, Echeinidae, Istiophoridae, Nematiidae, Rachycentridae, Xiphiidae, Carangidae.

#### **Family Carangidae**

Carangids are yet another vast group consisting of several families, several genera and species. Six families are included under Carangiformes and the family Carangidae is the largest of them and includes jacks, pompanos, jack mackerels,

runners, scads. The important features used to identify carangids are the presence of two preanal spines, scutes on the body and scalation in the breast area. It forms an important fishery along the Indian coast with most of the species being commercially valuable and exploited by several gears. Some species are popular in sport fishing. Three species have been successfully bred and being cultured.

#### **Order Scombriformes**

Scombriformes is an order of bony fish containing nine families which were classified under the suborders Scombroidei and Stromateoidei. This group includes different species of pelagic fish (the mackerels, tunas, bonitos) mostly from the family Scombridae, all being very important and favored food fishes with very high domestic as well as export demand. They are found in both temperate and tropical seas, mostly living along the coast or offshore in the oceanic environment.

Mackerel species typically have stream lined body, vertical stripes on their backs and deeply forked tails, two separate dorsal fins and finlets following the dorsal and anal fins. Forked caudal fin, with a slender ridged base is another characteristic feature. The first (spiny) dorsal fin and the pelvic fins are normally retracted into body grooves.

Fishes are medium to large sized; all undertake either short distance long distance migrations. Smaller mackerel are forage fish for larger predators, including larger mackerel. Sport fishermen value the fighting abilities of the king mackerel.

#### **Barracudas**

The barracudas are considered as one of the most predatory fishes in the marine system. With a wide distribution in warm- temperate waters is represented by several species. They can be easily identified by the scaled slender body, two well-separated dorsal fins with the anterior fin having five spines, and the posterior fin having one spine and 9 soft rays. The posterior dorsal fin is similar in size to the anal fin and is situated above it. The lateral line is prominent and extends straight from head to tail. The spinous dorsal fin is placed above the pelvic fins and is normally retracted in a groove. The caudal peduncle is stout and the fin is moderately forked, a jutting lower jaw, and a large mouth with many large, sharp teeth. Their gill covers have no spines and are covered with small scales. They are popular as sport fishes, and also valued as food. *Sphyrna*, is the only genus in the

family Sphyraenidae and included several species. *S. putnamae*, *S. obtusata*, *S. jello*, *S. forsteri*, *S. barracuda*, *S. arabiansis* are the dominant species in India.

### Order Istiophoriformes

These are a group of highly migratory pelagic fishes characterised by prominent bills, or rostra and popularly referred to as billfishes. They are found in all oceans, although they usually inhabit tropical and subtropical waters and highly valued as gamefish by sports fishermen. They include sailfish and marlin, which make up the family Istiophoridae, and swordfish, sole member of the family Xiphiidae.

### Order Pleuronectiformes

Commonly called flatfishes, this is a diverse group with many forming a great part of the commercial fishery in Atlantic and Pacific waters, but with little information from the tropics where they sometimes go as discards and bycatch. Nearly 65 species recorded from Indian waters with major families being Psettodidae with a single genus and species, Cynoglossidae and Soleidae. The other families are only zero contributors to fishery.

### Order Tetraodontiformes

The Tetraodontiformes are represented by 10 extant families and at least 349 species overall; most are marine and dwell in and around tropical coral reefs, but a few species are found in freshwater streams and estuaries. Prominent families include the Balistidae (Triggerfishes), Diodontidae (Porcupinefishes), Molidae (Molas or Ocean Sunfishes), Monacanthidae (Filefishes), Ostraciidae (Boxfishes), Tetraodontidae (Puffers), Triacanthidae (Triplespines), Triacanthodidae (Spikefishes).

Documentation of biodiversity has become a very important aspect in view of the climatic and anthropogenic influences on the habitat. The fish diversity of any regime has great significance in assessment of the habitat and also contributes to the sustainable management of the resources.

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