PRESENT STATUS OF ICHTHYOFAUNAL DIVERSITY OF INDIAN SEAS

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Introduction

Indian fish taxonomy has a long history, which started with Kautilya's *Arthasastra* describing fish as a source for consumption as early as 300 B.C and the epic on the second pillar of Emperor Ashoka describing the prohibition of consumption of fish during a certain lunar period which can be interpreted as a conservation point of view. Modern scientific studies on Indian fishes could be traced to the initial works done by Linnaeus in 1758. M. E. Bloch is one of the pioneers in the field of fish taxonomy along with the naturalists, zoologists and botanists who laid the foundation for fisheries research in India such as Bloch and Schneider (1795-1801) and Lacepède (1798-1803). Russell who worked on 200 fishes off Vizagapatanam during 1803. Hamilton (1822) described 71 estuarine fishes of India in his work *An Account of Fishes Found in the River Ganges and Its Branches.* The mid 1800s contributed much in the history of Indian fish taxonomy since the time of the expeditions was going through. Cuvier and Valenciennes described 70 nominal species off Puducherry, Skyes, Gunther and *The Fishes of India* by Francis Day and another book *Fauna of British India* Series in two volumes describing 1,418 species are the two most indispensable works on Indian fish taxonomy to date.

In the 20th century, the basis of intensive studies on the different families and groups of freshwater fishes was done 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 (1980) described about 600 species of fishes in the work *Fishes of Laccadive Archipelago* in 1980. Talwar and Kacker (1984) gave a detailed description of 548 species under 89 families in his work Commercial *Sea Fishes of India. The FAO Species Identification Sheets for Fishery Purposes- Western Indian Ocean* (Fischer and Bianchi, 1984) is still a valuable guide for researchers. Recently, Talwar and Jhingran (1991a, 1991b) published description on 930 inland species of India known till date.

Basics of sample collection, preservation and species identification of finfish

Fish resources are considered as an important renewable resources. With increasing fishing pressure, the only option left for the sustainability of fisheries is their rational management. Proper management is possible with a thorough knowledge of the dynamics of the fish stocks. For a meaningful study of the dynamics, knowledge of natural history of the species is necessary and this in turn can be acquired by the correct identification of fish species. This assumes greater importance in tropical seas where, a multitude of closely related and morphologically similar species occur. The role of taxonomy and proper identification cannot be overstressed in studies of population dynamics. Acquaintance with the main species should be such that there should no errors in identification of them in any special form such as racial differentiation, abnormalities, malformation due to decay or disease. Species identification study is also a step towards understanding the bewildering biodiversity that characterizes in the marine ecosystem. Measuring linear dimensions of whole or parts of fish is probably the most widely used technique in taxonomic studies. Such observations are made with taps and calipers. Measurements are usually but not always taken along straight lines.

A. **Fish Collection Methods**. The major objective of the bioinventory is to identify all the available species in the habitat using all the gear combinations. Two types of gears are employed *viz*., active and passive categories. Passive gear is usually set and left stationary for a period and commonly used gear are gillnet and traps. Active gears used in the inventory are seine nets, trawl nets, dip nets, hooks and line and electric fishing. Different factors affect fish sampling such as water depth, conductivity, water clarity, water temperature, fish size and fish behavior.

B. **Identification of fish:** Characters of importance for the identification of fishes should be studied correctly to identify the species. Line drawings, colour plates and photographs provide basis for the learning the salient characters which can be for their classification. Identification keys can be used as distinguishing characters of each family and order according to the phylogeny.

   1. Determine the family based on "Key".

   2. Identify to the lowest taxonomic unit listed in key to the family of which the fish is a member

   3. Verify the final determination by ascertaining or by comparing the similarities of the specimen with illustration.

   4. Match the collected specimen with previously identified specimen by taxonomist.

   5. Confirm the geographical range as given in the standard texts includes the locality from which the specimen was taken.

6. Compare the descriptions given in the FAO identification sheets, Catalog of Fishes and Fish base.

C. Measurements

Smoothly working dividers or digital calipers can be used for measurements. A steel scale of good quality is recommended for precise reading. Measuring board commonly used in fishery biology investigations is not suitable for taxonomic studies. All measurements are taken in a straight line. Definition of Body Measurements (All measurements along the antero-posterior axis).

1. **Total Length (TOL):** The greatest dimension between the most anteriorly projecting part of the head and the farthest tip of the caudal fin when the caudal rays are spread out together.

2. **Standard Length (STL)**: The distance from the anterior most part of the head backward to the end of the vertebral column (structural base of caudal rays).

3. **Fork Length (FOL):** Distance from the tip of snout to the end of the middle ray of the caudal fork when the fish is being flattened out.

4. **Head Length (HEL):** Taken from the tip of the snout to the posterior most point reached by the bony margin of the operculum.

5. **Pre-orbital length (PRO):** Distance from the tip of the snout to the forward point of eye.

6. **Eye diameter (EYD):** Horizontal diameter of the visible part of the eye, i.e., the distance between the front edge and the back edge of the orbit.

7. **Postorbital length (PSO):** Distance from the backward point of eye to middle of the backward bony edge of the operculum.

8. **Upper jaw length (UPJ):** Length of maxillary is taken from the anterior most point of the premaxillary to the posterior point of the maxilla.

9. **Lower jaw length (LOJ):** Length of lower jaw from anterior tip to angle of mouth.

10. **Body depth (BDD):** Distance between the middle point of dorsal finbase to straight downward central margin of the body, excluding fins.

11. **Pre-dorsal length 1 (PD1):** Distance from the tip of the snout to the forward origin of the dorsal (intersection point of the forward edge of the first ray of the dorsal, D1, with the outline of the back, the fish being flattened out)

12. **Pre-dorsal length (PD2):** Distance from the tip of snout to the forward origin of the dorsal (intersection point of the forward edge of the first ray of the dorsal, D2, with the outline of the back, the fish being flattened out).

13. **Pectoral fin length (PEL):** Distance from the extreme base of the uppermost ray to the farthest tip of the fin, filament if any.

14. **Pelvic fin length (PVL):** Distance from the extreme base of the uppermost ray to the farthest tip of the fin, filament if any.

15. **Dorsal fin length 1 (DF1):** Distance from the origin of the tip of the fin to the anterior lobe.

16. **Dorsal fin length 2 (DF2):** Distance from the origin of the tip of the fin to the anterior lobe.

17. **Inter dorsal length (IDL):** Distance from the base of the last spine (ray) of first dorsal to the intersection point of second dorsal fin.

18. **Pectoral fin base length (PEB)**: Distance from the base of the anterior fin ray of the pectoral (P) to the backward end of the last ray, the pectoral being extended on the side of the fish in its normal position.

19. **Pelvic fin base length (PVB):** Distance from the base of the anterior fin ray of the pelvic fin (P) to the backward end of the last ray, the ray being extended on the side of the fish in its normal position.

20. **Dorsal fin base length (DB1**): Distance from the forward origin of the dorsal (D1) to the backward edge (Intersection point of the backward edge of the last spine, D', with the outline of the back, the fin being extended).

21. **Dorsal fin base length (DB2)**: Distance from the forward origin of the dorsal (D2) to the backward edge (Intersection point of the backward edge of the last ray, D2, with the outline of the back, the fin being extended.

22. **Anal fin length (AFL):** Distance from the origin of the anal between the and fin tip of the fin to the anterior most outer tip of the anal fin.

23. **Anal fin base length (ABL):** Distance from the forward origin of the anal (A) to its backward edge (intersection point of the backward edge of the last ray, A' with outline of the abdomen, the fin being extended).

24. **Caudal peduncle length (CPL):** Distance from the base of the second dorsal end to origin of the caudal fin.

25. **Caudal peduncle depth (CPD):** Depth of the caudal peduncle.

26. **Pre-pelvic length (PRP):** Distance from the tip of the snout to the anterior origin of the pelvic (intersection point of the forward edge of the first ray of the pelvic, with the contour of the abdomen, the fin being extended).

27. **Pre-pectoral length (PRV)**: Distance from the tip of the snout to the margin of the insertion of pectoral fin.

28. **Pre-anal distance (PRA):** Distance from the tip of the snout to the forward origin of the anal (interior point of the forward edge of the first ray of the anal, A, with the outline of the abdomen, the fin being extended).

Taxonomists also play an important role in supporting the study of the richness of diversity as well as protecting and making vigilant of the diverse system. The assessed diversity of the oceans is just a drop, and the unrevealed sources are yet to be explored making the world more biodiversity rich. Hence the need to conserve the ichthyofaunal diversity is to be looked into as they pose major threats that need to be tackled and sorted out. The role of Marine Protected Areas (MPAs) and fish sanctuaries have been designated in many places worldwide, which can help to protect and restore threatened species. Human activities are the major causes for the loss of biodiversity and degradation of marine and coastal habitats, which needs immediate attention and comprehensive action plan to conserve the biodiversity for living harmony with nature. Some of the measures such as control of excess fleet size, control of some of the destructive gears, regulation of mesh size, avoid habitat degradation of nursery areas of the some of the species, reduce the discards of the low value fish, protection of spawners, implementation of reference points and notification of marine reserves for protection and conservation of marine and coastal biodiversity. The Wild Life (Protection) Act, 1972 amended by the Government make sure of the species protected under this Act and any capture, killing and trade of these species is punishable.

Species richness

Of the 33,059 total fish species from the world, India contributes of about 2492 marine fishes owing to 7.4% of the total marine fish resources. Of the total fish diversity known from India, the marine fishes constitute 76 percent, comprising of 2492 species belonging to 941 orders 240 families (Table 1). Among the fish diversity-rich areas in the marine waters of India, the Andaman and Nicobar archipelago shows the highest number of species, 1431, followed by the east coast of India with 1121 species and the west coast with 1071. As many as 91 species of endemic marine fishes are known to occur in the coastal waters of India. As of today, about 50 marine fishes known from India fall into the Threatened category as per the IUCN Red List, and about 45 species are Near-Threatened and already on the path to vulnerability. However, only some species (10 elasmobranchs, 10 seahorses and one grouper) are listed in Schedule I of the Wildlife (Protection) Act, 1972 of the Government of India.

Table 1. Species diversify of marine fishes of India

No	Order	Family	No. of Genera	No. of species
Class: Elasmobranchii				
1	Hexanchiformes			
1		Hexanchidae	2	2
2	Heterodontiformes			
2		Heterodontidae	1	1
3	Echinorhiniformes			
3		Echinorhinidae	1	1
4	Orectolobiformes			
4		Rhincodontidae	1	1
5		Hemiscylliidae	1	5
6		Stegostomatidae	1	1
7		Ginglymostomatidae	1	1
5	Lamniformes			
8		Odontaspididae	2	3
9		Pseudocarchariidae	1	2
10		Lamnidae	2	3
11		Alopiidae	1	3
6	Carcharhiniformes			
12		Pseudotriakidae	1	1
13		Scyliorhinidae	6	9
14		Proscylliidae	1	1
15		Triakidae	2	4
16		Hemigaleidae	4	4
17		Carcharhinidae	10	26
18		Sphyrnidae	2	5
7	Squaliformes			
19		Etmopteridae	2	7
20		Somniosidae	2	2
21		Centrophoridae	2	8
22		Squalidae	1	5
8	Pristiformes			
23		Pristidae	2	5

9	Torpediniformes			
	24	Narkidae	2	4
	25	Narcinidae	2	7
	26	Torpedinidae	1	5
10	Rajiformes			
	27	Rhinobatidae	4	10
	28	Rhyncobatidae	1	4
	29	Zonobatidae	1	1
	30	Acanthobatidae	1	1
	31	Rajidae	7	8
11	Myliobatiformes			
	32	Hexatrygonidae	1	1
	33	Dasyatidae	7	28
	34	Gymnuridae	2	4
	35	Myliobatidae	2	8
	36	Mobulidae	2	9
	37	Placiobatidae	1	1
Sub class: Holocephali				
12	Chimaeriformes			
	38	Rhinochimaeridae	1	1
	39	Chimaeridae	1	1
Class Actinopterygii				
13	Elopiformes			
	40	Elopidae	1	2
	41	Megalopidae	1	1
14	Albuliformes			
	42	Albulidae	1	2
15	Notacanthiformes			
	43	Halosauridae	2	5
	44	Notacanthidae	1	1

16	Anguilliformes			
	45	Anguillidae	1	5
	46	Moringuidae	1	6
	47	Muraenidae	10	38
	48	Synaphobranchidae	2	3
	49	Ophichthidae	17	24
	50	Colocongridae	1	1
	51	Congridae	12	17
	52	Muraenesocidae	4	6
	53	Nemichthyidae	2	2
	54	Serrivomeridae	1	1
	55	Nettastomatidae	2	2
17	Clupeiformes			
	56	Clupeidae	12	26
	57	Dussumieriidae	1	2
	58	Engraulidae	5	34
	59	Chirocentridae	1	2
	60	Pristigasteridae	4	12
18	Gonorynchiformes			
	61	Chanidae	1	1
19	Siluriformes			
	62	Ariidae	10	25
	63	Plotosidae	1	3
	64	Bagaridae	2	4
20	Stomiiformes			
	65	Gonostomatidae	4	6
	66	Sternoptychidae	4	8
	67	Phosichthyidae	2	3
	68	Stomiidae	6	9

21	Aulopiformes			
	69	Chlorophthalmidae	1	3
	70	Ipnopidae	2	4
	71	Synodontidae	4	23
	72	Paralepididae	2	3
	73	Evermannellidae	2	2
	74	Alepisauridae	1	2
22	Myctophiformes			
	75	Neoscopelidae	2	3
	76	Myctophidae	11	41
23	Lampriformes			
	77	Veliferidae	1	1
	78	Lophotidae	1	1
	79	Regalecidae	1	1
	80	Ateleopodidae	2	3
24	Polymixiiformes			
	81	Polymixiidae	1	4
25	Gadiformes			
	82	Bregmacerotidae	1	1
	83	Macrouridae	9	18
	84	Moridae	1	2
26	Ophidiiformes			
	85	Ophidiidae	16	28
	86	Carapidae	3	5
	87	Bythitidae	6	7
	88	Aphyonidae	1	1
27	Batrachoidiformes			
	89	Batrachoididae	4	6

28	Lophiiformes			
	90	Lophiidae	2	4
	91	Antennariidae	2	9
	92	Chaunacidae	1	1
	93	Ogcocephalidae	5	11
	94	Diceratiidae	1	1
	95	Oneirodidae	1	1
	96	Ceratiidae	1	1
29	Mugiliformes			
	97	Mugilidae	7	18
30	Atheriniformes			
	98	Atherinidae	4	9
	99	Notocheiridae	1	1
31	Beloniformes			
	100	Belonidae	4	8
	101	Hemiramphidae	5	16
	102	Zenarchopteridae	2	8
	103	Exocoetidae	6	18
32	Stephanoberyciformes			
	104	Melamphaidae	1	1
33	Cypridontiformes			
	105	Aplocheilidae	1	1
34	Beryciformes			
	106	Monocentridae	1	1
	107	Trachichthyidae	2	3
	108	Berycidae	2	4
	109	Holocentridae	4	25
35	Argentiniformes			
	110	Platytroctidae	3	4
	111	Alepocephalidae	9	14

36	Zeiformes			
	112	Parazenidae	1	1
	113	Grammicolepididae	2	2
	114	Zeidae	1	2
37	Gasterosteiformes			
	115	Pegasidae	2	4
38	Syngnathiformes			
	116	Aulostomidae	1	1
	117	Fistulariidae	1	3
	118	Centriscidae	2	4
	119	Macrorhamphosidae	1	1
	120	Solenostomidae	1	2
	121	Syngnathidae	14	42
39	Scorpaeniformes			
	122	Apistidae	1	1
	123	Aploactinidae	4	6
	124	Bembridae	1	1
	125	Dactylopteridae	1	5
	126	Peristediidae	5	7
	127	Platycephalidae	11	16
	128	Scorpaenidae	15	35
	129	Setarchidae	2	3
	130	Synanceiidae	5	13
	131	Tetrarogidae	9	12
	132	Triglidae	2	7
40	Polynemiformes			
	133	Polynemidae	5	11

41	Perciformes			
134		Acropomatidae	2	5
135		Ambassidae	2	11
136		Apogonidae	19	63
137		Bathyclupeidae	1	1
138		Bramidae	3	3
139		Caesionidae	4	16
140		Caproidae	1	2
141		Carangidae	20	66
142		Centrogenyidae	1	1
143		Chaetodontidae	8	48
144		Coryphaenidae	1	2
145		Datnioididae	1	1
146		Drepaneidae	1	2
147		Echeneidae	3	6
148		Emmelichthyidae	1	1
149		Gerreidae	2	11
150		Haemulidae	3	28
151		Hapalogenyidae	1	1
152		Kyphosidae	1	3
153		Lactariidae	1	1
154		Latidae	2	2
155		Leiognathidae	9	22
156		Lethrinidae	5	24
157		Lobotidae	1	1
158		Lutjanidae	10	45
159		Malacanthidae	2	3
160		Menidae	1	1
161		Monodactylidae	1	3
162		Mullidae	3	27
163		Nemipteridae	4	33

164	Opistognathidae	1	7
165	Ostracoberycidae	1	1
166	Pempheridae	2	7
167	Plesiopidae	3	5
168	Pomatomidae	1	1
169	Priacanthidae	3	9
170	Pseudochromidae	4	9
171	Rachycentridae	1	1
172	Sciaenidae	19	43
173	Serranidae	19	85
174	Sillaginidae	2	11
175	Sparidae	7	12
176	Symphysanodontidae	1	3
177	Toxotidae	1	2
178	Acanthuridae	5	39
179	Ammodytidae	1	3
180	Blenniidae	26	65
181	Callionymidae	4	21
182	Cepolidae	2	4
183	Champsodontidae	1	2
184	Chiasmodontidae	3	3
185	Cirrhitidae	4	8
186	Clinidae	1	1
187	Creediidae	1	1
188	Eleotridae	11	18
189	Ephippidae	3	4
190	Gobiidae	71	190
191	Kuhliidae	1	3
192	Kurtidae	1	1
193	Labridae	28	85
194	Cichlidae	2	3

195	Samaridae	2	2
196	Microdesmidae	3	9
197	Pentacerotidae	1	1
198	Percophidae	2	3
199	Pholidichthyidae	1	1
200	Pinguipedidae	1	12
201	Pomacanthidae	6	21
202	Pomacentridae	19	92
203	Scaridae	7	29
204	Scatophagidae	1	1
205	Schindleriidae	1	2
206	Siganidae	1	17
207	Terapontidae	2	4
208	Trichonotidae	1	2
209	Tripterygiidae	3	8
210	Uranoscopidae	2	6
211	Xenisthmidae	1	1
212	Zanclidae	1	1
213	Ariommatidae	1	1
214	Centrolophidae	1	2
215	Istiophoridae	3	5
216	Nomeidae	2	3
217	Scombridae	11	22
218	Scombrolabracidae	1	1
219	Stromateidae	1	2
220	Trichiuridae	6	12
221	Kraemeriidae	1	1
222	Sphyraenidae	1	10
223	Gempylidae	9	10
224	Xiphiidae	1	1

42	Pleuronectiformes			
	225	Psettodidae	1	1
	226	Citharidae	1	1
	227	Paralichthyidae	2	9
	228	Bothidae	9	21
	229	Pleuronectidae	3	4
	230	Soleidae	11	27
	231	Cynoglossidae	3	21
43	Tetradotnifromes			
	232	Triacanthodidae	6	6
	233	Triacanthidae	3	5
	234	Balistidae	11	22
	235	Monacanthidae	14	22
	236	Ostraciidae	4	7
	237	Triodontidae	1	1
	238	Tetradontidae	8	32
	239	Diodontidae	3	6
	240	Molidae	3	4
			941	2492

Reference: Table prepared based on the list of species published in Eschmeyer, W. N., 1998. **Eschmeyer, W. N. and R. Fricke (eds). 2015.** Gopi, K.C. and Mishra, S. S., 2014. Akhilesh et al., 2014; Joshi et al., 2016.

Marine and coastal diversity

Gujarat Coast

Gujarat has the longest coastline of more than 1,600 km and the most extensive continental shelf of nearly 164,000 km^2, which represents nearly 20% and 32 % of India's coastline and continental shelf. The EEZ of Gujarat covers 214,000 km^2. The coast has been broadly divided into four sections: the Gulf of Kachchh, the Saurashtra coast, the Gulf of Khambhat and the South Gujarat coast. The ecological India's first Marine National Park was notified in the Gulf of Kachchh. The habitats exhibit considerable diversity and they include mangroves, salt

marshes, coral reefs, beaches, dunes, estuaries, intertidal mudflats, gulfs, bays and wetlands. Gujarat has India's second largest extent of area under the mangroves. The major rivers are Narmada, Tapti, Sabarmati and Mahi. Gulf of Khambhat (Gulf of Cambay) is 190 km wide at its mouth between Diu and Daman, rapidly narrows to 24 km. The gulf receives many rivers, including the Sabarmati, Mahi, Narmada, and Tapti. The Gulf of Kachchh is rather shallow with a depth of nearly 60 m at the mouth to less than 20 m near the head. The total gulf area is about 7350 km^2. In the Gulf of Kachchh, there are 42 islands & some islets, covering a total area of about 410.6 km^2. About 306 fish species are listed from the sea and coastal waters of Gujarat. The fishery at present is dominated by fishes like ribbonfishes (*Trchiurus lepturus*), Bombay duck (*Harpodon nehereus*), croakers, carangids, threadfin breams, lizardfishes, tuna (*Euthynnus affinis, Thunnus tonggol, Katsuwonus pelamis, Thunnus albacores* and *Sarda orientalis*), seerfish, pomfrets, catfish, flatfishes and non-penaeid prawns. The Bombay duck (*Harpodon nehereus*) fishery was dominant at Nawabunder, Rajpara and Jaffrabad along the Saurashtra coast. Out of total 306 reported species, 23 fish species were found in the IUCN's Red Data list. Importantly, 9 of these species belong to shark families, including the whale shark, are also listed in Schedule I of Wildlife Protection Act, 1972.

Mumbai Coast

The Maharashtra coast that stretches between Bordi/Dahanu in the North and Redi/Terekhol in the South is about 720 km long and 30-50 km wide. The shoreline is indented by numerous west flowing river mouths, creeks, bays, headlands, promontories and cliffs. There are about 18 prominent creeks/estuaries along the coast many of which harbor mangrove habitats. Bombay duck fisheries form the mainstay of the commercially important fisheries of the coast from Ratnagiri to Broach. The coastline between Bombay and Kathiawar is found to be productive for Sciaenids, *Leptomelanosoma indicus* (=*Polynemus indicus*), *Polynemus* spp., perches and eels. The Gulf of Cambay and North Bombay coast are also rich in Bombay duck fisheries. About 285 species have been reported from the coast. Major finfishes along this coast was Bombay duck, ribbonfish, sharks, pomfrets, lizardfish, catfishes, oil sardine, anchovy, barracudas, full beaks, sailfish, cobia, wolf herring, groupers, whitefish and mackerel.

Konkan Coast

The Konkan coast stretches like a beautiful chain of 720 km formed from the coastal districts of states of Maharashtra, Goa and Karnataka. Many river mouths, creeks, small bays, cliffs and beaches, interspersed with historic forts, lend an alluring charm to this landscape. Konkan is also rich in coastal and marine biodiversity. Mangrove forests, coral reefs, charismatic marine species like dolphins, porpoises, whales, sea turtles, etc., many species of coastal birds and other fauna make the Konkan coast a veritable treasure trove biological diversity. The Malvan Marine Sanctuary has spread over 29 km^2; the sanctuary is rich in coral and marine

life. The Karwar group of islands with its unique rocky with sandy shore supports a wide range of fauna. There are more than 170 different species of food fishes landing in the coast and is famous for its large shoals of mackerel, *Rastrelliger kanagurta* dominating the coasts of Karnataka. Oil sardine along with *Sardinella fimbriata,* anchovies, clupeids, ribbonfishes, seerfishes, *Lactarius* sp., carangids, pomfrets, croakers, catfish, whitefish, flatfishes, silver bellies also contribute much to the fisheries of both the coasts.

Malabar Coast

Malabar Coast which stretches from Goa to Kanyakumari supports vast habitats such as Mangroves, Swamps, coral reefs, Sea grass meadows, beaches and deltaic regions. About 308 fish species has been reported off Malabar Coast of which most of them are clupeids followed by, groupers, anchovies, scombirds, snappers and butterfly fishes. Oil sardine along with Indian mackerel, threadfin beams, lizardfish's, eels, several carangids, sharks, rays, the Malabar sole, *Cynoglossus semifasciatus,* catfishes, small croakers, pomfrets, tuna, groupers, snappers, pigfacebreams, priacanthids, silverbellies, contribute to the commercial fishery along the Malabar coast. *Acanthurus matoides, A. xanthopteres, Apogon aureus, Chaetodon collare, Diodon hystrix, Gymnothorax flavimarginatus, Pseudobalistes flavimarginatus, Ostracion tuberculatum, Lactaia cornuta, Plataxteira, Pteroise volitans, Siganus javus, Tetradon immaculatus* are important ornamental species for their abundance and economic value.

Lakshadweep

The Union territory of Lakshadweep consists of 36 islands covering an area of 32 km^2 of which 10 islands are inhabited, 20,000 km^2 of lagoons and 4000 km^2 oceanic zones. Among the fishes of Lakshadweep, those of ornamental value are abundant. Of 603 species of marine fishes belonging to 126 families that are reported from the islands, at least 300 species belong to the ornamental fish category. Oceanic species of tuna such as Skipjack and Yellowfin tuna constitute the major tuna resources from Lakshadweep Islands. The main economy of the islanders is dependent on the tuna catch and fishing is done for nearly six months of the year from October to April. The most common species of sharks that occur in Lakshadweep are the Spade-nose shark/Yellow dog shark, and the Milk shark. The Blacktip Shark and Hammerhead shark are also commonly found in the waters around Lakshadweep.

Gulf of Mannar

The Gulf of Mannar located in the Southern part of the Bay of Bengal with a string of 21 islands which has been declared as a marine national park under the Wild Life (Protection) Act 1972 by the Government of India. The reserve covers 10,500 km^2, which comprises of a variety of sensitive marine habitats like coral reefs, mangroves and sea grasses, and could be considered as one of the most productive ecosystems. The core area of the reserve is

comprised of a 560 km^2 of coral islands and shallow marine habitat. The Gulf of Mannar alone produces about 20% of the marine fish catch in Tamil Nadu. Of 2200 fish species distributed in Indian waters, 650 species have so far been recorded from the Gulf of Mannar. The finfish resources, mainly comprises of small pelagics, barracudas, silver bellies, rays, skates, eels, carangids, flying fish, full beaks and half beaks. The demersal finfish resources, mainly associated coral reefs are threadfin breams, grouper, snappers, emperor and reef associated fishes. Further, large pelagic species like skipjack tuna, yellow fin tuna, bigeye tuna, kawakawa, frigate tuna and seer fish, bill fishes, eagle rays are most abundant in offshore and oceanic areas, but also occur in coastal waters are found in certain areas of the Gulf of Mannar.

Palk bay

Palk Bay is situated on the southeast coast of India encompassing the sea between Point Calimere near Vedaranyam in the north and the northern shores of Mandapam to Dhanushkodi in the south. The Palk Bay itself is about 110 km long and is surrounded on the northern and western sides by the coastline of the State of Tamil Nadu in the mainland of India. The coastline of Palk Bay has coral reefs, mangroves, lagoons and sea grass ecosystems. Elasmobranchs are the largest group of fishes and are well represented in the fishery wealth of the Rameswaram Island on the Palk Bay side. This is one of the best fishing grounds for smaller sardines, silver bellies, common white fish and half beaks, mullets and sciaenids. The common fishes found in this area also include Sharks, Rays, Skates, Tiger-sharks rays, and Hammer-headed sharks.

Coromandel Coast

Seer fishes are most abundant in the coromandel coast of Tamil Nadu along with miscellaneous fisheries formed of trichiurids and percoids. The flying fish fishery is an important seasonal fishery on the east coast of India extending from Madras to Point Calimere along the Coromandel coast. Three species of flying-fish, viz., *Hirundichthys coromandelensis, Cheliopogon spilopterus* and *C. bahiensis*, are generally found in these waters, but more than 90% of the catch consists of *H. coromandelensis*.

Andaman and Nicobar islands

The Andaman and Nicobar islands situated in the Bay of Bengal constitutes of about 524 islands with a coastline of 1962 km. The major habitats of the coastal region include the bio-diverse coral reefs with both fringing reefs off the east coast and barrier reefs off the west coast, mangroves, estuaries and wetlands. Coral reefs are the most complex ecosystems in the seas. Fish communities reach their highest degree of diversity in these ecosystems, and differ enormously within and between reefs in the same area and between geographic

regions since the confluence of Andaman fishes with the waters of pacific as well as Indian Ocean. A total of 1431species under 586 genera with 175 families has been reported from Andaman waters. The number of reef fishes is the highest among the Indian reefs with a contribution of 72.5% of the recorded fishes of the region. Major species belong to the family pomacentridae and gobiidae.

West Bengal

The Sundarbans mangrove forests form a geographical landmark at the Ganges delta. The Sundarbans biosphere reserve is a majestic natural region in the world which covers 102 swampy island, mangroves, estuaries, backwaters and waterways. The Sundarbans represent the largest remaining tract of coastal mangrove wetlands in tropical Asia formed at the estuarine phase of the Ganges- Brahmaputra river system. The Indian Sundarbans in the north east coast of India occupies 9630 Km^2 and are bounded by River Hooghly in the West, River Raimangal in the East, Bay of Bengal in the South and Dampier Hodges line in the North. There are 56 islands of various sizes and shapes in Sundarbans and these are separated from each other by a network of tidal channels. Sundarban boast around 172 species of fishes. Along the coast the fisheries comprise of sardines, sharks, anchovies and other miscellaneous clupeoids. Sundarbans is the nursery for nearly 90% of the aquatic species of the eastern coast, the coastal fishery of eastern India is dependent upon Sundarban. Most commercially important marine and estuarine fishes are; *Lates calcarifer, Tenualosa ilisha, Liza parsia, Liza tade, Harpadon nehereus, Plotosus canius, Pampus argenteus, Rhinobatos annandalei, Pangasius pangasius, Polydactylus indicus, Chanos chanos, Eleutheronema tetradactylum, Leptomelanosoma indicum, Polynemous paradiseus* and *Pama pama.*

Estuarine and brackish water diversity

India has rich estuarine and other brackish water resources along the east and west coasts formed by the Ganges, Mahanadi, Brahmaputra, Godavari, Krishna, Cauvery, Narmada and Tapti rivers, and smaller coastal rivers along the west coast, mainly in Kerala, Karnataka and Goa. The total brackish water resources of India as estimated by the Government of India were 1.44 million ha. The states of Odisha, Gujarat, Kerala and West Bengal have rich brackish water resources. West Bengal is endowed with rich brackish water area, estimated to be 405,000 ha with Hooghly-Matlah estuary accounting for 8,029 km² and marshy area of Sunderbans to be 2,340 km². The estuary serve as a nursery ground for migrant species proving spawning grounds for the migratory fishes such as *Hilsa ilisha, Polynemus paradiseus, Sillaginopsis domina, Pangasius pangasius, Pama pama, Polynemus tetradactylus* and *Leptomelanosoma indicum.* About 172 species of fishes has been reported from the estuary of which 99 occupy higher salinity zones. Odisha has a total brackish water resource of 417,537 ha. Estuaries, lakes and backwater account for 247,850 ha, 79,000 ha and 8,100 ha respectively. The Mahanadi estuary lies in the Cuttack and Puri districts of Odisha and

drains into Bay of Bengal. The major fauna includes *Tenualosa ilisha, Nematalosa nasus, Sardinella* sp.*, Ilisha* sp.*, Mugil cephalus, Planiliza parsia* and other perches.

The Chilka lagoon is the biggest brackish water lagoon of the east coast of India and is designated as a Ramsar site since 1981. The area during summer and rainy season has been estimated to be 906 and 1,105 km², respectively. The brackish water of Andhra Pradesh is about 2.0 lakh ha and mangrove swamp of 27,500 ha. It supports almost 268 species of fishes which includes *Nematalosa nasus, Mystus gulio, Planiliza macrolepis, Tenualosa ilisha* and *Gerres setifer.* Pulicat Lake is a very important brackish water lake of Nellore district of Andhra Pradesh and the rest in Tamil Nadu region with a total area 77,000 ha. The fishery includes *Nematalosa nasus, Planiliza macrolepis, Sillago sihama, Chanos chanos,* etc. The Godavari estuarine system has an area of 330 km², drains to Bay of Bengal on the east coast in the state of Andhra Pradesh. The major fisheries are formed by *Gerres filamentosus, Caranx* sp.*, Sillago sihama, Platycephalus* sp.*, Lates calcarifer* and *Mugil cephalus.*

Threats and conservation of ichthyofaunal diversity

The major threats to ichthyofaunal diversity are:

❍ **Pollution**: Untreated sewage, garbage, fertilizers, pesticides, industrial chemicals, plastics. Most of the pollutants on land eventually make their way into the ocean, either deliberately dumped there or entering from water run-off and the atmosphere. Not surprisingly, this pollution is harming the entire marine food chain - all the way up to humans.

❍ **Unsustainable fishing**: 90% of the world's fisheries are already fully exploited or overfished, the catch of juveniles also pose threat to the diversity of fishes. Unsustainable fishing is the largest threat to ocean life and habitats. Untargeted fish catching methods brings about large quantities of fishes and other fauna that leads to loss of the species.

❍ **Inadequate protection**: Oceans cover over 70% of our planet's surface, but only a tiny fraction of the oceans has been protected: just 3.4%. Even worse, the vast majority of the world's few marine parks and reserves are protected in name only.

❍ **Tourism and development**: Around the world, coastlines have been steadily turned into new housing and tourist developments, and many beaches all but disappear under flocks of holiday-makers each year.

❍ **Shipping**: Heavy traffic is leaving its marks of oil spills; ship groundings, anchor damage, and the dumping of rubbish, ballast water, and oily waste are endangering marine habitats around the world.

- **Oil and gas**: Important reserves of oil, gas, and minerals lie deep beneath the seafloor. However, prospecting and drilling for these poses a major threat to sensitive marine habitats and species.

- **Aquaculture**: Fish farming is often regarded as the answer to declining wild fish stocks. But the farming of fish is actually harming wild fish, through the pollution from the farms discharge, escaped farmed fish, increased parasite loads, and the need to catch wild fish as feed.

- **Climate change**: Global warming and climate change are already having a marked effect on the oceans through coral bleaching, rising sea level and changing species distribution. Strategies are needed to deal with these phenomena, and to reduce other pressures on marine habitats already stressed by rising water temperatures and levels.

- **Invasion of alien species**: The introduction of harmful aquatic organisms to new marine environments is believed to be one of the four greatest threats to the world's oceans. Those species are described as 'invasive' if they are ecologically and/or economically harmful.

Fishes are of immense value for ecosystems, hence they are to be valued, nourished and conserved. Fish as well as fisheries forms the economic as well as social backbone of Indian society. Unfortunately, over dependence and over exploitation of these naturally bestowed resources has led to a heavy fall in the number and in turn affect the biodiversity of the system. These provide recreational, physiologic and aesthetic values to the people of interest. This has been a resource of exchange in capital, investment and livelihood for majority. Fish culture, processing, trade and marketing have been providing with sufficient job opportunities for the common man. Various fishery agreements have been established internationally as well as domestically, which have immense importance in conservation of fish biodviersity. Institutes and researchers are greatly indebted to nature for the scientific information collected from various research activities.

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