

Chapter 17

Deep-Sea Fish Distribution Along the South-West Region of Indian EEZ

S. Venu

Abstract The deep sea of South West region of Indian EEZ (200–1,100 m depth) was explored and the distribution of demersal fishes was studied. The fish samplings from 164 stations using 38 m High speed Demersal trawl and 45.6 m expo models demersal trawls onboard FORV Sagar Sampada of the Ministry of Earth Sciences, Government of India during 1998–2002 and 2005–2007 are described in this chapter. Total of 149 deep-sea fish species belonging to 123 genera, 70 families, and 24 orders were collected and identified beyond 200 m depth of the area encompassing 7° and 15° N Latitude in the Indian EEZ. The order Ophiphidiformes have shown maximum bathymetrical as well as spatial distribution in all depth zones. Anguilliformes were found in all depth zones except in 501–800 and 800–1,100 m. Fishes of the order Carcharhiniformes, Aulopiformes, Beryciformes, Scorpaeniformes, Perciformes, and Pleuronectiformes have also shown a wide range of distribution.

Keywords Distribution · Deep sea · Demersal fish · South west coast · Indian EEZ

17.1 Introduction

Pisces constitute more than half of the vertebrates (Eschmeyer 2003). The number of valid species of fishes is nearing 31,000 with over 500 new species added in 2008 and it is expected that the final number will most likely exceed 35,000 (Eschmeyer and Fong 2009). Fish species new to science continued to describe at a rate of over 250 per year. The marine fishes constitute approximately 60 % of the estimated living fish species in the world (www.calacademy.org/research/ichthyology).

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The first authentic record of the deep-sea fishes from India was made with the help of fishes collected during the explorations made by R.I.M.S. “Investigator” in the book “A Descriptive Catalogue of the Indian deep sea fishes in the Indian Museum” by Alcock in 1889. The R.I.M.S. “Investigator” had surveyed 711 stations in the Indian Ocean covering the range 5°–29° N., 46°–98° E during 1884–1914 and collected specimens up to a depth of 3652 m. “Valdivia” expedition (1898–1899) covered 12 stations in the Bay of Bengal in the geographical range 0°2′S–6° N, 73°–93° E and sampled between the sounding depths of 296–2,500 m. The John Murray expedition (1933–1934) surveyed 212 stations in the Indian Ocean within the range 29° N–7° S, 32°–73° E in the Arabian Sea in the depth 27–4,793 m (Misra 1962). Tholasilangam et al. (1964) gave some insight to the bathypelagic fishes from the continental slope of southwest coast of India. Other major studies during this period included those by Jones (1965), Rao (1965), Silas and Prasad (1966), Silas and Regunathan (1974), Silas and Selvaraj (1980).

A major contribution to the knowledge of demersal fishes of Indian EEZ was provided by Fishery Survey of India and their studies were mostly concentrated on the continental shelf and slope (Philip et al. 1984; Joseph 1984; Oommen 1985; John and Sudarsan 1988; Sudarsan and Somavanshi 1988; Sulochanan and John 1988; Vijayakumaran and Naik 1988; Philip and Mathew 1996). Recently, the exploratory fishing cruises onboard *FORV Sagar Sampada* have brought out many little known deep sea fishes from the Indian EEZ beyond 200 m depth. The major studies are those of James and Pillai (1989), Reuben et al. (1989), Sivakami (1990), Sudarsan (1993), Panicker et al. (1993), Khan et al. (1996), Sivakami et al. (1998), Venu and Kurup (2002a, b, c, 2006a, b), Thomas et al. (2003), Kurup et al. (2005, 2008), Jayaprakash et al. (2006), Deepu et al. (2007), Divya et al. (2007), Venu and Kurup (2009). The recent studies on deep sea fish taxonomy from Indian EEZ include the documentation and redescription of *Glyptophidium oceanium* from the west coast (Kurup et al. 2008), *Dicrolene nigricaudis* (Cubelio et al. 2008) deep sea eel *Bassozetus robustus* (Cubelio et al. 2009).

17.2 Methods

Materials for the present study were collected from the exploratory demersal trawling operations conducted onboard *FORV Sagar Sampada* along the southwest region of Indian EEZ during the periods 1998–2002 and 2005–2007. The upper continental slope region of 7°–15° N was surveyed as part of Cruise Nos. 174, 183, 189, 196, 197, 238, and 241 of *FORV Sagar Sampada* (Fig. 17.1). 38 m High Speed Demersal Trawl II (HSDT) and 45.6 m Expo-model Demersal Trawls were used for fishing in the above cruises in the depth from 200 to 1,100 m. Fish samplings were done at 164 stations. The catch composition and species wise catch in kg at each fishing station were recorded and the specimens were taken to the laboratory for detailed identification. The entire study area was divided into four transects based on the latitude and were each transect was divided into three

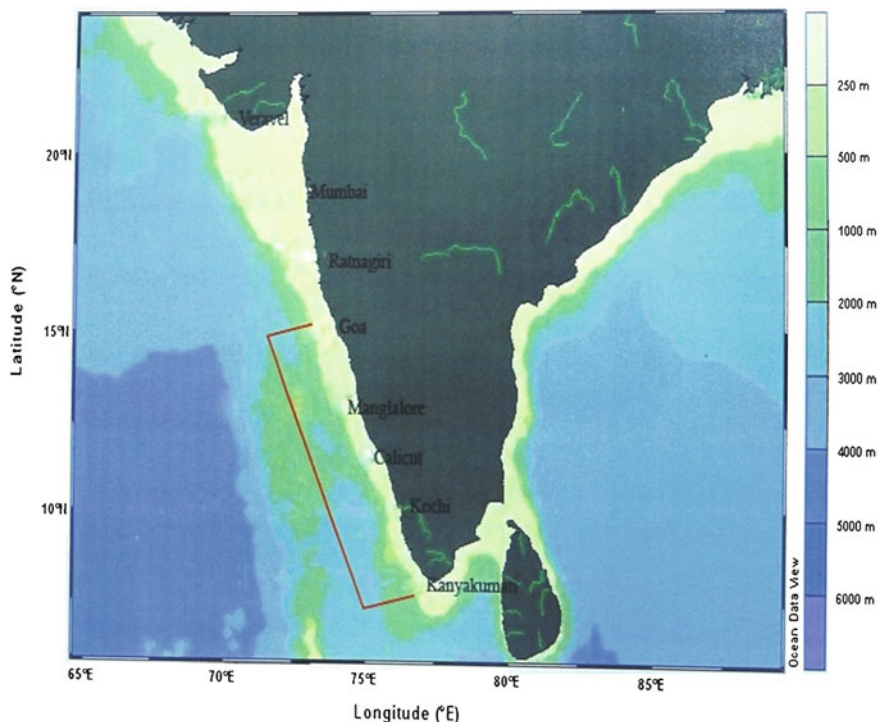


Fig. 17.1 Map showing the study area—South West coast of India

depth zones. The transects so arrived at are 7° – 9° , 9° – 11° , 11° – 13° , and 13° – 15° N and depth zones were 201–500, 501–800, and 801–1,100 m (Panicker et al. 1993; Khan et al. 1996; Venu and Kurup 2002a). The fishes were identified up to species level with the help of authentic identification keys (Goode and Bean 1895; Alcock 1889; Fischer and Bianchi 1984; Smith and Heemstra 1986, www.fishbase.org).

17.3 Results

17.3.1 Species Composition

During the period of study, 149 species of fishes belonging to 123 genera, 70 families, and 24 orders were identified and recorded. The order Perciformes dominated with 26 species belongs to 17 families followed by the order Ophidiiformes with 17 species belonging to 2 families. The spatial and bathymetrical species composition and distribution of Deep-sea fishes along southwest coast of India is given in Table 17.1.

Fishes of the Order Ophidiiformes have shown maximum bathymetrical as well as spatial distribution in all transects and depth zones studied except in 501–800 and 801–1,100 m in the 7°–9° N latitude. Anguilliformes also showed a wider distribution with occurrence in all the transects and depth zones except in 501–800 and 801–1,100 m in the 7°–9° N transect and 801–1,100 m in the 9°–11° N transect. Fishes of the orders Carcharhiniformes, Aulopiformes, Beryciformes, Scorpaeniformes, Perciformes, and Pleuronectiformes have also shown a wide distribution in all transects.

This study revealed that *Apristurus indicus*, *Coloconger raniceps*, *Gavialiceps taeniola*, *Chlorophthalmus bicornis*, *Hypopleuron caninum*, *Polymixia japonica*, *Priacanthus hamrur*, *Psenopsis cyanea*, *Bembrops caudimacula*, *Cubiceps squamiceps*, *Neoepinnula orientalis*, and *Chascanopsetta lugubris* were distributed in all the transects. Altogether 15 species were found to have distribution in all transects except 7°–9° N latitude. Five species have shown distribution in all transects except in the 13°–15° N latitude. Whereas two species viz. *Pterois russelii* and *Pterigotrigla hemisticta* have shown their occurrence except in the 9°–11° N latitude. *Cubiceps pauciradiatus* was absent only in the catches in transect 11°–13° N latitude.

17.3.2 Latitude 7°–9° N

In general, the numerical strength of species was found to be very less when compared to other transects studied (Fig. 17.2). 35 species belonging to 26 families and 11 Orders were recorded from this transect. Altogether 8 families were recorded under the Order Perciformes. However, most of the families consisted of one or two species. Perciformes with 10 species followed by Scorpaenidae and Aulopiformes were the important orders found in this transect. Highest number of species (3 Nos.) was recorded under the family Chlorophthalmidae viz. *Chlorophthalmus nigromarginatus*, *Chlorophthalmus agassizi*, and *Chlorophthalmus bicornis*. The families Gempylidae, Centrolophidae, Ophidiidae, Nomeidae, and Triacanthodidae, Priacanthidae were represented with two species each. All the other families have only one species in this transect.

17.3.3 Latitude 9°–11° N

The exploratory fishing surveys conducted in this transect have recorded 95 species from the depth between 201 and 1,100 m (Fig. 17.2). The depth zone 501–800 m recorded the highest of 52 species followed by 201–500 m depth zone (42 species) while only a single species was recorded from depth zone 801–1,100 m. Majority of the fish species comes under the order Perciformes in this transect with 13 in 201–500 m depth zone and 9 from 501 to 800 m depth

Table 17.1 Spatial and Bathymetrical species composition of deep sea fishes along southwest coast of India

Classification	7-9 N		9-11 N		11-13 N		13-15 N		
	Depth m		Depth m		Depth m		Depth m		
	201-500	501-800	801-1,100	201-500	501-800	801-1,100	201-500	501-800	801-1,100
Order: Myxiniformes									
Family: Myxiniidae									
<i>Eptatretus hexatrema</i>	-	+	-	-	-	-	-	-	-
Order: Carcharhiniformes									
Family: Scyllorhinidae									
<i>Cephaloscyllium sufflans</i>	-	-	+	-	-	-	-	-	-
<i>Apristurus saldanha</i>	-	-	-	-	-	-	-	-	-
<i>Apristurus indicus</i>	+	+	-	+	+	+	+	+	-
<i>Bythaelurus hispidus</i>	-	-	+	-	-	-	-	+	-
<i>Bythaelurus lutarius</i>	-	-	-	-	+	-	-	-	-
Family: Proscylliidae									
<i>Eridacnis sinuans</i>	-	+	-	+	+	-	+	-	-
<i>Eridacnis radcliffei</i>	-	+	-	+	+	-	+	+	-
Order: Squaliformes									
Family: Echinorhinidae									
<i>Echinorhinus brucus</i>	-	-	-	+	+	-	+	+	-
Family: Somniosidae									
<i>Centroscyllium crepidater</i>									
Family: Etmopteridae									
<i>Etmopterus baxteri</i>	-	-	-	-	-	+	-	-	+
<i>Etmopterus pusillus</i>	-	-	-	-	-	-	-	-	-
Family: Centrophoridae									
<i>Centrophorus lusitanicus</i>	-	-	-	-	-	-	-	+	-
<i>Centrophorus granulatus</i>	-	-	-	-	-	-	-	+	-

(continued)

Table 17.1 (continued)

Classification	7-9 N		9-11 N		11-13 N		13-15 N	
	Depth m	201-500	Depth m	201-500	Depth m	201-500	Depth m	201-500
<i>Centroporus uyato</i>	-	-	-	-	+	-	-	-
Order: Rajiformes								
Family: Rajidae								
<i>Raja miraletus</i>	-	+	-	-	-	-	-	-
<i>Leucoraja circularis</i>	-	-	-	-	-	-	-	+
<i>Dipturus johannisdavisi</i>	-	-	-	-	-	-	-	+
Order: Torpediniformes								
Family: Narcinidae								
<i>Benthobatis moresbyi</i>	-	+	-	-	+	-	-	+
Order: Chimaeriformes								
Family: Rhinochimaeridae								
<i>Neoharriotta pinnata</i>	-	+	-	-	+	-	-	+
<i>Rhinochimaera atlantica</i>	-	-	-	-	-	-	-	-
<i>Harriotta raleighana</i>	-	-	-	-	+	-	-	+
Order: Albuliformes								
Family: Halosauridae								
<i>Halosaurus carinicauda</i>	-	-	-	-	+	-	-	+
Family: Notacanthidae								
<i>Notacanthus indicus</i>	-	-	-	-	+	-	-	+
Order: Anguilliformes								
Family: Colococongridae								
<i>Colococonger raniceps</i>	+	-	-	+	-	+	+	-
Family: Synaphobranchidae								

(continued)

Table 17.1 (continued)

Classification	7-9 N		9-11 N		11-13 N		13-15 N		
	Depth m		Depth m		Depth m		Depth m		
	201-500	501-800	801-1,100	201-500	501-800	801-1,100	201-500	501-800	801-1,100
<i>Histiobranchus bathybius</i>	-	-	-	-	+	-	-	-	-
<i>Synaphobranchus kaupii</i>	-	+	-	-	+	-	-	-	-
Family: Congridae									
<i>Bathycongrus wallacei</i>	-	-	-	-	+	+	-	-	-
<i>Bathuroconger vicinus</i>	-	-	-	-	+	+	-	-	+
<i>Rhynchoconger ectenurus</i>	-	-	-	+	-	-	+	-	-
<i>Promyllanor purpureus</i>	-	-	-	-	-	-	-	+	-
Family: Muraenesocidae									
<i>Sauromuraenesox vorax</i>	-	-	-	-	-	-	+	-	-
<i>Xenomystax trucidans</i>	-	+	-	+	+	-	-	-	-
<i>Gavialiceps taeniola</i>	+	+	-	+	+	+	+	+	+
Family: Nemichthyidae									
<i>Nemichthys scolopaceus</i>	-	+	-	-	+	-	-	+	-
<i>Avocettina paucipora</i>	-	+	-	-	+	-	-	-	-
Order: Osmeriformes									
Family: Alepocephalidae									
<i>Rouleina nuda</i>	-	+	-	-	+	-	-	-	-
<i>Alepocephalus bicolor</i>	-	+	-	-	+	-	-	+	-
<i>Alepocephalus blanfordii</i>	-	-	-	-	+	-	-	-	+
<i>Talismania longifilis</i>	-	+	-	-	-	-	-	-	+
<i>Narceus lloydii</i>	-	-	-	-	-	-	-	-	+
<i>Bajacalifornia calcarata</i>	-	-	-	-	-	-	-	-	+
Family: Platyroctidae									

(continued)

Table 17.1 (continued)

Classification	7-9 N		9-11 N		11-13 N		13-15 N	
	Depth m	201-500	Depth m	201-500	Depth m	201-500	Depth m	201-500
<i>Platytristes mirus</i>	-	-	-	-	-	-	-	-
Order: Ateleopodiformes								
Family: Ateleopodidae								
<i>Ateleopus indicus</i>	+	-	+	-	+	-	-	-
Order: Stomiiformes								
Family: Sternoptychidae								
<i>Argyrolepecus hemigymnus</i>	-	-	-	-	+	-	-	-
Family: Stomiidae								
<i>Astronesthes martensii</i>	-	-	+	-	-	-	-	-
Order: Aulopiformes								
Family: Evermannellidae								
<i>Evermannella indica</i>	-	-	-	-	-	-	+	-
<i>Coccorella atrata</i>	-	-	-	-	-	-	-	-
Family: Paralepididae								
<i>Lestidium nudum</i>		+						
<i>Stemonosudis rothschildi</i>	-	+	-	-	-	-	-	-
<i>Magnisudis indica</i>	-	+	-	-	+	-	-	-
Family: Chlorophthalmidae								
<i>Chlorophthalmus bicornis</i>	+	+	-	+	-	+	-	-
<i>Chlorophthalmus nigromarginatus</i>	+	+	-	+	-	-	-	-
Family: Ipnopidae								
<i>Bathypterois atricolor</i>	-	-	+	-	-	-	+	-

(continued)

Table 17.1 (continued)

Classification	7-9 N		9-11 N		11-13 N		13-15 N		
	Depth m		Depth m		Depth m		Depth m		
	201-500	501-800	801-1,100	201-500	501-800	801-1,100	201-500	501-800	801-1,100
Family: Araulopidae									
<i>Paraulopus maculatus</i>	+	-	-	-	-	-	-	-	-
Family: Synodontidae									
<i>Saurida longimanus</i>	+	-	-	-	-	-	-	-	-
<i>Saurida undosquamis</i>	+	+	-	+	-	-	-	-	-
Order: Myctophiformes									
Family: Neoscopelidae									
<i>Neoscopelus microchir</i>	-	+	-	+	-	-	+	-	-
<i>Scopelogys tristis</i>	-	-	-	-	-	-	-	-	-
Order: Polymixiiformes									
Family: Polymixiidae									
<i>Polymixia nobilis</i>									
<i>Polymixia japonica</i>	+	+	-	+	-	-	+	-	-
Order: Gadiformes									
Family: Moridae									
<i>Physiculus roseus</i>	-	+	-	+	+	-	+	+	-
Family: Macrouridae									
<i>Bathygadus melanobranchus</i>	-	-	-	-	+	+	-	-	+
<i>Gadomus capensis</i>	-	+	-	-	+	-	-	-	-
<i>Coelorinchus braueri</i>	-	+	-	-	-	-	-	-	-
<i>Coelorinchus quadricristatus</i>	-	+	-	-	+	-	-	-	-
<i>Coelorinchus flabellispinnis</i>	-	+	-	-	+	-	-	-	-
<i>Coryphaenoides macrolophus</i>	-	+	-	-	+	+	-	-	-

(continued)

Table 17.1 (continued)

Classification	7-9 N			9-11 N			11-13 N			13-15 N		
	Depth m			Depth m			Depth m			Depth m		
	201-500	501-800	801-1,100	201-500	501-800	801-1,100	201-500	501-800	801-1,100	201-500	501-800	801-1,100
<i>Malacocephalus laevis</i>	-	+	-	-	+	-	-	+	-	+	-	-
<i>Nezumia investigatoris</i>	-	+	-	-	+	-	-	+	-	-	-	-
Order: Ophidiiformes												
Family: Ophidiidae												
<i>Brotulotaenia crassa</i>	+	-	-	+	-	-	-	-	-	+	-	-
<i>Lamprogrammus exatus</i>	-	-	+	-	-	+	-	+	-	+	+	-
<i>Lamprogrammus niger</i>	-	-	-	-	-	-	-	-	+	-	+	-
<i>Spectrunculus grandis</i>	-	-	-	-	-	-	-	-	-	+	+	-
<i>Luciobrotula baritschi</i>	-	+	-	-	+	-	-	+	-	+	+	-
<i>Hypopleuron caninum</i>	+	+	-	+	+	-	-	+	-	+	+	-
<i>Glyptophidium lucidum</i>	-	+	-	+	-	-	-	-	-	-	-	-
<i>Glyptophidium argenteum</i>	-	-	-	-	-	-	-	+	-	+	-	-
<i>Glyptophidium oceanium</i>	-	-	-	-	-	-	-	+	-	-	-	-
<i>Glyptophidium macropus</i>	-	+	-	-	+	-	+	+	-	-	-	-
<i>Bassozetus robustus</i>	-	-	-	-	-	-	-	-	-	-	-	-
<i>Dicrolene multifilis</i>	-	-	-	-	-	-	-	+	-	+	-	-
<i>Dicrolene nigricaudis</i>	-	-	-	-	-	-	-	+	-	-	-	-
<i>Dicrolene tristis</i>	-	-	-	-	-	-	-	+	-	+	-	-
<i>Monomitopus conjugator</i>	-	-	-	-	-	-	+	-	-	-	-	-
<i>Neobythites multistriatus</i>	-	-	-	-	-	-	-	-	-	+	-	-
<i>Neobythites steatiticus</i>	-	-	-	-	-	-	-	-	-	+	-	-
<i>Neobythites macrops</i>	-	+	-	-	+	-	-	+	-	+	-	-
Family: Bythitidae												

(continued)

Table 17.1 (continued)

Classification	7-9 N			9-11 N			11-13 N			13-15 N		
	Depth m			Depth m			Depth m			Depth m		
	201-500	501-800	801-1,100	201-500	501-800	801-1,100	201-500	501-800	801-1,100	201-500	501-800	801-1,100
<i>Grammonus ater</i>	-	-	-	-	+	-	-	-	-	-	+	-
<i>Hepthocara simum</i>	-	-	-	-	-	-	-	-	+	-	-	-
Order: Lophiiformes												
Family: Lophiidae												
<i>Lophiodes mutilus</i>	-	-	-	-	-	-	+	-	-	-	-	-
<i>Lophiomus setigerus</i>	-	-	-	-	-	-	+	-	-	-	-	-
Family: Chaunacidae												
<i>Chaunax pictus</i>	-	-	-	-	+	-	-	-	-	-	+	-
Family: Melanocetidae												
<i>Melanocetus murrayi</i>	-	-	-	-	-	-	-	+	-	-	-	-
Family: Ceratiidae												
<i>Cerattus uranoscopus</i>	-	-	-	-	-	-	-	-	-	+	-	-
Family: Diceratiidae												
<i>Dicerattias trilobus</i>	-	-	-	-	-	-	-	-	-	-	-	-
<i>Bufoerattias wedli</i>	-	-	-	-	-	-	-	-	-	-	-	-
Family: Ogocephalidae												
<i>Halieutaea stellata</i>	+	-	-	-	-	-	+	-	-	-	-	-
<i>Halieutaea coccinea</i>	-	-	-	-	-	-	-	-	-	+	-	-
<i>Halieutopsis micropa</i>	-	-	-	-	+	-	-	-	-	-	-	-
Order: Lampridiformes												
Family: Trachipteridae												
<i>Zu elongatus</i>	-	-	-	-	-	-	-	-	-	-	-	-
Order: Beryciformes												
	-	-	-	-	-	-	-	-	+	-	-	-

(continued)

Table 17.1 (continued)

Classification	7-9 N		9-11 N		11-13 N		13-15 N	
	Depth m	201-500	Depth m	201-500	Depth m	201-500	Depth m	201-500
Family: Anoplogastridae								
<i>Anoplogaster cornuta</i>	-	-	-	-	+	-	-	-
Family: Diretmidae								
<i>Diretmichthys parini</i>	-	+	-	-	-	-	-	-
Family: Berycidae								
<i>Beryx decadactylus</i>	-	+	-	-	+	-	-	-
<i>Beryx splendens</i>	-	-	-	-	+	-	-	-
Family: Trachichthyidae								
<i>Gephyroberyx darwini</i>	-	+	-	-	-	-	-	-
<i>Hoplostethus melanopus</i>	-	+	-	-	-	-	-	-
<i>Hoplostethus mediterraneus</i>	+	+	+	+	+	-	-	-
Order: Zeiformes								
Family: Parazenidae								
<i>Cytopsis rosea</i>	-	+	-	-	-	-	-	-
Family: Zeidae								
<i>Zenopsis conchifer</i>	-	+	-	+	-	-	-	-
Order: Scorpaeniformes								
Family: Scorpaenidae								
<i>Setarches longimanus</i>	+	-	+	+	-	-	-	-
<i>Ectreposebastes tinus</i>	-	+	-	-	-	-	-	-
<i>Pterois russelli</i>	+	-	-	+	-	+	-	-
<i>Scorpaena scrofa</i>	-	-	-	-	-	-	+	-
Family : Peristediidae								

(continued)

Table 17.1 (continued)

Classification	7-9 N		9-11 N		11-13 N		13-15 N	
	Depth m	201-500	Depth m	201-500	Depth m	201-500	Depth m	201-500
<i>Peristedion weberi</i>	-	-	+	-	+	-	-	-
Family: Dactylopteridae								
<i>Dactyloptena macracantha</i>	+	-	+	-	-	-	-	-
<i>Dactyloptena orientalis</i>	+	-	-	-	+	-	-	-
Family: Triglidae								
<i>Lepidotrigla spiloptera</i>	+	-	+	-	+	-	-	-
<i>Pterygotrigla hemisticta</i>	+	-	-	-	+	-	+	-
Order: Perciformes								
Family: Serranidae								
<i>Chelidoperca investigatoris</i>	-	-	-	-	+	-	+	-
Family: Priacanthidae								
<i>Heteropriacanthus cruentatus</i>	+	-	-	-	-	-	+	-
<i>Priacanthus hamrur</i>	+	-	+	-	+	-	+	-
Family: Nemipteridae								
<i>Parascopopsis aspinosa</i>	+	-	+	-	-	-	-	-
Family: Bathyclupeidae								
<i>Bathyclupea hoskynii</i>	-	+	+	-	-	+	-	+
Family: Epigonidae								
<i>Epigonus pandionis</i>	-	-	+	-	+	-	-	-
Family: Pentacerotidae								
<i>Histiopertus typus</i>	-	+	-	-	-	-	-	-
Family: Cepolidae								
<i>Oxstonia simoterus</i>	-	+	-	-	-	-	-	-

(continued)

Table 17.1 (continued)

Classification	7-9 N		9-11 N		11-13 N		13-15 N		
	Depth m		Depth m		Depth m		Depth m		
	201-500	501-800	801-1,100	201-500	501-800	801-1,100	201-500	501-800	801-1,100
Family: Acropomatidae									
<i>Acropoma japonicum</i>	-	-	-	+	-	-	+	-	-
<i>Synagrops philippinensis</i>	-	+	-	-	-	-	-	-	-
<i>Synagrops japonicus</i>	+	-	-	-	-	-	-	-	-
Family: Centrolophidae									
<i>Psenopsis cyanea</i>	+	+	-	+	+	-	+	+	-
Family: Nomeidae									
<i>Cubiceps pauciradiatus</i>	+	+	-	-	-	-	-	+	-
<i>Cubiceps squamiceps</i>	+	+	-	+	-	-	+	-	-
<i>Psenes cyanophrys</i>	-	-	-	-	-	-	+	-	-
Family: Percophidae									
<i>Bembrops caudimaculata</i>	+	+	-	+	-	-	+	-	-
Family: Uranoscopidae									
<i>Uranoscopus crassiceps</i>	-	-	-	-	-	-	-	-	-
<i>Xenocephalus australiensis</i>	-	-	-	-	+	-	-	-	-
Family: Callionymidae									
<i>Callionymus sagitta</i>	+	+	-	+	-	-	-	-	-
Family: Gempylidae									
<i>Ruvettus pretiosus</i>	-	-	-	-	-	-	-	+	-
<i>Neopinnula orientalis</i>	+	+	-	+	-	-	+	+	-
<i>Rexea prometheoides</i>	-	+	-	+	-	-	-	-	-
<i>Nealotus tripes</i>	-	-	-	-	-	-	-	+	+
<i>Promethichthys prometheus</i>	-	+	-	-	-	-	-	-	-

(continued)

Table 17.1 (continued)

Classification	7-9 N		9-11 N		11-13 N		13-15 N	
	Depth m	201-500	Depth m	201-500	Depth m	201-500	Depth m	201-500
	201-500		201-500	801-1,100	201-500	801-1,100	201-500	801-1,100
Family: Trichiuridae								
<i>Trichiurus auriga</i>	+	-	-	-	-	-	-	-
Order: Pleuronectiformes								
Family: Bothidae								
<i>Chascanopsetta lugubris</i>	+	-	+	-	+	-	+	-
<i>Psettina brevirostris</i>	-	-	+	-	+	-	+	-
Family: Cynoglossidae								
<i>Cynoglossus acutirostris</i>	-	-	+	-	+	-	+	-
<i>Cynoglossus carpenteri</i>	-	-	-	-	-	-	-	-
Family: Soleidae								
<i>Aesopia cornuta</i>	+	-	+	-	+	-	-	-
Order: Tetrodontiformes								
Family: Triacanthodidae								
<i>Macrorhamphosodes uradoi</i>	-	-	-	-	+	-	-	-

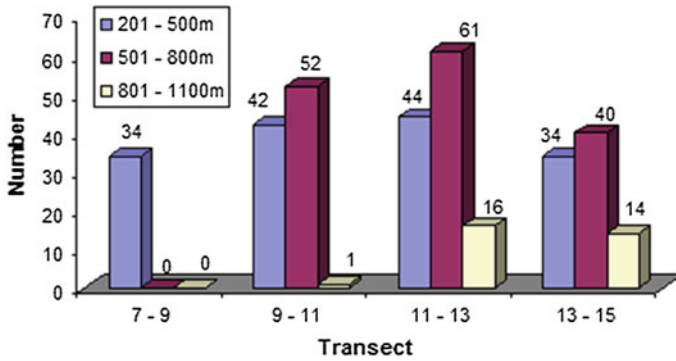


Fig. 17.2 Bathymetrical distribution of deep sea fish species along South West coast of Indian EEZ

zone. Order Gadiformes was represented by 9 species altogether of which 8 species were recorded in the depth zone 501–800 m. Six species under the Order Aulopiformes were recorded from 201 to 500 m depth zone.

Bathyclupea hoskynii, *Bembrops caudimacula*, *Callionymus sagitta*, *Hoplostethus mediterraneus*, *Hypopleuron caninum*, *Physiculus roseus*, *Harriotta reileighana*, and *Gavialiceps taeniola* showed a wider distribution among the 95 species reported with occurrence between the depths 201 and 800 m. *Lamprogrammus exutus* of Ophidiidae family was one species recorded from 801 to 1,100 m depth zone.

17.3.4 Latitude 11°–13° N

In this transect, 121 species were recorded 70 families (Fig. 17.2). Highest of 61 species were recorded from the depth zone 501–800 m followed by 201–500 m (44 species) and least from 501 to 800 m (16 species). Members of the Order Ophidiiformes showed dominance in this transect with the representations in all the depth zones while higher number of species were encountered in the depth 501 and 1,100 m. Order Perciformes dominated in the depth zone 201–500 m with 10 species followed by Scorpaeniformes with 6 species. In the depth zone 501–800 m, Order Gadiformes was represented by 8 and Carcharhiniformes by 7 species in the catches. In the depth zone 801–1,100 m, Ophidiiformes dominated in the catches followed by Anguilliformes, Osmeriformes, Aulopiformes, Gadiiformes, and Lophiiformes.

Members of the families Ophidiidae and Congridae were recorded with three species each in depth zone 201–500 m, followed by Proscylliidae, Lophiidae, Gempylidae, and Bothidae with two species each. In 501–800 m depth zone, Ophidiidae dominated with 9 species followed by Macrouridae (7 species). While 5 were recorded under Scyliorhinidae and 4 in Alepocephalidae. The families

Stomiidae, Nemichthyidae, Congridae, Synphobranchidae, Rhinochimaeridae, and Proscylliidae were represented with two species each. In the depth zone 801–1,100 m, four species under Ophidiidae family and two from Macrouridae were recorded.

Among the various species recorded, *Gavialiceps taeniola* was the lone species present in all the depth zones. Species like *Echinorhinus brucus*, *Apristurus indicus*, *Eridacnis radcliffei*, *E. sinuans*, *Xenomystax trucidans*, *Physiculus roseus*, *Glyptophidium macropus*, *Hypopleuron caninum*, *Hoplostethus mediterraneus*, and *Psenopsis cyanea* were found distributed between 201 and 800 m. Whereas, *Bathyroconger vicinus*, *Bathygadus melanobranchus*, *Coryphaenoides macrolophus*, *Dicrolene tristis*, and *Lamprogrammus exutus* showed their presence in the higher depths between 501 and 1,100 m.

17.3.5 Latitude 13°–15° N

88 species belong to 60 families were encountered from this transect (Fig. 17.2). Depth zone 501–800 m was characterised by the highest number of species belonging to 40 families followed by 201–500 m with 34 while depth zone 801–1,100 m showed the least with 14 families. The order Perciformes dominated the depth zone 201–500 m in this transect also while 7 species were found in the depth zone 501–800 m. Ophidiiformes were having 10 species in this depth zone. In the depth zone 801–1,100 m, Osmeriformes dominated with 4 species followed by Ophidiiformes with 3 species.

17.4 Discussion

The exploratory surveys carried out in the southwest region of Indian EEZ between 7° and 15° N lat have revealed many new potential fishing grounds as well as unconventional fishery resources in the deeper waters beyond 200 m depth. Although the catches from these stations were fluctuating, the results were promising toward fulfilling the attempt of delineating the resource potential of the deep sea fishery resources of the area. The new grounds identified in the continental slope area now can be utilized by the deep sea fishing industry for the harvesting of unconventional resources for the enhancement of marine fish production from the country.

The results of the present study have shown that 149 fish species belonging to 123 genera, 70 families, and 24 orders embarked the entire study area with varying degrees of bathymetrical as well as spatial distribution. It is worth reporting that in many of the families very few species were found and majority of them were represented by a single species. Most of the genera are represented with single species and rarely, more than two species in a genus.

The pattern seen in the spatial distribution of deep-sea fishes revealed that there are greater aggregation of species in transect 11°–13° N latitude. Whereas bathymetrically the depth zone 501–800 m accounted for the maximum number of species. Results of previous studies also agree with the present findings. Prasad and Nair (1973) have shown high abundance of deep-sea fishes such as *C. agassizi*, *N. orientalis*, *P. cyanea*, and *C. natalensis* in the upper continental slope (180–450 m depth zone) in the Indian EEZ. Philip et al. (1984), Oomen (1985), Sivaprakasam (1986), Panicker et al. (1993), Khan et al. (1996), Sivakami (1990), Venu and Kurup (2002a), and Jayaprakash et al. (2006) identified certain pockets at depth of 200–500 m along the southwest region of Indian EEZ as target areas for exploitation of deep sea resources. Venu and Kurup (2006a) reported that the *Neoepinnula orientalis* and *Psenes squamiceps* are more abundant in the 7°–10° N latitude. Sivakami et al. (1998) reported a potential yield of *Chlorophthalmus* spp. as 81,328 t along this region.

The Centrolophid fish *P. cyanea* showed more distribution in the depth zone 201–500 m in the 7°–13° N latitude and was found to be an exploitable non-conventional resource with tremendous potential as a commercial species. Venu and Kurup (2002b, c) reported similar results from the south west region of Indian EEZ. Panicker et al. (1993) reported *Centrolophus* sp. and *Chlorophthalmus* spp. as dominant species in the depth zone 200–500 m in lat. 7°–17° N, off west coast of India. According to Khan et al. (1996), *P. cyanea* showed peak abundance in depth zone 301–400 m and moderate abundance both in zones 101–200 and 201–300 m. Sivakami (1990) observed a promising potential for *Psenopsis* spp., along with other resources in the south west zone in the depth range 151–398 m.

Out of 149 species recorded from the study area, 40 were found to have a circumglobal distribution, showing their presence in all the three major oceans viz. Atlantic, Pacific, and Indian Ocean. 6 species were exclusive to Atlantic Ocean and 4 species were distributed only in Pacific Ocean. 71 species among the total were reported previously from Atlantic Ocean, 88 from Pacific, and 133 from Indian Ocean including the species of shared distribution between these oceans (Alcock 1889; Goode and Been 1895; Misra 1947, 1952, 1953; Fischer and Bianchi 1984; Smith and Heemstra 1986; Eschmeyer and Fong 2009, www.fishbase.org, www.calacademy.org/research/ichthyology). 49 species were reported from both the Atlantic and Pacific Oceans while 56 species shared between Atlantic and Indian Oceans and 74 between Pacific and Indian Oceans. The previous reports from Indian Ocean have shown that there are 43 species of fishes exclusively distributed in this Ocean among the remaining 103. 9 species among the remaining 60 shared their geographical distribution between Atlantic and Pacific Oceans. Among the remaining 51 species, 16 are reported from both Atlantic and Indian Ocean. The rest of the 35 species were reported previously from the Pacific as well as Indian Oceans.

The bathymetric temperatures of the temperate and tropical zones tend to be more or less uniform, while the surface temperatures are fluctuating. The isotherms may serve as an indicator to the taxonomist in dealing with the relationships of the species and subspecies from the zoogeographical point of view (Misra 1962).

According to Smith (1953), species common to the Indo-Pacific and the tropical Atlantic and the Mediterranean may be “relics of intermingling, for not very long ago in geological time conditions were different, and there was almost certainly a warm water connection between the Indian and Atlantic Oceans.” It has been proved that in the low latitudes, thermocline is between 200 and 1,000 m (Pickard and Emery 2003).

Many of the Families and Orders are represented in the study area with very few species. Many species were observed to share similar habitat as their counterparts in the other oceans. So it may also be concluded that there will be more species in the study area which could not be collected in the samplings carried out during this study. A much well organized and thorough study can unearth the real diversity of fishes inhabiting the deeper waters of southwest coast of India.

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References

- Alcock AW (1889) Natural history notes from H. M. Indian marine survey steamer ‘investigator,’ Commander Alfred carpenter, R. N., D. S. O., commanding.-No. 13. On the bathybial fishes of the Bay of Bengal and neighbouring waters, obtained during the seasons 1885–1889. *Ann Mag Nat Hist (Ser. 6)* 4(24):450–461
- Cubelio SS, Joseph G, Venu S, Kurup BM (2009) New record of deep sea cusk eel *Bassozetes robustus* Smith and Radcliffe (1913) (ophidiiformes: Ophidiidae) from the Indian EEZ with a redescription. *J Mar Biol Ass India* 51(1):118–121
- Cubelio SS, Joseph J, Venu S, Deepu AV, Kurup BM (2008) Redescription of *Dicrolene nigricaudis* (Alcock 1899) a rare species of deep sea cusk eel (Ophidiiformes: Ophidiidae) from Indian EEZ. *India J Mar Sci* 38(2):166–169
- Deepu AV, Divya VH, Kurup BM (2007) Catch and biology of *Alepocephalus bicolor* (Alcock 1891) from the southwest coast of India. *J Mar Biol Assn India* 49(2):239–242
- Divya T, Hashim M, Jayaprakash AA (2007) Distribution and abundance of deep sea eel, *Gravialiceps taeniola* along the continental slope off Indian EEZ. *J Mar Biol Assn India* 49(1):81–85
- Eschmeyer WN (ed.) (2003) Catalog of fishes. Updated database version of March 2003. Catalog databases as made available to FishBase in March 2003
- Eschmeyer WN, Fong JD (2009) Species of fishes by family/subfamily. Online version <http://research.calacademy.org/research/ichthyology/catalog/SpeciesByFamily.html>
- Fischer W, Bianchi G (1984) FAO species identification sheets for fishery purposes. Western Indian Ocean (Fishing Area 51). Prepared and printed with the support of the Danish international development agency (DANIDA). Rome, Food and Agricultural Organization of the United Nations, vol I–IV
- Goode GB, Bean TH (1895) Oceanic ichthyology: deep-sea and pelagic fishes of the world. *Smithson Inst Spec Bull* 2:553 123 pl
- James PSBR, Pillai VN (1989) Fishable concentrations of fishes and crustacean in the offshore and deep sea areas of the Indian exclusive economic zone based on observations made onboard FORV Sagar Sampada. In: Mathew KJ (ed.) Proceedings 1st Workshop on Scientific

- Result FORV Sagar Sampada. Department of Ocean Development, New Delhi, 5–7 June 1989, pp 201–213
- Jayaprakash AA, Kurup BM, Sreedhar U, Venu S, Thankappan D, Pachu AV, Manjebayakath H, Thampy P, Sudhakar S (2006) Distribution, diversity, length-weight relationship and recruitment pattern of deep-sea finfishes and shellfishes in the shelf-break area off southwest Indian EEZ. *J Mar Biol Ass India* 48(1):56–67
- John ME, Sudarsan D (1988) Assessment of the stock of big eye snappers (Fam. Priacanthidae) in the Indian seas with a note on their pattern of abundance. Symp. Tropical Marine Living Resources, MBAI, Cochin
- Jones S (1965) Comments on the so-called rare marine fishes of the genera *Dactyloptena* Jordan and Richardson and *Lepidotrigla* Gunther recently reported from Madras. *J Mar Biol Ass India* 7(1):124–126
- Joseph KM (1984) Salient observations on the results of fishery resources survey during 1983–84. *Bull Fish Surv India* 13:1–11
- Khan FM, Zacharia PU, Nandakumaran K, Mohan S, Arputharaj M R, Nagaraja D, Ramakrishnan P (1996) Catch, abundance and some aspects of biology of deep sea fish in the south eastern Arabian sea. In: Pillai VK, Abidi SAH, Ravindran V, Balachandran KK, Agadi VV (eds) Proceedings Second workshop Scientific Result FORV Sagar Sampada, Department of Ocean Development, New Delhi, pp 331–346
- Kurup BM, Thomas J, Venu S (2005) Distribution and biology of *Chlorophthalmus bicornis* Norman, beyond 250 m depth off the south west coast in the Indian EEZ. *J Mar Biol Ass India* 47(1):57–62
- Kurup BM, Cubelio SS, Joseph G, Venu S, Deepu AV (2008) First documented record and redescription of *Glyptophidium oceanium* (Ophidiiformes: Ophidiidae) from the Indian Ocean. *JMBA2—Biodiversity Records*, Published on-line, p 4
- Misra KS (1947) A check-list of the fishes of India, Burma and Ceylon
- Misra KS (1953) An aid to the identification of the fishes of India, Burma and Ceylon. II. Clupeiformes. Baihyclupeiformes. Scopeliformes and Ateleopiformes. *Rec Indian Mus*, SO(3&4):367–422
- Misra KS (1952) An aid to the identification of the fishes of India. Burma and Ceylon. I. Elasmobranchii Holocephali *Rec Indian Mus* 49(I):H9–137
- Misra KS (1962) An aid to the identification of the common commercial fishes of India and Pakistan. *Rec India Mus (Calcutta)* 57 (pts 1–4):1–320
- Oommen Varghese P (1985) Deep sea resources of the south west coast of India. Bull. No. 11 IFP, Cochin
- Panicker PA, Boopendranath MR, Abbas MS (1993) Observations on deep sea demersal resources in the exclusive economic zone off southwest coast of India. *Fish Tech* 30:102–108
- Philip KP, Mathew K (1996) Length—weight relationship and relative condition factor in *Priacanthus hamrur* (Forsskal). *Fish Tech* 33(2):79–83
- Philip KP, Premachand B, Avhad GK, Joseph PJ (1984) A note on the deep sea demersal resource of Karnataka—North Kerala coast. *Bull Fish Surv India* 13:23–29
- Pickard GL, Emery WJ (2003) Descriptive physical oceanography. An introduction. Butterworth Heinemann, Oxford, p 320
- Prasad RR, Nair PVR (1973) India and Indian Ocean Fisheries. *J Mar Biol Ass India* 15(1):1–19
- Rao NKV (1965) On a record of *Epinnula orientalis* Gilchrist and Von Bonde, a bathypelagic fish, from the Konkan coast. *J Mar Biol Ass India* 7(1):217–218
- Reuben S, Sudhakara Rao G, Luther G, Appa Rao T, Radhakrishnan K, Appanna Sasthry V, Radhakrishnan G (1989) An assessment of the bottom trawl fishery resources of the north east coast of India. *Bull Cent Mar Fish Res Inst*, 44(Part I):59–77
- Silas EG, Prasad NK (1966) Studies on demersal fishes of the deep neritic waters and the continental slope. 1. On the stromateoid fish *Psenes indicus* (Day) from the Indian Seas, with comments on the genus and related species and notes on its biology. *India J Fish* 13(1&2):183–218

- Silas EG, Regunathan A (1974) Studies on demersal fishes of the deep neritic waters and the continental slope. 3. On the occurrence of the oil fish, *Rivettus pretiosus* Cocco (Gempylidae: Pisces) on the upper continental slope along the south west coast of India. *J Mar Biol Assoc India* 16(1):291–294
- Silas EG, Selvaraj GSD (1980) Studies on demersal fishes of the deep neritic waters and the upper continental slope. 3. On *Neoharriotta pinnata* (Schnackenberg), a potentially important re-source. *J Mar Biol Assoc India* 22:149–158
- Sivakami SE, Vivekanandan P, Nammalwar M, Feroz Khan PU, Zacharia G, Mohanraj, Grace Mathew, Jayasankar P (1998) The non-conventional finfish resources of the Indian EEZ. In: Hameed MS, Kurup BM (eds.) *Technological Advancements in Fisheries*, pp 243–255. Publ. No. 1- School Indl. Fish., Cochin University of Science and Technology, Cochin
- Sivakami S (1990) Observations on the demersal fishery resource of the coastal and deep sea areas of the exclusive economic zone of India. In: *Proceedings first workshop scientific result FORV Sagar Sampada*, 5–7 June, 1989. pp 215–231
- Sivaparakasam TE (1986) What is store in deep sea? Result of explorations into the demersal fishery resources of the Indian EEZ. *Occ Pap Fish Surv India* 3–23
- Smith JLB (1953). *The sea fishes of southern Africa*. Central News Agency Ltd, South Africa, pp xvi–564
- Smith MM, Heemstra PC (1986) Family Ophidiidae. In: Smith MM, Heemstra PC (eds.) *Smiths sea fishes*. Springer, New York, p 1047
- Sudarsan D, Somavanshi VS (1988) Fishery resources of the Indian Economic Zone with special reference to upper east coast. *Bull Fish Surv India* 16:1–26
- Sudarsan D (1993) Marine fishery resources in the exclusive economic zone of India. *Fish Technology, Low energy fishing 1993*. In: *Proceedings National Workshop Low Energy Fishing*, 8–9 August 1991, Cochin, pp 3–11
- Sulochanan D, John ME (1988) Offshore, deep sea and oceanic fishery resources of Kerala coast. *Bull Fish Surv India* 16:27–48
- Tholasilingham T, Venkatordman G, Kartha KNK (1964) On some bathypelagic fishes taken from the continental slope off the southwest coast of India. *J Mar Biol Assoc India* 6:268–284
- Thomas J, Venu S, Kurup BM (2003) Length-weight relationship of some deep sea fish inhabiting the continental slope beyond 250 m depth along the west coast of India. *NAGA, World Fish Center Quart* 26(2):17–21
- Venu S, Kurup BM (2002b) Observations on the biology of some fishes collected from 250 to 750 meter along the EEZ of India. In: Goddard S, Al-Oufi H, McIlwain J, Claereboudt M (eds), In: *Proceedings 1st International Conference on Fisheries, aquaculture and Environment of NW Indian Ocean*. Sultan Qaboos University, Muscat
- Venu S, Kurup BM (2006a) Distribution and biology of deep-sea fishes *Neopinnula orientalis* Gilchrist and von Bonde 1924 and *Psenes squamiceps* (Lloyd 1909) from west coast of Indian EEZ. *J Mar Biol Assoc India* 48(1):24–28
- Venu S, Kurup BM (2002a) Distribution and biology of the deep sea fish *Psenopsis cyanea* (Alcock) inhabiting continental slope of the west coast of India. *J Mar Biol Assoc India* 44(1&2):176–186
- Venu S, Kurup BM (2006b) Life history traits of silver roughy *Hoplostethus mediterraneus* (Cuvier) (Family: Trachichthyidae) from the continental slope of south west coast of India. *Fish Tech* 43(2):204–211
- Venu S, Kurup BM (2002c) Distribution and abundance of deep sea fishes along the west coast of India. *Fish Tech* 39(1):20–26
- Venu S, Kurup BM (2009) Spatial and bathymetrical distribution of deep sea perciform fishes along southwest coast of India. In: Vivekanandan E et al. (eds.) *MECOS, Book of Abstracts*, Mar Biol Assn India, 9–12 Feb 2009, Cochin, p 163
- Vijayakumaran K, Naik SK (1988) A study of the stock of *Priacanthus hamrur* (Forsskal) during March and September between Lat. 11–16 N along the west coast of India. *Fish Surv India Spl Pub* 2:106–119