

## Deep-sea ecosystems of the Indian Ocean

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The deep Indian Ocean is composed of a variety of habitat types, including abyssal plains, oxygenated slopes and basins, seamounts, and trenches. The geomorphological features of the Indian Ocean include mid-ocean ridges, abyssal plains and few deep-sea trenches. Although the Indian Ocean has relatively few seamounts and islands, it contains numerous submarine plateaus and rises. We review what is known of deep-sea benthic habitats studied with modern techniques in the Indian Ocean. Recent biological studies conducted in the Central Indian Ocean Basin (CIOB) suggested remarkably rich and diverse micro-, meio-, macro- and megabenthic communities on the abyssal sea floor. The megafaunal assemblage of the CIOB has high biomass but low diversity. While macrofaunal biomass decreased away from the shore, the meiofaunal biomass increased with distance. The discovery of 'Kairei' and Edmond hydrothermal field near the Rodriguez Triple Junction suggests that mid-ocean ridge systems in the Indian Ocean are potential sites for hydrothermal mineralization and contain active vent fields. There are no available estimates for the numbers of seamounts in the Indian Ocean based on echo sounder recordings. Satellite altimetry data indicate that the Indian Ocean has an intermediate number of generally small to moderate-sized seamounts, mostly associated with its ridge systems. The fauna of Indian Ocean seamounts remains virtually unexplored.

**[Key words:** Benthic ecosystems, Deep-sea, Indian Ocean]

### 1 Introduction

The Indian Ocean is the third largest ocean in the world, yet its benthic fauna remains relatively little explored scientifically. The *Valdivia* expedition<sup>1</sup> sampled the free-swimming larvae of the deep-water brachiopod *Pelagodiscus* in surface waters, with the benthic fauna being collected<sup>2</sup> from depths as great as 2490 m. The John Murray Expedition (1930s) worked mainly in shallow water, but some deepwater bivalves were recorded<sup>3</sup>. The Swedish Deep Sea Expedition (1947–1948) on the *Albatross* sampled extensively in all the oceans<sup>4</sup>, collecting bottom living specimens and cores from the deep sea<sup>5</sup>. During 1950–52, the *Galathea* expedition deep-water fauna were collected between Sri Lanka and the Kenyan coast, as well as along the Mozambique Channel to South Africa<sup>5</sup>. The taxonomic studies based on these expeditions were added to by Soviet cruises to the Indian Ocean<sup>6,7</sup>. Although information on the abyssal environment of the Indian Ocean has increased considerably in the last few years, greater attention has generally been paid to tectonic and geological studies, rather than biological processes in the Indian Ocean. Only a few

investigations were directed to a quantitative evaluation of deep Indian Ocean benthic stocks<sup>8</sup> and its deep-sea ecosystems still remain poorly known. Considering the Census of Marine Life's (CoML) worldwide initiative to document, investigate and protect the global marine biodiversity, review of the existing information is very essential. In this paper, we review what is known of deep-sea benthic habitats in the Indian Ocean, studied with modern techniques such as deep-tow photography, Remotely Operated Vehicles (ROVs), and with box and multiple corers.

### 2 Indian Ocean Features

The geomorphological features of the Indian Ocean include mid-ocean ridges, abyssal plains, deep-sea trenches, few seamounts and islands, and numerous submarine plateaus and rises (Fig.1). The continental rises are gradually sloping plains of terrigenous sediment, mainly from the Indus and Ganges rivers<sup>9</sup>. The abyssal plain south of the Bay of Bengal is the flattest large area of the earth's surface<sup>10</sup>. Much of this plain was formed due to a turbidity flow down the northern slopes, extending 3000 km southwards into

the deep sea.

The Indian Ocean is sub-divided into a number of major basins by long sections of mid-ocean ridge (Fig. 1). Some of the ridges such as the Ninety-East Ridge, the Mascarene Ridge and the Chagos-Laccadive Ridge are aseismic and do not appear to be sites of active seafloor spreading. Active ridges include the Carlsberg Ridge and the Mid-, Southwest and the Southeast Indian Ridges, the last two of which extend beyond the limits of the Indian Ocean, connecting with the global mid-ocean ridge system.

**2.1 Deep-water masses**

Antarctic bottom water occupies depths below 3800 m and flows across the Madagascar continental slope as a deep western boundary current<sup>11</sup>. The oxygen concentrations follow the flow pattern, decreasing towards the north in the Arabian Sea and Bay of Bengal. The Indian Deep Water, formed from North Atlantic Deep Water carried into the Indian Ocean, occupies depths between 1500 and 3800 m and spreads north in the western boundary current.

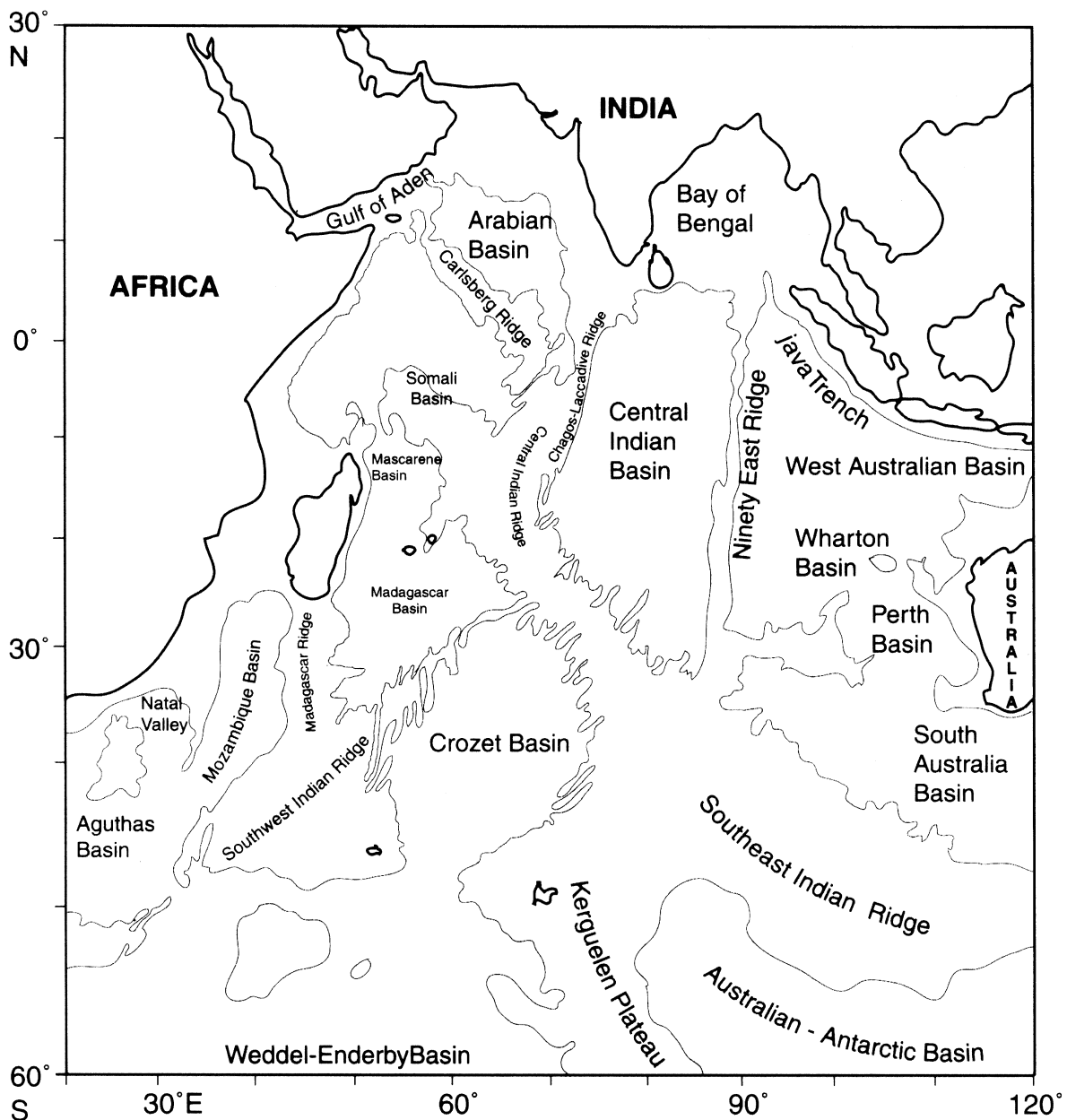


Fig. 1—Topography of the Indian Ocean region

## 2.2 Substratum type

Most of the Indian Ocean seafloor, particularly that remote from land, is covered with calcareous ooze<sup>12</sup>. Thick terrigenous sediments, having high concentrations (2–5% by wt) of organic carbon, and composed mostly of terrestrial plant material, detritus, and mineral grains transported by rivers<sup>13,14</sup>, occur in the northern and western parts of the Indian Ocean, especially the Arabian Sea and the Bay of Bengal<sup>13-15</sup>. In the Bay of Bengal, terrigenous sedimentation from the Ganges is particularly extensive<sup>16</sup>, reaching depths of 5000 m. In the Arabian Sea, there is an organic carbon maximum (4.9%) at 400 m, owing apparently to preferential preservation and accumulation of organic matter under low-oxygen conditions in the bottom water<sup>13</sup>. Sediments are very thin on the crests of mid-ocean ridges, and essentially absent on the ridge axes. Because of the oligotrophic nature of the equatorial Indian Ocean, siliceous sediments are rare in low latitudes of the Indian Ocean. Red clay is present mostly in the eastern and southern Indian Ocean, near the equator and high latitudes. It is composed of fine-grained, organic-poor sediments resulting from volcanic activity at ridges<sup>12,16</sup>. The topographic highs, which are in the proximity of three major fracture zones, are composed of hard, massive basalts occurring at the crests, along the slopes and on the foothills as talus deposits<sup>17</sup>. In the southeast and southwest Indian Ocean, and in the Mozambique Basin, there are extensive pavements of manganese nodules<sup>18</sup> at depths of about 4000 m.

## 3 Deep-sea Fauna

### 3.1 Benthic faunal composition

Recent biological studies conducted in the Central Indian Ocean Basin (CIOB) suggested remarkably rich and diverse micro-, meio-, macro- and megabenthic communities on the deep-sea floor<sup>19-27</sup>. However, the majority of the above studies were conducted in a limited area, with a specific objective (assessing the impact of deep-sea mining) and hence the inferences from CIOB data may not necessarily reflect the patterns of benthic standing stock for the entire Central Indian Ocean (CIO).

### 3.2 Meiofauna

The meiobenthic assemblages of the abyssal plains of the Indian Ocean are made up of 20 metazoan groups (Table 1). The depth integrated average abundance varied between 21 and 52 meiofauna<sup>25</sup>

(< 0.5 mm size) per 10 cm<sup>2</sup> (mean=33.1 ± 0.63 SD; n=7; Fig.2). Nematodes were numerically the most abundant taxon with 37% of the total number collected, followed by turbellarians, gastrotriches, polychaetes and harpacticoid copepods with relative abundances of 35, 11, 9, 4 and 1%, respectively. According to Parulekar *et al.*<sup>28</sup> and Ingole *et al.*<sup>20</sup> the contribution of meiofauna to the total standing crop is insignificant. The biomass values ranged from 0.02 to 0.41 g/m<sup>2</sup> with a mean value of 0.08 g/m<sup>2</sup> in the deeper regions of the Indian Ocean. Though the meiofaunal biomass tended to decrease with increasing depth, no statistically significant correlation was found. According to Ingole<sup>25</sup> the meiofaunal abundance in the CIOB falls within the reported range from similar depths in Pacific Ocean<sup>29,30</sup>. The macrofaunal biomass decreased away from the shore, suggesting a distance-dependent inverse relationship between macrofaunal biomass and distance from shore<sup>28</sup>. Overall, the contribution of macro- and meiofauna biomass to the benthic standing crop<sup>20</sup> was in the ratio of 31 to 1.

### 3.3 Vertical distribution

Deep-water meiofauna is generally concentrated on a relatively thin surface layer of the bottom deposits because of the availability of food and oxygen. The vertical profile of meiofauna in the sediment column

Table 1—Meiobenthic group diversity observed in the CIOB area during various INDEX cruises (\*: Rare; \*\*: Low; \*\*\*: High)

Taxon groups	Density level
Nematoda	***
Turbellaria	**
Harpacticoida	**
Gastrotricha	**
Foraminifera	**
Cumacean	**
Polychaeta	**
Kynorincha	*
Crust.Nauplii	**
Tardigrada	*
Decapod larvae	*
Zoea larvae	*
Halacarida	**
Amphipoda	**
Tanaisia	*
Echinoderm larvae	*
Isopoda	**
Ostracoda	*
Crinoid larvae	*
Nemertina	*
Hydrzoa	*

differed considerably between stations in the Indian Ocean<sup>20,25</sup> especially in the top 2 cm layers. Meiofauna was present down to a sediment depth of 30 cm (Fig. 2) but  $\geq 70\%$  of the specimens were found between the surface and 6 cm depth with the bulk (45%) confined to the top 2 cm. While discussing the impact of physical disturbance on the deep sea meiofauna, Ingole *et al.*<sup>21,25</sup> demonstrated that nematodes and turbellarians are capable of penetrating deeper into the anoxic sediment layer. This may be the result of feeding pressure and predation by macrobenthos. Bioturbation activity of larger macro- and megabenthic organisms appears to be higher in the CIOB area<sup>24</sup>, which may also help the burrowing of meiofauna in deeper sediment depths.

### 3.4 Macrofauna

The macrofauna of the Central Indian Ocean (CIO) is comprised of 24 major groups belonging to 15 phyla, predominantly Protozoa, Porifera, Mollusca, Annelida, Arthropoda and Echinodermata (Table 2). Polychaeta was the dominant group in terms of number of individuals, contributing over 33% to the total macrofaunal population. Their density varied from 20 to 649 no/m<sup>2</sup> with a mean value of  $124.2 \pm 40.3$  no/m<sup>2</sup>. Crustacea (23%) was the most diverse group and dominated the fauna in number of taxa (10 taxa). Amphipods (7.1%), isopods (5.3%), ostracods (4.0%) were major groups with higher percent prevalence. Paracaridean shrimps (0.8%), thalassinoid decapods (0.8%), cumaceans (0.6%), brachyuran crabs (0.3%), pagurid crabs (0.2%) and

Tanaidacea (0.1%) were the other crustaceans. Gastropods and bivalves were the main constituents of molluscs and together formed over 15% of macrofaunal density. Protozoa (5%) was represented by foraminiferans (3.5%) and radiolarians (1.1%). Echinoids (1.7%), ophiuroids (1.2%) and holothurians (0.6%) represented Echinodermata (4%). Bryozoa (2%), Nemertinea (1%), Echiurida (1%) and Brachiopoda (1%) were the other faunal groups contributing over 1% to the macrofauna. Miscellaneous forms such as turbellarians, hydrozoans, sponges, sipunculid worms, siphonophores and fish larvae contributed about 7% to the faunal

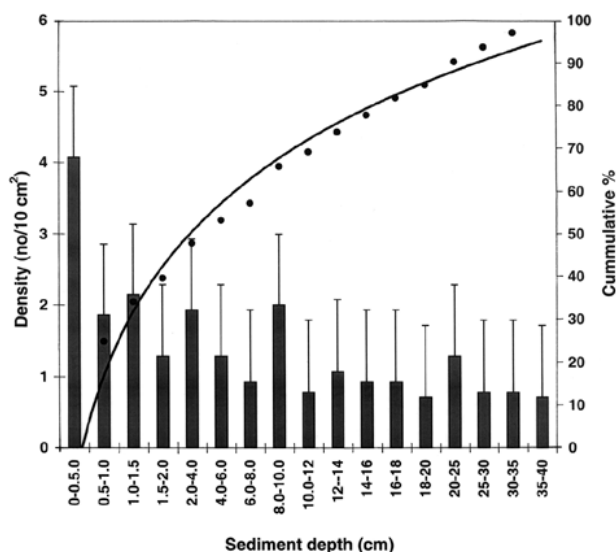


Fig. 2—Vertical distribution of meiofauna in the CIOB area

Table 2—Composition (%) and abundance (no/m<sup>2</sup>) of macrofauna in the Central Indian Ocean, arranged in the order of dominance<sup>19</sup>

Taxon	Range	Mean	±SD	%
Polychaeta	20-649	124.18	40.33	32.97
Gastropoda	29-177	35.21	47.09	9.34
Amphipoda	20-203	26.8	6.33	7.11
Isopoda	20-180	20.1	13.04	5.33
Bivalvia	29-116	16.52	23.48	4.39
Unidentified	0-174	15.77	24.17	4.19
Ostracoda	20-295	15.19	26.32	4.03
Nematoda	29-118	14.88	14.51	3.95
Oligochaeta	20-319	14.8	25.63	3.93
Harpacticoida	20-177	14.29	11.86	3.79
Foraminifera	20-236	13.19	21.64	3.50
Echinoidea	20-300	6.51	11.28	1.73
Bryozoa	0-89	5.87	4.19	1.56
Nemertina	0-30	5.51	5.36	1.46
Echiuridae	20-89	5.46	6.87	1.45
Branchiopoda	0-148	4.67	8.08	1.24
Ophiuroidea	0-60	4.60	5.94	1.22
Radiolarian	0-59	4.28	7.41	1.14
Paracaridean shrimp	0-60	3.27	2.83	0.87
Turbellaria	15-78	3.24	5.61	0.86
Hydrozoa	20-118	3.17	5.61	0.84
Sipuncula	30-59	3.04	2.76	0.81
Thalassinoid Decapoda	15-59	2.96	5.12	0.79
Cumacea	9-59	2.42	2.40	0.64
Holothuroidea	20-60	2.22	3.85	0.59
Fish larvae	0-30	1.80	3.12	0.48
Dentaliidae	0-58	1.60	2.77	0.42
Brachyuran crab	0-90	1.25	2.16	0.33
Monoplacophora	0-60	0.83	1.44	0.22
Pagurid crab	0-20	0.55	0.96	0.15
Siphonophora	0-29	0.53	0.93	0.14
Soft coral	0-30	0.42	0.72	0.11
Sponges	0-30	0.42	0.72	0.11
Pteropoda	0-30	0.42	0.72	0.11
Tanaidacea	0-30	0.42	0.72	0.11
<b>Total (no/m<sup>2</sup>)</b>		<b>376.39</b>	<b>345.97</b>	<b>99.92</b>

composition.

### 3.5 Distribution of macrofauna

Macrobenthic density in the CIOB varied from 30 to 1430 no/m<sup>2</sup> (mean = 376 ± 346; n = 56), and biomass (wet wt) varied from 0.11 to 12.75 g/m<sup>2</sup> (mean = 1.0 ± 1.9; n = 55; Table 2)<sup>19</sup>. A particularly high density (7085 no/m<sup>2</sup>) was observed at a single station in the western region (08°42'644''S;59°50'207''E) but as it was relatively shallow (500 m), it was not included for the calculation of the mean. In general, longitudinal distribution of macrobenthic density showed gradual increase from east to the west<sup>19</sup>. Maximum mean values were observed between 8–9°S and 57–62°E. High faunal density occurred in brown oozy silty sand and clayey silty bottom<sup>19</sup>. The western region has relatively shallower depths compared to the east. As assessed from the regression coefficients, abundance (density) of macrofauna decreased steadily with increasing water depth<sup>19</sup>.

### 3.6 Megafaunal communities

The megafaunal assemblage of the CIOB has high biomass but low diversity<sup>27</sup>. The density and diversity enumerated from video recordings and still-photography varied between 3 and 8 individuals per 100 m<sup>2</sup> (mean: 5.9 ± 2.1; n=5). Length of the deep tow profiles varied from 3.26 to 4.58 km (mean: 4.3 ± 0.9), covering a surface area of 10003 to 14045 m<sup>2</sup> (mean: 11,702 ± 1541 m<sup>2</sup>). The fauna comprised of 13 invertebrate groups, viz. xenophyophores, sponges, hydroids, sea pens, sea anemones, bryozoans, shrimps, sea cucumbers (*Mesothuria murrayi*, *Molpadia* sp., *Pseudostichopus* sp), sea urchins, starfishes (*Hymenaster violaceus*), and brittle stars (*Ophiura* sp.). A total of 3311 individuals were observed on five profiles. A list of the megabenthic species reported from the CIOB area is presented in Table 3.

The xenophyophores were either embedded or rooted firmly in the sediment and were numerically the most important, representing ≈ 64% (2111 individuals) of the total megafaunal composition, followed by sea cucumbers (14%), sponges (13%), shrimps (3%), sea anemones (2%), sea urchins (1%), and starfish (1%). Fish (0.7%), bryozoans (0.7%), hydroids (0.6%), brittle stars (0.6%), and crinoids (0.2%) were relatively scarce (<1%). Of the two identified sponge species, *Hyalonema* sp. was more common than *Euplectella* sp. Fish belonging to the

genera *Typhlonus* and *Bathysaurus* also were observed in the area. Fifteen different types of sea cucumbers were observed, *Mesothuria murrayi* being the dominant type. Starfish (*Hymenaster violaceus*) were frequently seen on the sediment surface associated with large mounds.

## 4 Hydrothermal systems

Most hydrothermal systems studied to date are located either in the Pacific or in the north central Atlantic Ocean. The Central Indian Ridge (CIR) is important biogeographically and evolutionarily, since it is the main link between the Atlantic and the Pacific vent faunas. This makes the CIR system an attractive target for mid-ocean ridge studies<sup>19</sup>. However to date, only 20 species of vent-specific organisms are known from the Indian Ocean<sup>19</sup> out of the >500 are known hydrothermal species.

The recent discovery of hydrothermal vents in the Indian Ocean<sup>31</sup> strongly suggests the possibility of more such activity in the region. As suggested by Lonsdale<sup>32</sup>, searching for local clusters of filter feeding animals might be one of the simplest methods for locating the precise sites of active hydrothermal vent. With this view Ingole<sup>19</sup> reanalyzed data on the abundance and biomass of macrobenthos from the CIOB. Based on the distribution pattern of diverse macrobenthic groups such as shrimps, ophiuroids, asteroids, crinoids, polychaetes and bivalves with relatively higher abundance in and around Carlsberg Ridge and Central Indian ridge Ingole<sup>19</sup> speculated the possibility of continuous supply of dead organic material from the ridge system and this was sustaining the high benthic abundance.

The macrofaunal abundance and biomass measured from the vent environment could be 500 to 1000 times higher than that of the surrounding deep-sea environment. The high abundance and biomass of macrofauna recorded at a few locations in the western area of CIOB<sup>19</sup> may be related to the very recent finding of hydrothermal vents over the Central Indian Ridge (CIR) System. The discovery of 'Kairei' hydrothermal field near Rodriguez Triple Junction and Edmond field near 23°52'S suggests that mid-ocean ridge systems in the Indian Ocean are potential sites for hydrothermal mineralization and contain active vent fields. The high abundance of macrobenthos around Carlsberg Ridge (CR)<sup>19,33</sup> and CIR observed by Ingole *et al.*<sup>19,22</sup> points toward the possibility of more unexplored hydrothermal vent

Table 3—List of the deep-sea megabenthic species collected from the CIOB area

Class	Family	Genus	Species	Identification is based on
Xenophyophorea	Stannomida	<i>Stannophyllum?</i>		**
Hexactinellida	Euplectellidae	<i>Euplectella</i>		**
Hexactinellida	Heteroderidae	<i>Hyalonema</i>		***
Anthozoa	Actinaria			**
Polychaeta	Polynoidea			**
Polychaeta	Flabelligeridae			**
Polychaeta	Flabelligeridae			**
Polychaeta	Spionidae			**
Crustacea	Tetragonicipitidae	<i>Phyllopodopsyllus</i>		**
Crustacea	Balanomorpha?			**
Crustacea	Crangonidae	<i>Neocrangon</i>		**
Crustacea	Gammaridae			**
Crustacea	Cirolanidae	<i>Eurydice</i>		**
Crustacea	Tanaidae			**
Crustacea	Palinuridae	<i>Puerulus</i>		**
Crustacea	Cariaea			***
Arachida	Halacaroidea			**
Asteroidea	Porcellanasteridae	<i>Hymenaster</i>	<i>Violaceus</i>	**
Ophiuroidea	Ophiuridae	<i>Ophiura</i>		**
Holothuroidea	Molpadiidae	<i>Molpadia</i>		**
Holothuroidea	Deimatidae	<i>Deima</i>	<i>validum</i>	*
Holothuroidea	Pelagothuriidae	<i>Enypniastes</i>	<i>eximia</i>	*
Holothuroidea	Epidiidae	<i>Amperima</i>	<i>rosea</i>	*
Holothuroidea	Elpidiidae	<i>Peniagone</i>	<i>gracilis</i>	*
Holothuroidea	Elpidiidae	<i>Peniagone</i>	<i>leander</i>	*
Holothuroidea	Synallactidae	<i>Pseudostichopus</i>	<i>mollis</i>	*
Holothuroidea	—	<i>Pseudostichopus</i>		**
Holothuroidea	—	<i>Mesothuria</i>	<i>murrayi</i>	**
Holothuroidea	—	<i>Synallactes</i>	<i>profundi</i>	*
Holothuroidea	Psychropotidae	<i>Psychropotes</i>	<i>longicauda</i>	*
Holothuroidea	—	<i>Benthodytes</i>	<i>sanguinolenta</i>	*
Holothuroidea	—	<i>Benthodytes</i>	<i>typica</i>	*
Holothuroidea	—	<i>Psychropotes</i>	<i>semperiana</i>	*
Holothuroidea	—	<i>Psychropotes</i>	<i>verrucosa</i>	*
Holothuroidea	—	<i>Benthodytes</i>	<i>incerta</i>	*
Holothuroidea	—	<i>Psychropotidae</i>		*
Osteichthyes	Bathysauridae	<i>Bathysaurus</i>	<i>mollis</i>	**
Osteichthyes	Ophidiidae	<i>Typhlonus</i>	<i>nasus</i>	*

\*: Photograph; \*\*: collection & photograph; \*\*\* only collection

sites in this region. However, no investigation on the microbes or any other sulphide-related benthic organism has been reported so far from the CIR. Animal assemblages at abyssal depths may also depend on chemoautotrophic production associated with continental margin 'seeps'. As suggested by Gage & Tyler<sup>34</sup>, seeped fluids exhibit a fauna taxonomically similar to that of hydrothermal vents such as tubeworms, vesicomid and mytilid bivalves, which can use the carbon from dissolved methane through symbiotic bacteria. Future studies, therefore, need to be directed towards finding the chemoautotrophic production with close grid seabed

sampling that could give substantial clues for possible hydrothermal activities.

### 5 Seamount communities

The seamounts of the Indian Ocean are the most poorly known of its habitats. Satellite altimetry data indicates that the Indian Ocean has an intermediate number of generally small to moderate-sized seamounts, mostly associated with its ridge systems<sup>35</sup>. They occur on all large morphostructures, particularly in the western part, along mid-ocean ridges and fracture zones. Volcanic seamounts are concentrated mainly in deep-sea basins and on north-south ridges<sup>36</sup>.

Wilson & Kaufmann<sup>37</sup>, in their review of biological data from seamounts worldwide, reported only two seamounts sampled in the entire Indian Ocean; a mere 13 species were recorded from them. Soviet and French expeditions carried out since the 1980s have sampled more seamounts within the Indian Ocean (see<sup>38</sup> for a full bibliographic list). However, their efforts focused on the ichthyofauna and plankton, related to interest in potential seamount fisheries in the region (e.g.<sup>39,40</sup>). Data on benthic fauna are virtually lacking. Apparently some 77-bottom trawl and 8 grab samples were taken, with taxa identified among the Madreporaria, Cirripedia, Decapod and Brachiopoda<sup>38</sup>. Virtually nothing is known of such major groups as echinoderms, soft corals, sponges, polychaetes, benthic crustaceans and molluscs (except cephalopods).

#### 5.1 Seamount fisheries of the Indian Ocean: The threat

The Soviets first developed fisheries on seamounts in the Indian Ocean in 1980<sup>41</sup>. The main target species were alfoncino (*Beryx splendens*), two species of rubyfish (*Emmelichthys* spp.) and two butterflyfish species (Centrolophidae). Total catch in 1980 was about 6000 tonnes, which declined continuously over the next five years to <1000 t. The fishery resumed in 1994 and landings have generally ranged between ~1600 and 3500 t. The fishing zones ranged widely across seamounts of the Madagascar, Southwest Indian and Mid-Indian Ridges in the Western Indian Ocean and the mid-Indian, Ninety-East and Broken Ridges of the Eastern Indian Ocean.

Deeper seamount fisheries, primarily for orange roughy (*Hoplostethus atlanticus*), developed in the Indian Ocean in the late 1990s, targeting spawning fish on the Madagascar Ridge. The fisheries were in international waters, unregulated and the landings largely unreported. The fishery peaked in 1999 and 2000 with between 10,000 and 20,000 tonnes<sup>42</sup> roughly landed each year. As many as 35-40 vessels participated during 1999-2000, but the fishery has declined to about 5000 tonnes landed<sup>42, 43</sup>. Seamount fisheries around Tasmania have had substantial impacts on the seamount benthic fauna<sup>44</sup>. The impacts on Indian Ocean seamounts are not known yet.

#### Conclusion

Analyses of the benthic data although speculate the possibility of hydrothermal activity along the Central Indian Ridge systems, future study, however, is needed towards finding the chemoautotrophic

production with close grid seabed sampling that could give substantial clues for possible hydrothermal activities. Even though macro-and meiofauna of the abyssal plain have been studied in greater extent, the data is lacking in taxonomic identification. Although seamount fisheries, has been developed in the Indian Ocean in the late 1990s. The fishing was mainly in the international waters, unregulated and the landings largely unreported. The data on benthic fauna of the seamounts are virtually lacking. The biological data from seamounts worldwide, reported only two seamounts sampled in the entire Indian Ocean; a mere 13 species were recorded from them. Virtually nothing is known of such major groups as echinoderms, soft corals, sponges, polychaetes, benthic crustaceans and molluscs (except cephalopods).

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