Nature Environment and Pollution Technology
An International Quarterly Scientific Journal

Vol. 7	No. 4	pp. 615-626	2008

Original Research Paper

Studies on Oceanic Zooplankton in the Continental Slope of Andaman Waters of Bay of Bengal

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Key Words:
Oceanic zooplankton
Zooplankton volume
Zooplankton biomass
Species diversity
Continental slope
Andaman waters

ABSTRACT

The biomass, density, diversity and distribution of oceanic zooplankton were studied from 25 stations along the continental slope of Andaman waters of Bay of Bengal during February to March 2007. A total of 68 species of zooplankton belonging to 56 genera and 16 groups were recorded from the waters of the continental slope. The biomass of zooplankton in terms of dry weight ranged from 792-2828mg/100m^3 while volume and numerical density varied from 8.1-16.2 mL/100m^3 and 19240-47223 Nos./100m^3 respectively. Copepods were the dominant group in all the stations of study. The results obtained for the physico-chemical parameters of seawater are also discussed in the paper.

INTRODUCTION

Zooplankton are the secondary producers playing a vital role in marine trophic levels and highly responsible for the fishery potential of seas. Their distribution is ubiquitous in world oceans. They measure in size from several microns to 2 cm and some species are considerably larger. According to the depth-wise distribution, marine zooplankton can be classified as ‘Oceanic Plankton’ i.e., plankters inhabiting waters beyond continental shelves and ‘Neritic Plankton’ i.e., plankters inhabiting waters overlying continental shelves. Although voluminous intensive studies on marine zooplankton in the tropical seas of India are available, all those studies were restricted to either coastal or neritic waters. The studies pertaining to the zooplankton of oceanic waters, especially on continental slopes, are very scanty. However, the previous works in Andaman waters on zooplankton abundance, distribution in relation to thermocline and diversity (Madhupratap et al. 1981 a,b,c), chaetognaths (Nair et al. 1981) and copepods in Campbell Bay (Goswami & Rao 1981) were reported. Furthermore, the studies on these organisms on the oceanic waters of eastern Arabian Sea (Goswami 1983), Indian Ocean (Vijayalakshmi 1984, Dalal & Parulekar 1986) standing stock of zooplankton on west coast of India (Krishnakumari & Achuthankutty 1989), Lakshadweep archipelago (Achuthankutty et al. 1989, Goswami & Uma Goswami 1990), Straits of Malacca (Rezai et al. 2003) are worth mentioning. The present investigation has been undertaken along the Continental slope of Indian Exclusive Economic Zone (EEZ) in Andaman waters of Bay of Bengal to assess the distribution and diversity of zooplankton communities.

MATERIALS AND METHODS

The present study was carried out from the continental slope region of Bay of Bengal bordering the Andaman archipelago. The Andaman and Nicobar Islands of India have an EEZ of 0.6 million km^2 with the continental shelf of 35,000 km^2. The zooplankton samples were collected from 25 stations along the western region of Andaman EEZ at a mean distance of 20-40 nautical miles between the stations covering an area of 3240 sq. nautical miles (Fig. 1) during February to March 2007. The depth of study area was 2000 to 3000 m. The GPS coordinates of the stations along with the date and time of sampling are given in Table 1. The sampling of zooplankton was performed by onboard *MFV Matsya Drushti* of Fishery Survey of India, Chennai.

Zooplankton samples were collected by surface haul using Heron-Tranter Plankton net having 1 m dia mouth and 4.5 m long with a mesh size of 300µ for 10 minutes at 2 knot speed. The amount of water passed through was calculated by using flow meter while hauling the net. The collected plankton samples were preserved in 4% formalin. The wet weight of the zooplankton was determined after washing with distilled water and thereafter filtering through filter paper. The dry weight was determined by drying the filtered samples in a hot air oven at 70°C till constant weight. The

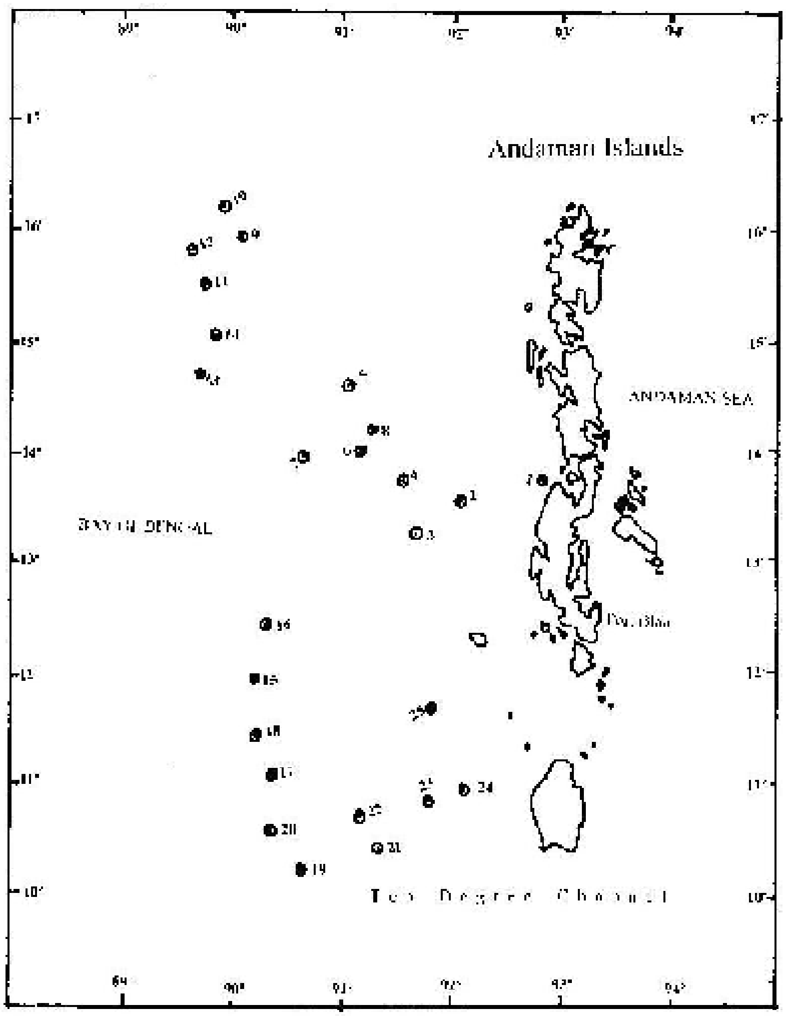

Fig. 1: Map showing the sampling stations along Indian EEZ of Andaman waters of Bay of Bengal.

Table 1: Coordinates of sampling stations along Andaman EEZ of Bay of Bengal.

Station No.	Coordinates	Date of sampling	Time(hrs)
1	Latitude 13°25.861'N Longitude 92°11.725'E	15/02/2007	07 20
2	Latitude 13°35.385'N Longitude 92°05.477'E	15/02/2007	15 45
3	Latitude 13°35.477'N Longitude 92°05.407'E	16/02/2007	08 00
4	Latitude 13°34.017'N Longitude 91°35.776'E	16/02/2007	11 00
5	Latitude 13°47.014'N Longitude 91°32.013'E	16/02/2007	16 45
6	Latitude 14°27.667'N Longitude 91°02.688'E	17/02/2007	08 00
7	Latitude 14°09.163'N Longitude 91°03.813'E	17/02/2007	11 00
8	Latitude 14°05.640'N Longitude 90°37.434'E	18/02/2007	08 00
9	Latitude 14°12.963'N Longitude 90°36.593'E	18/02/2007	16 30
10	Latitude 13°30.223'N Longitude 90°05.794'E	19/02/2007	08 00
11	Latitude 13°45.481'N Longitude 89°56.228'E	19/02/2007	16 00
12	Latitude 13°11.862'N Longitude 89°45.213'E	20/02/2007	08 00
13	Latitude 13°20.267'N Longitude 89°38.452'E	20/02/2007	16 00
14	Latitude 12°28.973'N Longitude 89°48.766'E	21/02/2007	08 00
15	Latitude 12°37.884'N Longitude 89°50.167'E	21/02/2007	16 00
16	Latitude 12°13.526'N Longitude 90°09.627'E	22/02/2007	08 00
17	Latitude 12°23.528'N Longitude 90°11.855'E	22/02/2007	15 15
18	Latitude 11°25.758'N Longitude 90°15.149'E	23/02/2007	08 00
19	Latitude 11°34.483'N Longitude 90°09.652'E	23/02/2007	15 30
20	Latitude 10°32.288'N Longitude 90°35.879'E	24/02/2007	08 00
21	Latitude 10°40.031'N Longitude 90°29.337'E	24/02/2007	15 30
22	Latitude 10°38.088'N Longitude 91°11.560'E	25/02/2007	08 00
23	Latitude 10°44.688'N Longitude 91°07.848'E	25/02/2007	15 30
24	Latitude 11°08.327'N Longitude 91°45.617'E	26/02/2007	07 30
25	Latitude 11°12.580'N Longitude 91°47.431'E	26/02/2007	12 00

results were calculated as mg/100m^3 of seawater. Zooplankton volume was measured by displacement method. In this method samples were filtered and blotted with filter paper and the mass was transferred to a measuring cylinder having known volume of 4% formalin prepared in seawater. The rise in level of seawater in measuring cylinder was recorded. The difference between final and initial reading gives volume of zooplankton. The results were expressed as mL/100 m^3 of seawater. The number of zooplankton in the samples was calculated by using Sedgewick Rafter Counting Cell. Species of zooplankton were identified up to species level under binocular microscope by referring standard Manuals and Monographs.

The physico-chemical parameters such as salinity and temperature of surface seawater were measured by STD meter, Model STD 1050, Japan, while transparency was assessed by Secchi disc. The data for atmospheric pressure, relative humidity and wind speed was also collected by using ZZ 6-5, Ship Meteorological Instrument.

The species diversity of zooplankton was calculated according to the Shannon-Weiner formula.

$$H' = -\Sigma \, Pi \log_e pi$$

Where Pi = Proportion of the i^{th} species in the collection and H' = Diversity of a theoretically infinite population.

RESULTS

The physicochemical parameters of the oceanic waters are the prime factors indicating the water quality which directly influence primary, secondary and tertiary productivity in marine environment. The quintessence of the results acquired from the physicochemical parameters along the continental slope of Andaman waters revealed that there is no significant variation among the stations for all the parameters studied (Table 2). However the salinity ranged from 32.10 ppt at station-5 to 33.19 ppt at station-19. The values of water transparency varied between 20 m and 35 m at the stations-15 and 10 respectively, whereas the depth of the water column ranged from 2095 m at station-25 to 2795 at station-22. The atmospheric temperature ranged from 26.3°C to 32.6°C at stations-16 and 4 respectively, while surface seawater temperature varied from 23.2°C at station-15 to 28.0°C at stations-2 and 3. The barometric pressure of the study area showed values ranging between 1001 hPa and 1019 hPa at stations-24 and 7, 12, 14 respectively whereas the wind speed was noticed with the minimum of 1.3 m/sec at station-18 to maximum of 10.8m/sec at station- 12. The wide variation for the data on relative humidity was observed ranging from 6% at stations-5, 17, 23 to 90% at station-4.

The qualitative and quantitative estimation of zooplankton, collected from 25 stations along the continental slope of Indian EEZ of Andaman waters of Bay of Bengal, are depicted in Tables 3 and 4. A total of 68 species of zooplankton belonging to 16 groups and 56 genera were recorded during the study.

Copepods were the dominant group at all the stations and their composition of occurrence ranged from 33.99% at station-2 to 85.95% at station-22. Foraminiferans were the subdominant group in

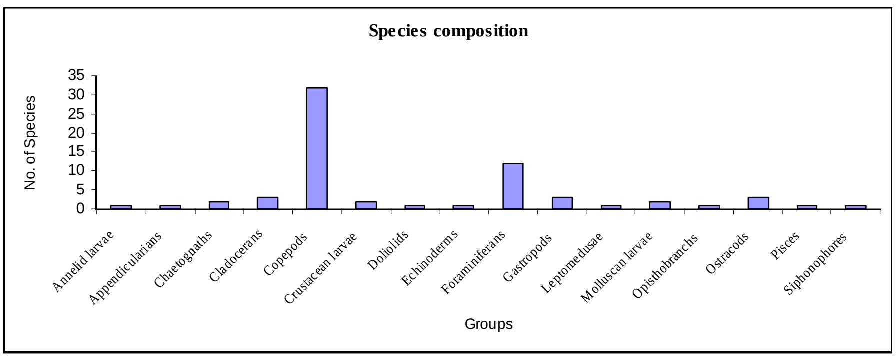

Fig. 2: Species composition of zooplankton in the study area.

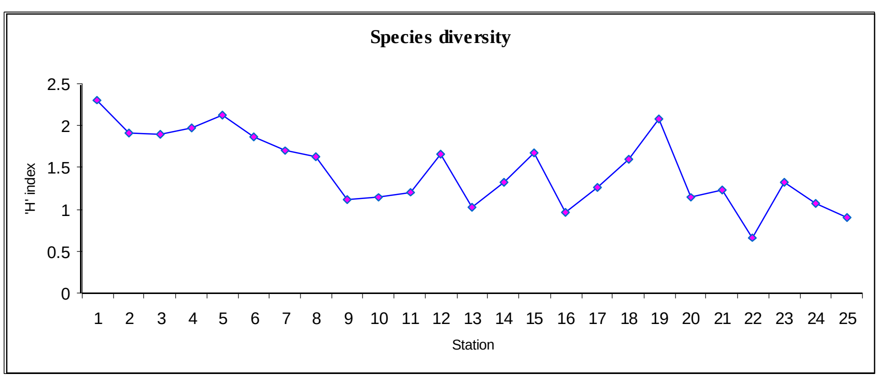

Fig. 3: Species diversity of zooplankton in the study area.

Table 2: Environmental parameters collected at sampling stations.

Station No.	Atm. Temp. (°C)	Seawater Temp. (°C)	Water Depth (m)	Water transparency (m)	Barometric Pressureh (Pa)	Relative humidity (%)	Wind speed (m/sec)	Salinity (ppt)
1	32.0	26.7	2341	25	1018	7	2.2	32.14
2	29.0	28.0	2357	24	1015	8	4.2	32.21
3	31.6	28.0	2331	24	1016	8	5.0	32.16
4	32.6	26.9	2331	25	1018	90	6.2	32.74
5	25.5	24.0	2362	25	1016	37	5.2	32.10
6	27.4	25.3	2429	34	1018	6	6.6	32.24
7	27.0	27.0	2428	33	1019	8	3.1	32.28
8	26.8	26.1	2726	29	1018	5	2.4	32.29
9	27.4	26.1	2730	30	1016	7	9.0	32.74
10	26.7	26.7	2550	35	1017	5	6.0	32.91
11	27.1	26.2	2556	33	1018	7	6.2	32.22
12	26.4	26.4	2652	23	1019	17	10.8	32.69
13	26.4	26.4	2650	22	1015	18	7.8	32.22
14	25.6	25.6	2778	25	1019	17	4.0	32.33
15	24.6	23.2	2728	20	1018	15	4.0	32.58
16	26.3	25.6	2652	29	1016	16	1.9	32.64
17	27.0	25.8	2650	27	1018	6	3.3	33.15
18	27.3	26.1	2683	29	1013	8	1.3	33.15
19	27.5	27.2	2635	28	1012	5	4.5	33.19
20	27.1	26.7	2782	29	1014	7	2.3	33.19
21	28.3	27.2	2780	28	1013	11	3.4	32.89
22	28.1	26.4	2795	30	1014	17	4.9	32.96
23	31.0	27.5	2790	28	1002	6	1.6	32.59
24	28.8	26.4	2096	31	1001	7	2.9	32.62
25	30.8	26.4	2095	33	1013	8	3.7	32.53

most of the stations and their percentage composition varied from 5.44% at station-20 to 24.39% at station-7. Besides that, molluscan larvae and crustacean larvae occurred in considerable composition at quite a number of stations. Copepods were the only group found in all stations of study. The total number of zooplankton groups obtained from the different stations ranged from 6 at station-17 to 15 at stations-1, 5, 19.

Biomass of zooplankton: The biomass of zooplankton in terms of fresh weight, dry weight, volume and numerical density were estimated for all the stations. The fresh weight of zooplankton ranged from 3128mg/100m^3 at station-12 to 6217 mg/100m^3 at station-23, whereas dry weight varied from 792 mg/100m^3 to 2828mg/100m^3 for the same stations. Similarly, the volume of zooplankton ranged between 8.1 and 16.2 mL/100m^3 at station-12 and station-23 respectively. However, the numerical density of zooplankton along the study area showed minimum as 19240 Nos./100m^3 at station-12 and maximum as 47223 Nos./100m^3 at station-23.

Diversity and distribution of zooplankton: Although 68 species of zooplankton recorded from the study area, their distribution is widely varied from 31 species at station-9 to 55 species at station-1 (Fig.2). The species diversity of zooplankton calculated during the present study was ranged from 0.67 at station-22 to 2.31 at station-1 (Fig. 3). The copepod diversity was the dominant as they represented 32 species followed by foraminiferans comprised of 12 species. It is fascinating to note that the copepod *Euterpina acutifrons* was the only species distributed at all 25 stations of the study. Other species had a different degree of distribution. It was also observed that no species of

Table 3: Qualitative and quantitative estimation of zooplankton at different stations along the continental slope of Indian EEZ of Andaman waters of Bay of Bengal.

Station	1	2	3	4	5	6	7	8	9	10	11	12	13
Fresh weight (mg/100m^3)	4345	5281	5852	5020	4758	4670	4105	3850	3771	3710	3522	3128	3642
Dry weight (mg/100m^3)	1217	1878	2010	1722	1300	1202	1027	927	930	802	822	792	823
Volume (mL/100m^3)	21.5	13.2	13.8	12.7	11.0	10.8	10.0	9.3	9.1	8.7	8.7	8.1	8.6
Numerical density (Nos./100m^3)	29415	41523	45202	40752	34218	31560	28520	25630	24521	23237	20280	19240	22460
Group						Percentage Composition							
Annelid larvae	1.41	0.65	-	1.49	1.27	2.38	2.44	1.35	1.08	2.22	1.28	1.96	1.69
Appendicularians	1.41	1.31	-	1.49	1.27	-	1.22	-	1.08	-	2.56	0.98	5.08
Chaetognaths	4.93	7.84	2.91	1.49	1.27	3.57	3.66	2.70	2.15	1.11	1.28	0.98	-
Cladocerans	1.41	3.27	-	-	2.53	2.38	2.44	1.35	1.08	2.22	3.85	0.98	-
Copepods	47.89	33.99	63.11	62.69	56.96	42.86	36.59	56.76	44.08	50.00	43.60	50.98	59.32
Crustacean larvae	8.45	4.58	16.50	11.94	8.86	2.38	1.22	-	21.50	23.35	25.64	7.84	3.39
Doliolids (Cyclomyaria)	2.11	0.65	-	1.49	1.26	-	-	-	1.08	-	1.28	2.94	1.69
Echinoderm larvae	0.70	-	-	1.49	1.27	-	-	-	1.08	-	1.28	1.96	-
Foraminiferans	12.68	7.84	7.77	4.48	3.80	21.43	24.39	10.81	-	-	-	-	-
Gastropods	4.93	3.27	2.91	2.99	2.53	8.33	6.44	9.46	6.45	2.22	3.86	14.70	11.92
Leptomedusae	-	-	0.97	1.49	1.27	-	-	-	-	-	-	0.98	3.38
Molluscan larvae	5.64	1.93	4.86	-	5.05	9.53	10.98	10.82	10.74	8.88	11.54	9.80	1.69
Opisthobranchs	0.70	-	-	4.48	2.53	-	-	-	1.08	-	-	1.96	1.69
Ostracods	2.11	3.27	0.97	-	6.33	3.57	-	2.70	8.60	10.00	2.56	-	3.38
Pisces	4.93	1.31	-	2.99	3.80	2.38	5.75	4.05	-	-	-	2.94	1.69
Siphonophores	0.70	0.65	-	1.49	-	1.19	4.87	-	1.08	-	1.28	0.98	5.08
Total no. of groups	15	13	8	13	15	11	11	9	13	8	12	13	12

Station	14	15	16	17	18	19	20	21	22	23	24	25
Fresh weight (mg/100m^3)	3760	3380	3810	3274	4223	5138	4817	5203	5188	6217	5828	4285
Dry weight (mg/100m^3)	972	812	1027	828	1128	1967	1225	2022	2107	2828	2410	1135
Volume (mL/100m^3)	10.1	9.7	10.9	10.8	12.7	14.3	13.8	14.8	14.0	16.2	15.2	13.5
Numerical density (Nos./100m^3)	22831	21275	25460	29187	30218	46605	35490	40620	32110	47223	45280	13680
Group						Percentage composition						
Annelid larvae	3.00	1.45	2.99	-	-	0.83	-	1.33	-	0.54	-	-
Appendicularians	1.50	1.45	1.49	-	1.14	1.68	-	0.67	-	0.54	0.82	-
Chaetognaths	4.51	2.90	1.49	-	5.14	2.50	1.64	5.33	1.12	6.45	6.56	3.95
Cladocerans	3.00	4.35	2.24	2.63	4.57	9.58	2.17	4.67	-	1.08	0.82	3.95
Copepods	57.14	59.42	42.54	74.34	52.57	66.26	79.89	53.33	85.95	64.52	63.93	56.58
Crustacean larvae	9.02	7.25	2.24	1.32	8.00	3.33	1.63	7.33	2.25	2.69	2.46	-

Table cont.....

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Doliolids (Cyclomyaria)	-	-	-	-	1.72	0.83	-	-	-	0.54	-	-
Echinoderm larvae	-	0.72	-	-	0.57	044	-	0.67	-	-	-	-
Foraminiferans	4.50	5.80	12.69	7.89	8.57	3.76	5.44	8.67	-	9.12	9.84	-
Gastropods	1.50	2.17	-	4.00	4.00	2.50	-	5.33	5.06	3.22	2.46	15.79
Leptomedusae	-	-	-	-	-	0.83	-	-	-	-	-	-
Molluscan larvae	6.02	8.70	31.34	3.95	6.29	0.83	5.43	6.00	3.37	6.99	8.19	5.28
Opisthobranchs	-	-	-	-	-	-	-	-	-	-	-	1.32
Ostracods	3.60	3.62	-	-	2.86	5.42	3.26	3.33	1.69	1.08	1.64	9.21
Pisces	4.71	3.62	-	-	2.86	5.42	3.26	3.33	1.69	1.08	1.64	9.21
Siphonophores	1.50	0.72	-	-	-	0.44	-	0.67	-	0.54	1.64	-
Total no. of groups	12	13	8	6	12	15	8	13	7	13	12	8

foraminiferans was recorded in the stations-9 to 13, where Leptomedusae, doliolids and opisthobranchs had a sporadic distribution throughout the station.

DISCUSSION

The Andaman and Nicobar Islands have steeper continental slope with the depth of about 3500 m on the eastern and western slopes which is very irregular and has not yet been fully chartered. This is the region where the complex air-sea interaction phenomenon releases enormous energy for the genesis of the tropical cyclones which hit the east coast of India and the northeastern coast of Bay of Bengal almost every year (Gouveia et al. 1981). The sea surface temperature observed from the present study site is quite comparable with the earlier records i.e., 27-28°C made by Ramaraju et al. (1981). A noticeable difference was also observed in temperature of the waters below 1500 m on this area, which gradually decreased from 5°C at about 1500 m to 3°C at 1900 m. The salinity of the surface seawater observed through the present study shows the marginal variation among 25 stations (Table 2), which is agreed with the earlier findings varying from 31.87 to 33.6 ppt (Ramaraju et al. 1981) in this region. It is also reported that the thickness of the isohaline layer in the study area ranges from 11 to 31 m depth. The minor fluctuations in the salinity might be attributed to the variable quantities of freshwater inflow through the Straits of Malacca, South China Sea and tropical rain forests of Sumatra Islands.

Zooplankton being secondary producers, play a crucial role in the transfer of energy to higher trophic levels in the sea; the continental slope water of Andaman is oligotrophic in nature with low primary productivity. The production of large quantities of detritus, therefore, appears to supplement the inadequacy of these waters. The biomass of zooplankton in terms of volume calculated through the present observation ranges from 8.1 to 16.2 mL/100m^3. These values were nearly close to the previous records, 1.8 to 14.4 mL/100m^3 at these waters (Madhupratap et al. 1981a). The average biomass values reported from the Bay of Bengal ranged from 6.3 to 8.4 mL/100m^3 during southwest monsoon (Nair et al. 1977) and 2.5 to 15.4 mL/100m^3 during late southwest monsoon (Achuthankutty et al. 1980). Geographical distribution of zooplankton in the Indian Ocean, based on the International Indian Ocean Expedition (IIOE) data, shows highly productive areas around the Somali and Arabian Sea followed by northern Bay of Bengal which is also moderately high biomass (Rao 1993).

Table 4: Distribution and diversity of zooplankton species at different stations along the continental slope of the Indian EEZ of Andaman Waters

Sl No.	Species/Group	Station 1	2	3	4	5	6	7	8	9	10	11	12	13
	(1). Foraminiferans	+	+	-	+	+	+	-	+	-	-	-	-	-
1.	*Amhistegina lessoni* d'Orbigny	-	+	+	+	-	+	+	+					
2.	*Amphisorus hemprichii* Ehrenberg	+	+	-	-	+	-	-	+	-	-	-	-	-
3.	*Cibicides lobatulus* d'Orbigny	+	+	-	+	+	-	+	+	-	-	-	-	-
4.	*Siphonia reticulata* (Czjzek)	+	+	+	+	+	+	+	+	-	-	-	-	-
5.	*Loxostomum limbatum* var *costulatum* (Cushman)	+	+	+	+	+	+	+	+	-	-	-	-	-
6.	*Globigerina sacculifer* (Brady)	-	-	+	-	+	+	+	+	-	-	-	-	-
7.	*Quinqueloculina seminulum* (Linne)	+	-	+	-	+	-	+	+	-	-	-	-	-
8.	*Quinqueloculina subcuneata* Cush.	+	+	-	+	+	+	-	-	-	-	-	-	-
9.	*Rosalnia bradyi* (Cushman)	-	-	+	-	+	+	+	+	-	-	-	-	-
10.	*Rosalina globularis* d'Orbigny	-	-	+	-	-	+	-	+	-	-	-	-	-
11.	*Rosalina floridana* (Cushman)	+	-	+	+	+	+	+	-	-	-	-	-	-
12.	*Triloculina oblonga* (Montagu)	+	+	+	+	+	-	+	-	-	-	-	-	-
	(2). Appendicularians													
13.	*Oikopleura dioica*	+	+	-	+	+	-	+	-	+	-	+	+	+
	(3). Copepods													
14.	*Acrocalanus gracilils* Giesbrecht	+	+	+	+	+	+	-	+	+	-	+	+	-
15.	*Copilia mirabilis* Dana	+	+	+	+	+	+	-	+	-	+	-	+	-
16.	*Eucalanus attenuatus* (Dana)	+	+	+	+	+	+	+	-	-	+	-	-	+
17.	*Nannocalanus minor* (Claus)	+	+	-	-	-	-	+	+	-	+	+	+	+
18.	*Paracalanus parvus*(Claus)	+	+	+	+	+	+	+	+	-	+	+	+	+
19.	*Pseudodiaptomus serricaudatus* (T. Scott)	+	+	+	+	+	+	+	-	+	+	+	+	-
20.	*Pontella danae* Giesbrecht	+	-	-	-	+	+	-	+	+	-	-	+	-
21.	*Pontellina plumata* (Dana)	+	+	+	+	+	+	+	-	+	-	+	+	-
22.	*Isias tropica* Sewell	+	+	+	+	+	+	+	+	+	-	+	-	+
23.	*Corycaeus danae* Giesbrecht	+	+	+	+	+	+	+	-	+	+	+	+	+
24.	*Corycaeus catus* F. Dahl	-	-	-	+	-	+	-	-	-	+	+	+	+
25.	*Corycaeus speciosus*Dana	+	-	+	-	-	+	-	+	-	+	+	+	+
26.	*Euterpina acutifrons* (Dana)	+	+	+	+	+	+	+	+	+	+	+	+	+
27.	*Oithona brevicornis* Giesbrecht	+	+	+	-	+	+	+	-	+	+	+	+	+
28.	*Oithona similis* Claus	+	+	+	-	+	+	+	+	-	-	+	-	-
29.	*Oithona linearis* Giesbrecht	+	-	+	+	+	+	+	+	-	+	+	-	+
30.	*Sapphirina nigromaculata* Dana	-	+	+	+	+	+	+	-	-	-	+	+	-
31.	*Sapphirina ovatolancoelataa* Dana	+	+	+	-	-	-	-	-	+	+	-	-	-
32.	*Scoleithrix danae* (Lubbock)	-	-	-	+	-	-	-	-	-	-	-	-	-
33.	*Macrosetella gracilis* (Dana)	+	-	-	+	+	+	+	+	+	+	+	+	+
34.	*Macrocypris mima*	+	-	+	+	-	-	+	-	-	+	-	+	-
35.	*Metacalanus aurivilli* Cleve	+	-	-	+	+	-	-	+	-	+	-	+	-
36.	*Metis jausseamei* (Richard)	+	+	+	+	+	+	+	+	+	+	+	+	+
37.	*Microsetella norvegica* (Boeck)	+	-	+	-	+	-	+	+	-	+	-	+	-
38.	*Microsetella rosea* (Dana)	+	-	+	-	-	-	-	-	+	+	-	+	-
39.	*Miracia efferata Dana*	+	+	+	+	+	+	+	+	+	+	+	+	+
40.	*Oncaea venusta* Philippi	+	-	-	+	+	-	-	+	-	+	-	-	-
41.	*Lucicutia flavicornis* (Claus)	+	+	+	+	+	+	+	+	+	+	+	+	+
42.	*Labidocera acuta* (Dana)	-	+	+	+	-	+	-	+	+	-	+	-	-
43.	*Longipedia coronata* Claus	+	+	+	+	+	-	+	+	+	+	-	+	+
44.	*Longipedia weberi* A. Scott	+	-	-	-	+	-	-	-	-	+	-	+	+

Table cont...

...Cont Table 4

45.	*Temora discaudata* Giesbrecht	+	+	+	+	+	+	+	+	+	+	+	+	+
	(4). Ostracods													
46.	*Conchoecia indica*	+	+	+	-	+	+	-	+	+	+	+	-	+
47.	*Cypridina sinosa*	+	-	-	-	+	-	-	+	+	+	+	-	-
48.	*Macrocypris minna*	-	+	-	-	+	-	-	-	-	-	+	-	+
	(5). Leptomedusae													
49.	*Proboscidactyla stellata*	-	-	+	+	+	-	-	-	-	-	-	+	+
	(6). Crustacean larvae													
50.	Nauplii	+	+	+	+	+	+	+	-	+	+	+	+	+
51.	Larvae of *Labidocera pavo*	+	+	-	+	-	+	+	-	-	+	-	+	+
52.	Mysis stage of penaeid prawn	+	-	+	-	-	+	-	-	-	-	+	+	-
	(7). Annelid larvae													
53.	Spirobis larvae	+	+	-	+	+	+	+	+	+	+	+	+	+
	(8). Cladocerans													
54.	*Evadena tergestina*	+	+	-	-	+	+	+	+	+	+	+	+	-
55.	*Cypris* sp.	+	-	-	-	-	-	+	-	+	-	-	-	-
56.	*Podon* sp.	-	-	-	-	-	-	+	-	-	-	+	-	-
	(9). Chaetognaths													
57.	*Sagitta enflata*	+	+	+	+	+	+	-	+	+	+	-	+	-
58.	*Sagitta maxima*	-	+	+	+	-	+	-	-	+	+	+	+	-
	(10). Doliolids (Cyclomyaria)													
59.	*Dolioletta gengenbauri*	+	+	-	+	+	-	-	-	+	-	+	+	+
	(11). Echinoderms													
60.	Bipinnaria larva of starfish	+	-	-	+	+	-	-	-	+	-	+	+	-
	(12). Siphonophores													
61.	*Porpita porpita*	+	+	-	+	-	+	+	-	-	-	+	+	+
	(13). Gastropods													
62.	*Janthina janthina*	-	+	-	-	-	+	-	+	-	+	+	+	+
63.	*Janthina fragilis*	-	+	+	+	+	+	+	+	+	-	+	-	-
64.	*Spiratella* sp.	+	-	+	-	-	+	-	+	-	-	-	+	+
	(14). Molluscan larvae													
65.	Veliger larvae	+	+	+	-	+	+	+	+	+	+	+	+	+
66.	Pedi veliger larvae	+	-	-	+	-	-	-	-	-	-	-	-	+
	(15). Opithobranchs													
67.	*Crseis acicula*	+	-	-	+	+	-	-	-	+	-	-	+	+
	(16). Pisces													
68.	Fish eggs	+	+	-	+	+	+	+	+	-	-	-	+	+
	Total number of species	**55**	**43**	**42**	**45**	**50**	**45**	**40**	**40**	**31**	**34**	**36**	**41**	**32**
	Species diversity	2.31	1.92	1.90	1.98	2.12	1.86	1.70	1.62	1.12	1.15	1.20	1.65	1.03

Sl No.	Species/Group	Stations 14	15	16	17	18	19	20	21	22	23	24	25
	(1). Foraminiferans												
1.	*Amhistegina lessoni* d'Orb.	+	+	-	-	+	+	-	+	-	-	+	-
2.	*Amphisorus hemprichii* Ehren.	-	+	+	+	-	+	+	-	-	+	-	-
3.	*Cibicides lobatulus* d'Orb.	-	+	+	-	+	-	-	-	-	-	-	-
4.	*Siphonia reticulata* (Czjzek)	+	-	-	-	+	-	-	+	-	-	-	-
5.	*Loxostomum limbatum* var *costulatum* (Cushman)	+	+	+	+	+	-	+	-	-	+	+	-
6.	*Globigerina sacculifer* (Brady)	+	+	+	-	+	+	-	+	-	+	+	-
7.	*Quinqueloculina seminulum* (Lin.)	-	+	+	+	-	+	+	+	-	+	-	-
8.	*Quinqueloculina subcuneata* Cush.	-	+	+	+	-	+	+	+	-	+	-	-

Table cont...

...Cont Table 4

9.	*Rosalnia bradyi* (Cushman)	-	+	+	+	+	-	+	+	-	-	-	-
10.	*Rosalina globularis* d'Orbigny	+	+	-	+	+	+	+	+	-	-	+	-
11.	*Rosalina floridana* (Cushman)	-	+	-	-	-	+	+	-	-	+	+	-
12.	*Triloculina oblonga* (Montagu)	-	+	-	+	+	+	-	+	-	-	-	-
	(2). Appendicularians												
13.	*Oikopleura dioica*	+	+	+	-	+	+	-	+	-	+	+	-
	(3). Copepods												
14.	*Acrocalanus gracilils* Giesbrecht	+	+	+	+	-	+	+	-	+	+	-	-
15.	*Copilia mirabilis* Dana	-	-	-	+	+	-	+	+	+	-	-	+
16.	*Eucalanus attenuatus* (Dana)	-	-	+	-	+	-	+	-	-	+	+	-
17.	*Nannocalanus minor* (Claus)	+	+	+	+	+	+	+	+	+	+	+	+
18.	*Paracalanus parvus*(Claus)	+	+	+	+	+	+	+	+	+	+	+	+
19.	*Pseudodiaptomus serricaudatus* (T. Scott)	-	-	-	-	-	-	+	-	-	-	-	-
20.	*Pontella danae* Giesbrecht	+	-	-	-	+	-	-	-	+	-	+	-
21.	*Pontellina plumata* (Dana)	+	+	+	+	+	-	-	-	-	-	+	-
22.	*Isias tropica* Sewell	-	+	-	-	-	-	+	-	-	+	-	+
23.	*Corycaeus danae* Giesbrecht	+	-	-	+	-	-	+	-	-	+	-	+
24.	*Corycaeus catus* F. Dahl	+	-	+	-	-	+	-	-	+	+	-	-
25.	*Corycaeus speciosus*Dana	-	+	-	+	-	+	-	+	-	-	-	+
26.	*Euterpina acutifrons* (Dana)	+	+	+	+	+	+	+	+	+	+	+	+
27.	*Oithona brevicornis* Giesbrecht	+	+	+	+	-	+	+	-	+	-	+	-
28.	*Oithona similis* Claus	+	+	-	+	-	-	-	-	-	-	-	+
29.	*Oithona linearis* Giesbrecht	-	-	-	-	+	-	-	-	-	-	+	-
30.	*Sapphirina nigromaculata* Dana	+	-	-	-	+	-	+	-	-	-	+	-
31.	*Sapphirina ovatolancoelata*a Dana	-	-	+	+	-	-	-	-	-	-	-	-
32.	*Scoleithrix danae* (Lubbock)	-	-	+	-	-	-	-	-	-	-	-	+
33.	*Macrosetella gracilis* (Dana)	+	+	+	+	+	+	+	+	+	+	+	+
34.	*Macrocypris mima*	-	+	-	-	-	+	-	-	-	-	-	+
35.	*Metacalanus aurivilli* Cleve	+	+	+	+	+	+	+	+	+	+	+	+
36.	*Metis jausseamei* (Richard)	+	+	+	+	-	+	+	+	+	+	+	+
37.	*Microsetella norvegica* (Boeck)	+	+	+	+	+	+	+	+	+	+	+	+
38.	*Microsetella rosea* (Dana)	-	-	-	-	-	-	+	-	-	-	-	-
39.	*Miracia efferata Dana*	+	+	+	+	+	+	-	-	-	-	+	+
40.	*Oncaea venusta* Philippi	-	-	+	+	-	-	-	+	+	-	-	+
41.	*Lucicutia flavicornis* (Claus)	+	-	-	-	+	+	-	-	+	-	-	+
42.	*Labidocera acuta* (Dana)	+	-	+	-	-	+	-	+	+	-	+	+
43.	*Longipedia coronata* Claus	+	-	-	+	-	+	-	+	-	+	-	-
44.	*Longipedia weberi* A. Scott	+	-	-	+	+	-	-	-	-	+	+	-
45.	*Temora discaudata* Giesbrecht	-	+	+	+	+	+	+	+	+	+	-	-
	(4). Ostracods												
46.	*Conchoecia indica*	+	+	+	+	-	+	-	-	-	-	+	+
47.	*Cypridina sinosa*	+	+	+	+	+	-	-	-	+	+	+	-
48.	*Macrocypris minna*	+	-	+	+	+	+	-	-	-	+	+	+
	(5). Leptomedusae												
49.	*Proboscidactyla stellata*	-	-	-	-	-	+	-	-	-	-	-	-
	(6). Crustacean larvae												
50.	Nauplii	+	+	+	+	+	+	-	-	-	+	+	-
51.	Larvae of *Labidocera pavo*	+	+	+	+	+	+	+	+	+	+	+	-
52.	Mysis stage of penaeid prawn	+	+	+	+	-	-	-	-	+	+	+	-
	(7). Annelid larvae												
53.	Spirobis larvae	+	+	+	-	-	+	-	+	-	+	-	-
	(8). Cladocerans												

Table cont...

...Cont Table 4

54.	*Evadena tergestina*	+	+	+	-	-	+	-	+	-	+	+	+
55.	*Cypris* sp.	+	+	+	+	+	-	-	+	-	-	+	+
56.	*Podon* sp.	+	+	+	-	+	+	+	+	-	+	+	+
	(9). Chaetognaths												
57.	*Sagitta enflata*	+	+	-	-	+	+	+	+	+	+	+	-
58.	*Sagitta maxima*	+	+	+	-	-	+	+	+	+	+	+	+
	(10). Doliolids (Cyclomyaria)												
59.	*Dolioletta gengenbauri*	-	-	-	-	+	+	-	-	-	+	-	-
	(11). Echinoderms												
60.	Bipinnaria larva of starfish	-	+	-	-	+	+	-	+	-	-	-	-
	(12). Siphonophore												
61.	*Porpita porpita*	-	+	-	-	-	+	-	+	-	+	+	-
	(13). Gastropods												
62.	*Janthina janthina*	+	+	-	+	+	+	-	+	-	+	+	-
63.	*Janthina fragilis*	+	+	-	+	+	+	-	+	+	-	+	+
64.	*Spiratella* sp.	-	+	-	+	-	+	-	+	-	+	-	-
	(14). Molluscan larvae												
65.	Veliger larvae	+	+	+	+	+	+	+	-	+	+	+	+
66.	Pedi veliger larvae	+	+	-	-	+	+	+	+	+	-	-	-
	(15). Opithobranchs												
67.	*Creseis acicula*	-	-	-	-	-	-	-	-	-	-	-	+
	(16). Pisces												
68.	Fish eggs	+	+	-	-	+	+	+	+	+	+	+	+
	Total number of species	**43**	**47**	**38**	**38**	**39**	**45**	**31**	**36**	**25**	**38**	**38**	**28**
	Species diversity	1.32	1.67	0.97	1.27	1.60	2.08	1.14	1.23	0.67	1.32	1.07	0.91

Among 16 groups of zooplankton encountered from the present study, copepods were the dominant group at all the stations as their dominance ranged from 33.99 to 85.95%. Madhupratap et al. (1981c) also reported 53.9% of copepods in Andaman waters. However, the present study indicated the increment in the copepod diversity over the period of years. A total of 32 species of copepods recorded from the study area is well agreed with the findings of Madhupratap et al. (1981c) as they recorded 48 species belonging to 33 genera while 32 species with the composition of 52.7% noticed by Goswami & Goswami (1990) in Lakshadweep Islands. However, the productivity of zooplankton was poor in Andaman waters while comparing with Arabian Sea. Goswami (1983) reported 24 zooplankton taxa comprised of 80 species of copepods alone with the composition of 65% in the coastal waters of Goa. In general, the composition of copepods was constituted by a number of neritic and oceanic species. Forminiferans were also fairly abundant in the study area, although they were not reported in the earlier studies around these oceanic waters. The species diversity indices for the zooplankton of Andaman waters indicted that the values were moderately low (0.67-2.31) when compared with Lakshadweep waters (0.2-4.0) observed by Achuthankutty et al. (1989). The low biomass, density and diversity of zooplankton in the oceanic waters might be attributed to the low primary productivity (273mg C/m^3/day, Battathiri & Devassy 1981) coupled with the lack of adequate level of nutrients in seawater which are responsible for the enhancement of productivity. Furthermore, the variation in the zooplankton composition might be due to the diel vertical migration of these organisms and influence of oceanic currents.

The epitome of the results obtained for the zooplankton biomass distribution and density form the present study revealed that the values for these variable increased from oceanic waters to neritic/ coastal waters of Andaman (89° to 93° latitudes). Similar trend of variations was also observed by

Rezai et al. (2003) in Straits of Malacca where the biomass of zooplankton was generally higher in waters close to the near coastal areas than in the offshore areas. The availability of nutrients in higher concentration, which leads to primary productivity in the coastal waters, could be the causative factor for this trend of variation.

ACKNOWLEDGEMENT

The author thanks the Director, Zoological Survey of India, Kolkata and the Officer-in-Charge, Marine Biological Station, Zoological Survey of India for providing necessary facilities to undertake this study. The facilities extended by the Director General, Fishery Survey of India, Mumbai, Dr. P. Sivaraj, Zonal Director, and Dr. L. Ramalingam, Sr. Fisheries Scientist, Fishery Survey of India, Chennai and Captain and Engineers of *MFV Matsya Drushti* are gratefully acknowledged.

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