Research in
AGRICULTURE, LIVESTOCK and FISHERIES
ISSN : P-2409-0603, E-2409-9325
An Open Access Peer Reviewed Journal

Open Access
Research Article

Res. Agric. Livest. Fish.
Vol. 2, No. 1, April 2015: 151-160

ABUNDANCE AND COMPOSITION OF ZOOPLANKTON AT SITAKUNDA COAST OF CHITTAGONG, BANGLADESH

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ARTICLE INFO

Received
19.03.2015

Accepted
12.04.2015

Online
19.04.2015

Key words
Mangrove area
Zooplankton
Copepoda
Fish larvae

ABSTRACT

Eight groups of zooplankton were found at Sitakunda coast, Chittagong, northeastern part of the Bay of Bengal during January to June 2007. The identified groups were Appendicularia (2.46%), Chaetognatha (2.45%), Cladocera (2.31%), Copepoda (26.05%), Ctenophora (5.86%), Crustacean zooplankton (21.64%), Ichthyoplankton (17.77%) and Meroplankton (21.45%). Abundance of zooplankton varied from 413 to 7730 individuals/m^3.Mangrove vegetate area (station- VI) has the highest abundant possibly due to the organic and inorganic matters dissolved in the water while ship breaking area (station- IV) has the lowest abundant. Zooplankton population was significantly ($p>0.05$) higher in the mangrove vegetate area than the fishermen community area and ship breaking area. The mangrove vegetate area has the highest composition (57.06%) of zooplankton than the fishers community area and ship breaking area (29.77% and 13.16%, respectively). *Calanus* sp. (12.29%) belonging to Copepods and fish eggs (9.25%) belonging to Ichthyoplankton were the most abundant and *Oikopleura albicans* (0.66%) from Appendicularia, *Metapenaeus brevicornis* (0.71%) and *Metapenaeus monoceros* (0.90%) belonging to Crustacean larvae were the lowest abundant species found at three major investigated area.

To cite this article: MSK Khan, SA Uddin and MA Haque. 2015. Abundance and composition of zooplankton at sitakunda coast of Chittagong, Bangladesh. Res. Agric. Livest. Fish. 2 (1): 151-160.

INTRODUCTION

Zooplankton is an aquatic animal community that has limited swimming capacity against the ambient currents. Even with their quite limited swimming capacity, they carry out day-night periodic movements of hundreds of meters. They prefer to feed at night on the water surface and effectively graze the phytoplankton, and hence they referred to as living machines. They habitually represent a vital link between the microbial portion and the large grazers (Laval-Peuto et al., 1986; Pierce and Turner, 1994).The zooplankton, secondary consumer plays a key role in the food chain of aquatic ecosystem by transferring energy from phytoplankton to higher tropic levels leading to the production of fisheries to human exploitation. The health of marine ecosystems inherently linked to the abundance of zooplankton and their biodiversity. The potentiality of marine pelagic fishes directly or indirectly depends on the availability of zooplankton. In the aquatic ecosystem zooplankton are being used as the indicator species for the physical, chemical and biological processes due to their universal distribution, small size, and rapid metabolic and growth rates (Heinbokel, 1978; Fenchel, 1987), huge density, tinier life span, drifting nature, great species diversity and diverse tolerance to the stress (Gajbhiye, 2002).

A survey report of FAO (1985) stated that the tidal areas of Bangladesh are relatively rich in zooplankton. The abundance of zooplankton and their ecology in the coastal and estuarine environment of Bangladesh is little studied. Islam and Aziz (1975) studied on zooplankton of the northeastern part of the Bangladesh coastal area and identified a total of 18 genera and 18 species. Bhuyain et al. (1982) made an observation on the macro-zooplankter of the continental shelf of the Bay of Bengal and reported the occurrence and distribution of 18 calanoid copepods. Ali et al. (1985) recorded a periodic variation of zooplankton in the coastal estuarine water in the southeastern part of Bangladesh. The major groups of zooplankton are copepoda, decapoda, chaetognatha, cladocera and fish and shellfish larvae. Zooplankton diversity of salt marsh habitat in the Bakkhali river estuary, Cox's Bazar, Bangladesh has also studied by Ali (2006).

Coastal zone contains critical terrestrial and aquatic habitats, such as mangrove forests, wetlands and tidal flats. Sitakunda coast under the Chittagong district, northeastern part of the Bay of Bengal is adjacent to the Sandwip Chanel, having tidal mangrove, ship breaking yard and fishermen community area and an important source of fisheries resources. The purpose of this study is to provide more information on the abundance and composition of the zooplankton community on the Sitakunda Upazila coastal water, north of the Chittagong city, which is currently affected by ship-breaking activity on the shore.

MATERIALS AND METHODS

Sitakunda coast, which is the northeastern part of the Bay of Bengal, located in between 22°22′ and 22°42′ northern latitudes and in between 91°34′ and 91°48′ east longitudes. For the present investigation this coastal area was divided into three pre define activities community with six sampling stations (Fig. 1).Station-I (Salimpur) and station-II (Saidpur) was considered as a fishermen community area, station-III (Grisubedar Ship yard) and station-IV (PHP Ship yard) located in Bhatiari area was considered as ship breaking yard and station-V (Barabkunda) and station-VI (Muradpur) was considered as a tidal mangrove vegetate area.

Zooplankton sampling and isolation

The sampling was conducted during January to June 2007 by using a wooden boat. Zooplanktons were collected using a net (Hydrobios model 55 µm mesh size) ending with a cod end to retain the organisms which was towed horizontally. A flow meter (FMC 0.3) was attached within the aperture of the net to measure the amount of water displaced. At each station, the net was slanted three times for 45 minutes each while the boat was moving slowly. The sampling was taken place in the sub-surface layer (0.2m-0.5m) of the water column. Abundance of organisms was calculated from the volume of water displaced through the plankton net and expressed as numbers of individuals per cubic meter. Immediately after collection, the samples were preserved in 4% formalin (45% formaldehyde) in 250 ml plastic bottles and labeled. Then the samples brought to the laboratory of Institute of Marine Sciences and Fisheries, University of Chittagong for qualitative and quantitative analysis. For efficient sorting, a vital stain "Rose Bengal" was added and the sample left for overnight. Zooplanktons were sorted out with the help of fine brushes, needle, forceps and an inverted microscope (Model-Axiovert 25, CFL) and Sedgwick-Rafter chamber was used for counting.

Major groups were identified by the works of Patel (1975), Kasturirangan (1963), Koga (1984), Zafar and Mahmud (1989) for Copepoda; Wickstead (1965) and Smirnov (1996) for Cladocera; Srinivasan (1988), Andreu et al.(1989) and Bieri (1991) for Chaetognatha; Haq and Hasan (1975), Muthu et al. (1978), Amin and Mahmud (1979), Paulinose (1982), Deshmukh and Kagwade (1987), Rothlisberg (1983, 1987), Tirmizi et al. (1987) and Zafar (2000) for Crustacean zooplankton; Peter (1969), Newell and Newell (1979), Omori and Ikeda (1984), Zafar and Mahmud (1989), Olivar and Fortuno (1991) and Goswami & Padmavati (1996) for Meroplankton and Ichthyoplankton.

Data analysis

The zooplankton abundance was calculated using the following formula:

a. Total number of zooplankton specimens =Total counts of the specimens (say x)/ Volume of water filtered (V).
   No. /m3 = x/v (No. can also be expressed/ 100 m^{-3} or 1000 m^{-3}).
b. Total number of specimens of a particular zooplankton taxon
   = Total counts (x)/Volume of water filtered (Y)
   No. /m3 = x / y.
   SAS (2003) was used to analyze the data for analysis of variance (ANOVA).

RESULTS

Eight groups of zooplankton were identified, i.e. Appendicularia, Chaetognatha, Cladocera, Copepoda, Ctenophora, Crustacean zooplankton, Ichthyoplankton and Meroplankton at six different stations on Sitakunda coast, Chittagong, Bangladesh. In total 10 known species of Crustacean, 7 known and unidentified species of Meroplankton, 6 species of Copepoda, each 2 species of Appendicularia, Ctenophora and Ichthyoplankton and each one species of Cladocera and Chaetognatha were identified during the investigation. Abundance of zooplankton varied from 413 to 7730 individuals/m^3 (Table 1). Figure 2 (A and B) shows the composition of the various zooplankton group on Sitakunda coast and the contribution of those groups in each station.

Appendicularia

This class includes *Oikopleura albicans* and *O. dioica*, comprising together 2.46 % of the total zooplankton population (Table 1). They live in the pelagic zone, especially in the upper sunlight portion of the ocean. These zooplanktons were found in all stations, but in low number (63 indi/m^3) was observed in the Bhatiyari area near the ship breaking yard and large number (1150 indi/m^3) were observed in the mangrove vegetate area. Among them, a few *O. albicans* (12 indi/m^3) was found in ship breaking area.

Cladocera

Cladocera the lowermost group made only 2.32 % of the total zooplankton population and *Evadue sp*. was the only identified zooplankton, which was very common in all stations. The abundance of *Evadue sp.* was 56 indi/m^3 to 503 indi/m^3 (Table 2).

Ctenophora

The ctenophores designed 5.86 % of the total zooplankton population. This group composed of *Bolinopsis vitrea* and *Pleurobrachia* sp. and the percentage occurred 2.81 % and 3.05 %, respectively.

Chaetognatha

Chaetognatha were the second lowermost group, forming 2.45 % of total zooplankton (Table 1). In mangrove vegetate and fishermen community area, they found great number compare to ship breaking area near Bhatiyari. The highest abundance was 507 indi/m^3 and the lowest was 64 indi/m^3.

Copepoda

Copepods were the most abundant group encompassing 26.05 % of the total zooplankton population. This group consisted with *Calanus* sp., *Microsetella* sp., *Oncaea* sp., *Calanopia* sp., *Coryeacus* sp. and *Oithona* sp. During the study highest abundance 1,937 indi/m^3 was found in mangrove vegetate area (station VI) due to the high number of *Calanus* sp. while station-III & IV (Ship breaking area) was the lowest abundance 2 indi/m^3 and 7indi/m^3, respectively owing to *Oncaea* sp. *Calanus* sp. was the most abundant and found at all stations, comprising 12.29 % of the total zooplankton population (Table 2).

Crustacean zooplankton

Crustaceans were the second most plentiful group of zooplankton, founding 21.64% of the total population. This group was composed of *Acetes* larvae (7.87%), *Lucifer* larvae (4.14%), *Penaeid* larvae (7.41%) and *Sergestes* larvae (2.22%). The *Acetes* larvae were very common in this study. *Assets erythraeus* (2.67%), *Acetes indicus* (2.69%) and *Acetes japonicas* (2.51%) accounted for the majority of the crustacean zooplankton. The highest number (819 indi/m^3) of *Acetes erythraeus* occurred in the mangrove vegetate area (i.e. st. VI) and the lowest number (19 indi/m^3) in ship breaking area.

Lucifer

Lucifer sp. was very common and made only 4.14 % of the total zooplankton population. The amount of *Lucifer sp.* was quite high in mangrove vegetate and fishermen community water while the number was lower in the ship breaking area. The average abundance showed substantial differences in those tables.

Shrimp larvae

Penaeus and *Metapenaeus* larvae were regular component in the Penaeid zooplankton, constituting 5.81% and 1.61% of the total zooplankton population respectively. Among them *P. indicus* was most dominant species (1473 indi/m^3) occurred in mangrove vegetate area (station VI). The abundance was very low at ship breaking area for all species, i.e. *P. monodon* (19 indi/m^3), *P. indicus* (100 indi/m^3), *P. merguiensis* (14 indi/m^3), *Metapenaeus monoceros* (12 indi/m^3) and *Metapenaeus brevicornis* (15 indi/m^3).

In all stations, *Sergestes similis* also found in worthy number. In mangrove vegetation (926 indi/m^3) and fishermen community area (395 indi/m^3) the number was high, but in the ship breaking area (74 indi/m^3) the number was very low.

Meroplankton

Meroplankton consisted of Polychaete larvae (5.28%), Snail veliger (2.77%), Snail larvae (2.34%), Barnacle nauplius (2.18%), Barnacle cyprid (2.36%), Crab megalopa (3.12%) and Crab zoea (3.41%). Polychaete larvae were very common zooplankton and high in number. The average abundance in all stations showed no significant differences. Snail veligers and Snail larvae were also available at all stations. The amount of Barnacle nauplius and Barnacle cyprid was high in mangrove and fishermen community area rather than ship breaking area.

Ichthyoplankton

Fish eggs and larvae were very common and high in number, creating 9.25 % and 8.52% of total zooplankton respectively. Fish eggs and larvae found available in all investigated areas. The average abundance showed no significant differences between mangroves vegetate area and ship breaking area.

DISCUSSION

A sensible variation was observed in the zooplankton abundance in all stations. Table 2 shows the abundance of zooplankton in all sampling areas. Mangrove vegetate area have the highest abundant 35,755 individuals/m^3 and fishermen community area and ship breaking yard has 18,825 individuals/m^3 and 8,321 individuals/m3, respectively around the sampling period. Statistical analysis showed that the abundance of zooplankton population in the mangrove vegetate area was significantly higher ($p>0.05$) than the fishers community area and ship breaking area. The mangrove vegetate area has the highest composition (57.06%) of zooplankton then the fishers community area and ship breaking area (29.77% and 13.16%, respectively).

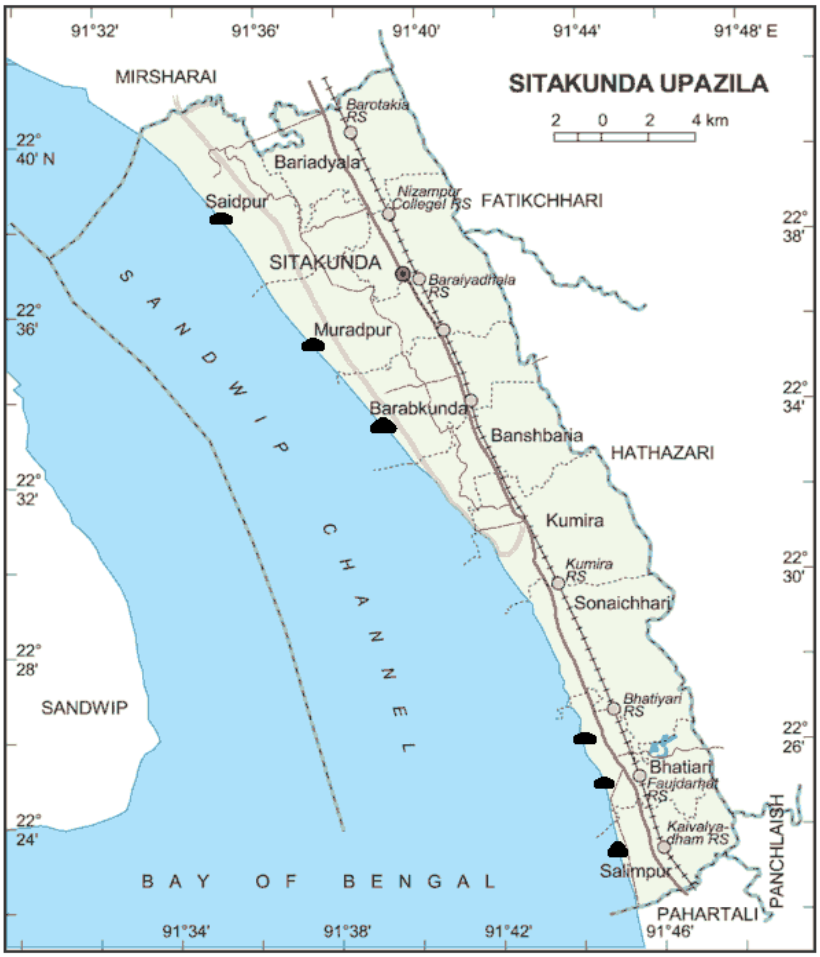

Figure 1. Map of study area (Sitakunda coast) with the location of sampling stations.

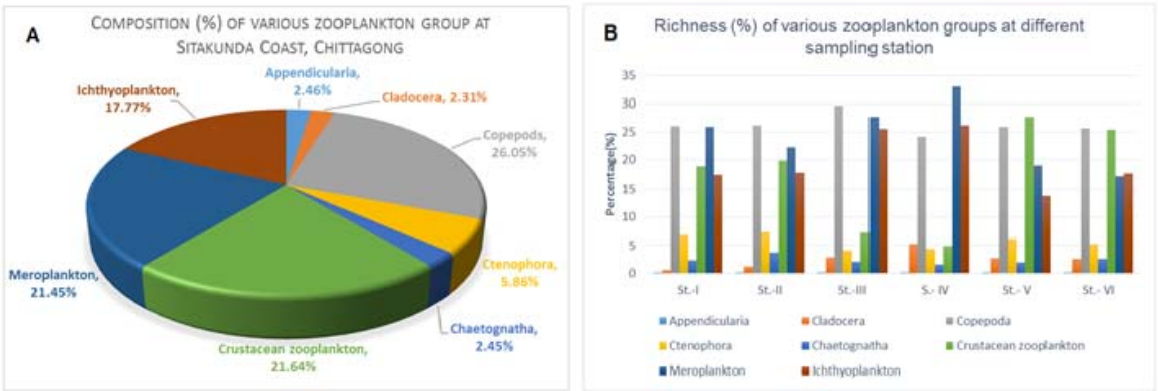

Figure 2. Percent composition of various zooplanktons (A) and their richness at different sampling station (B).

Table 1. List of major groups and species of zooplankton identified and their number and percentage at Sitakunda coast, Chittagong

Group	Species	Total No.	Percentage (%) within group	Overall (%)
Appendicularia	*Oikopleura dioica*	1135	73.32	1.80
	Oikopleura albicans	413	26.68	0.66
Copepods	*Calanus* sp.	7730	47.18	12.29
	Microsetella sp.	4993	30.48	7.94
	Oncaea sp.	852	5.20	1.35
	Calanopia sp.	639	3.90	1.01
	Coryeacus sp.	1312	8.01	2.08
	Oithona sp.	857	5.23	1.36
Cladocera	*Evadue* sp.	1457	43.17	2.32
	Pleurobrachia sp.	1918	56.83	3.05
Ctenophores	*Bolinopsis vitrea*	1767	100	2.81
Chaetognatha	*Sagitta* sp.	1544	100	2.45
Crustacean	*Lucifer* sp.	2602	19.11	4.14
	Sergestes similis	1395	10.25	2.22
	Penaeus monodon	1361	10.00	2.16
	Penaeus merguiensis	818	6.00	1.30
	Metapenaeus monoceros	566	4.16	0.90
	Metapenaeus brevicornis	447	3.28	0.71
	Penaeus indicus	1473	10.82	2.34
	Acetes erythraeus	1694	12.44	2.67
	Acetes indicus	1681	12.35	2.69
	Acetes japonicus	1577	11.58	2.51
Meroplankton	Polychaete larvae	3320	24.61	5.28
	Snail veliger	1740	12.90	2.77
	Snail larvae	1472	10.90	2.34
	Barnacle nauplius	1369	10.15	2.18
	Barnacle cyprid	1483	10.99	2.36
	Crab megalopa	1960	14.53	3.12
	Crab zoea	2148	15.92	3.41
Ichthyoplankton	Fish eggs	5820	52.07	9.25
	Fish larvae	5358	47.93	8.52
Total		**62901**		**100**

Table 2. Zooplankton abundance (individual/m^3) and their averages in fishers community area (St.-I and II), ship breaking area (St.-III and IV) and mangrove vegetate area (St.-V and VI) at Sitakunda coast, Chittagong.

Species	St-I	St-II	St- III	St- IV	St- V	St- VI	Average	Total	Overall %
Acetes erythraeus	109	98	32	19	372	487	186.17	1117	1.78
Acetes indicus	211	47	9	3	112	179	93.5	561	0.89
Acetes japonicus	149	1236	867	693	1884	1937	1127.67	6766	10.76
Barnacle nauplius	357	913	118	107	1353	1749	766.17	4597	7.31
Barnacle cyprid	297	112	2	7	286	366	178.33	1070	1.70
Bolinopsis vitrea	218	49	98	24	177	189	125.83	755	1.20
Calanopia sp.	102	118	79	81	298	419	182.83	1097	1.74
Calanus sp.	1113	94	98	72	253	311	323.5	1941	3.09
Coryeacus sp.	317	119	118	214	447	503	286.33	1718	2.73
Crab megalopa	277	399	66	91	533	427	298.83	1793	2.85
Crab zoea	319	307	107	87	472	576	311.33	1868	2.97
Evadue sp.	56	354	87	64	321	507	231.5	1389	2.21
Fish eggs	719	565	27	49	703	754	469.5	2817	4.48
Fish larvae	892	188	72	2	521	405	346.67	2080	3.31
Lucifer sp.	504	201	12	7	425	532	280.17	1681	2.67
M. brevicornis	37	127	2	12	254	327	126.5	759	1.21
M. monoceros	56	83	7	5	211	204	94.333	566	0.90
Microsetella sp.	753	49	12	3	142	204	193.83	1163	1.85
Oikopleura albicans	63	201	58	42	477	518	226.5	1359	2.16
Oikopleura dioica	127	147	23	19	577	819	285.33	1712	2.72
Oithona sp.	29	181	54	34	689	512	249.83	1499	2.38
Oncaea sp.	79	173	36	27	554	638	251.17	1507	2.40
Penaeus indicus	177	649	451	521	553	589	490	2940	4.67
Penaeus merguiensis	96	247	117	98	537	429	254	1524	2.42
Penaeus monodon	184	171	68	59	414	501	232.83	1397	2.22
Pleurobrachia sp.	402	209	17	21	346	419	235.67	1414	2.25
Polychaete larvae	557	119	9	54	483	521	290.5	1743	2.77
Sagitta sp.	211	321	236	361	354	411	315.67	1894	3.00
Sergestes similis	207	431	276	234	427	461	339.33	2036	3.24
Snail larvae	259	1031	612	503	1236	1719	893.33	5360	8.52
Snail veliger	312	697	473	565	1019	1712	796.33	4778	7.60
Total kind	31	31	31	31	31	31	31	31	
Total individual	9189	9636	4243	4078	16430	19325	10483.5	62901	100%

Large carnivorous zooplankters namely, the Ctenophora and Chaetognatha are planktonic predators of fish larvae. The correlation between fish larvae and their predators, i.e. Chaetognatha, and Ctenophora was 0.8611, 0.8083 respectively, at 95 % confidence. The correlation of fish larvae and Copepoda, which their prey species was 0.9100 at 95 % confidence.

At all stations, the dominant species in the Sitakunda coast were as *Calanus sp.*, *Microsetella* sp. belonging to Copepods, fish eggs and fish larvae belonging to Ichthyoplankton, Polychaete larvae and Crab zoea belonging to Meroplankton and *Lucifer* sp. belonging to Crustacean larvae. All most all species were lower at station III and IV, which was denoted as the ship breaking area probably due to oil pollution and other human activities. Copepods were the main contributors in the present investigation. Wimpenny (1966) and Omori and Ikeda (1976) reported that copepods are the most abundant zooplankton communities sampled in the world ocean. Houde and Lovdal (1982) showed that copepods are important components of larval fish food. The present investigation on Crustacean zooplankton found five commercially important species such as *Penaeus monodon, Penaeus merguiensis, Metapenaeus monoceros, Metapenaeus brevicornis* and *Penaeus indicus. Penaeus* and *Metapenaeus* have worldwide commercial importance in fisheries and aquaculture, and the larvae of many species have been reared in the respected shrimp hatchery.

In general, particularly in coastal waters, the composition and abundance of zooplankton varied remarkably due to the seasonal variations and their sheltered systems like coastal and mangrove waters. On the Sitakunda coast, in the mangrove vegetate area, total abundance of zooplankton was higher than the fishermen community area and ship breaking area. This is because of organic and inorganic matters dissolved in the water, which is ultimately support directly or indirectly to the zooplankton growth. Similar results have also been reported in the coastal waters of Bangladesh by Bhuiyan et al. (1982), Ali et al. (1985) and Zafar (2000).

Fraser (1969) and Suwanrunpha (1983) reported that big carnivorous zooplankters namely Ctenophora, Chaetognatha, Medusae and Siphonophora are planktonic predators of fish larvae. In this study, a high correlation between fish larvae and their predator, especially chaetognatha was observed. Thus, their presence in numbers of zooplankton could have a serious effect on the recruitment of larval fish and could be very significant for the fish stocks and for the fishing industry. Houde and Lovdal (1982), Balbontin et al. (1986) and Anderson (1994) presented that small zooplankton e.g. Copepods, Tintinnids, Cladocerans, larval molluscs etc. are important components of larval fish food. The present study found a high correlation between fish larvae and their prey, especially copepods. Positive correlations indicated that fish tend to aggregate where the standing stock of copepods is highest. However, Sameoto (1972) found no significant correlation between standing stock of copepods and the valued abundance of herring larvae. Manyauthors point out that zooplankton was influencing on fisheries. Krisshnapillai and Bhat (1981) found that the fish-catching rate was maximum in while the zooplankton productive rate was high. Jacob et al. (1981) reported that the peak times in the zooplankton biomass coincided with the peak periods of pelagic fisheries.

Unfortunately, information about the fisheries in the present studied areas was not available, so that correlation of fish catch and zooplankton abundance was not measured.

CONCLUSION

The zooplankton abundance in the three locations showed a much different from each other. The zooplankton abundance in mangrove vegetate area was higher than the fishermen community and ship breaking area. The abundance and composition of the zooplankton can be used as an indicator of marine productivity.

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