ZOOPLANKTON OF AGHANASHINI ESTUARY
CHAPTER V

Zooplankton of Aghanashini estuary.

Introduction

The productivity of an aquatic ecosystem depends upon the quality and quantity of the planktonic production. Generally the planktons are considered as an index of fertility of an ecosystem and biological yield depend to a great extent on adequate planktonic production. The phytoplankton and nekton act as primary producers of an eco-system, whereas the zooplankton functions as an intermediate link between primary producers and higher trophic levels.

According to Brown Lee and Jacobs (1987) zooplankton are those animals that live suspended in water column, move passively with water current, are an integral part of most aquatic-ecosystems. They provide an important trophic pathway in which biomass is moved up the food-web from very productive phytoplankton and bacteria to higher trophic levels including many commercially important fish and clam species. The production of feacal pellets by some of the zooplankton results in the rapid transport of nutrients and carbon from the surface layer to the benthos. Because of the pivotal trophic position of zooplankton, they could also play an important role in concentrating and in transporting toxic compounds to the food web.

Zooplankton includes all drifting animals. A congregation of organisms represented by numerous groups, mostly invertebrates constitute zooplanktonic
community. The most abundant members of zooplankton are largely herbivore crustacean copepods, the omnivorous euphausids and carnivorous chaetognaths. Other animal groups such as foramenifera, tunicata, amphipoda, mollusca, ceolenterata, ctenophores and radiolarians become locally dominant but generally make up less than 50 per cent of the total zooplanktonic biomass.

The different aspects of plankton were studied worldwide. Among them few important contributions are, Cronin et al (1962), Takahashi and Parsons (1972), Wooldridge (1976), Alves pekala (1980), Buttolph (1981), Grindley (1981), Turner (1982), Miller (1983), Por and Dor (1984) and Williams (1984). These works mostly include researches on phytoplankton and zooplankton of estuaries and adjacent coastal waters of world oceans. Raymont (1983) had given exhaustive treatise on the plankton productivity of oceans.

Tropical estuaries experience only a limited fluctuation in temperature but environment remains vigorous because of extreme changes in salinity and thus species composition in these systems is fairly distinct from the counterparts in the temperate regions (Grindley, 1981, Miller, 1983, Madhupratap, 1987).

A brief review of the literature on investigations of planktons of estuaries and coastal waters of India shows that there is considerable research work on some selected estuaries such as Hoogly- Matlah, Vellar, Cochin back waters, Mandovi – Zuari. There are some reports on other estuaries such as Godavari, Kadinamkulam backwater, Netravati- Gurupur and Kali. These studies related to

Apart from this, there are few reports on the specialized studies on particular components of plankton; Estuarine copepods in India (Pillai, 1971), Copepodes of Godavari estuary (Chandra Mohan, 1977), Cladocera of Mandovi-Zuari estuary (Goswamy and Devassy, 1991), Planktonic coelenterates of vasista-Godavari estuary (Sai Sastry and Chandra Mohan, 1989), Chaetognaths of Cochin back waters (Nair, 1974).
Though, there are some reports on planktonology of estuaries and near shore waters along the southeast and southwest coast of India, very little information is available on the Kanara coast of Karnataka state, India (Jhingran 1982), except from the reports on Planktons of Noarth-Kanara coast in relation to pelagic fishes (Ramamurty 1965), Zooplankton of inshore water of Karwar (Nair 1978; Naomi 1986), Zooplankton of Netravati-Gurupur estuary (Bhat and Gupta, 1983), and a preliminary report on the plankton of Kali estuary (Kusuma et al 1988) and Zooplankton of Sharavati estuary (Nakadi, 1992).

There are five estuaries in North Kanara District namely, Kali, Gangavali, Aghanashini, Sharavati, and Venkatapur. All these estuaries join the Arabian sea. These estuaries support considerable fish, prawn and molluscan resources of economic importance. Even though some work is done about the planktons of Kali and Sharavati estuary, no systematic work is done about the plankton of Aghanashini estuary. Therefore in the present work, an attempt is made to investigate zooplanktonic species distribution in Aghanashini estuary; for the period of one year. The investigation covers pre-monsoon (February to May), monsoon (June to September), and post-monsoon seasons (October to January).

**Materials and Methods:**

The plankton samples were collected at the interval of one month from different stations of investigation for a period of one year. The samples were
collected with Heron-Tranter net with mouth area of 0.25 m and mesh size of 330μm. Samples were collected by surface horizontal hauls for five minutes at every station. The amount of water filtered was calculated. The zooplankton samples collected were fixed and preserved in 5% formalin for further analysis. In laboratory, the samples were analyzed for species composition and concentration of particular planktonic groups.

**RESULTS**

The zooplankton of Aghanashini estuary was constituted by Protozoans, Hydromedusae, Ctenophores, Polychaetes, Cheatognaths, Mollusca, Copepods, Decapodes, Amhipods, Larval forms, Fish eggs and larva and some other miscellaneous groups. The month wise total zooplankton are expressed in number per meter $^3$ found at each station at different seasons and the percentage of the individual group of zooplankton are expressed as No/ m$^3$ is given in Tables 5.1 to 5.4 for four stations respectively. It is evident from the data that the total zooplankton per meter $^3$ for the year under study was maximum at station 1, (5845/m$^3$), followed by station 2, (5186/m$^3$) and station 3, (2602/ m$^3$) whereas it was remarkably low at station 4, (2052/ m$^3$) (Fig.5.2).

The group wise availability of zooplankton shows that copepods were found throughout the year in all four stations and dominates the zooplankton of Aghanashini estuary. The larval forms dominated by copepod nauplius represents the second largest group of zooplankton and found throughout the period of
investigation in all four stations. The fish eggs and larvae represent the third large group of zooplankton and observed in all four stations throughout the year of investigation. Planktonic protozoans, generally dominated by Acenthometron Sp., occupy the fourth place but their distributions are restricted to particular seasons of the year; among different species. The hydro-medusae, ctenophores, polychaetes, chetognaths, molluscs, decapods, protochordates and other miscellaneous species are confined to some stations at different seasons and not found in all four stations throughout the year.

Detailed information on the month wise availability of zooplankton including species is given in tables 5.1 to 5.4. respectively. It is possible to draw some generalization from this data, although the distribution of each group differs from month to month and station to station. The copepods were found throughout the year in all four stations, were relatively abundant during the pre-monsoon than the post-monsoon and monsoon periods. The maximum number of copepods were recorded at Station 1, during pre-monsoon period (4496/ m$^3$). Though the copepods were few in number at station 4, they were relatively more in number during the pre-monsoon period followed by post-monsoon and monsoon periods.

The phylum coelenterata is represented by hydromedusae, is observed only in station 1 and station 2. At station 1, they were found in all three seasons, but relatively more concentration during pre-monsoon period (31/ m$^3$), and less
during monsoon period (3.5 m³). They were very rare at station 2, observed only during monsoon (0.25 m³); and absent during other seasons.

The ctenophora represented by pleurobrachia sps. were observed at station 1 and station 2 only. The distribution of these species is confined to post-monsoon and pre-monsoon periods and was not observed during monsoon months. The concentration of pleurobrachia is comparatively more at station 1, during pre-monsoon months (27 m³) than post-monsoon period (14 m³). At station 2, the concentration during pre-monsoon was 4 m³ and less in Post-monsoon months (1 m³).

Tomopteris and sagitella sps. represent the planktonic polychaetes, of Aghanashini estuary. The distributions of planktonic polychaetes are restricted to station 1 and station 2. The station 1 showed more concentration than station 2. The concentration of planktonic polychaetes during pre-monsoon was 29 m³ and 14 m³ during post-monsoon at station 1, and not found during monsoon months. The planktonic polychaetes were observed only during pre-monsoon months at low concentration (0.25 m³) in station 2.

The cheatognatha, represented by sagitta sps. are observed only at station 1 and station 2 in low concentrations. At station 1, they were found throughout the year of investigation, whereas at station 2, they were found only during pre-monsoon months. The station 1 showed about 4 m³ during monsoon,
about 11.5/m³ during post-monsoon and about 15/m³ during pre-monsoon period. At station 2, about 4/m³ only during pre-monsoon months and were not observed during other two seasons. They were not at all observed in other two stations throughout the year of investigation.

The planktonic molluscans of Aghanashini estuary were represented by Heteropod and Creseis Sp. The molluscan plankton were also observed at first two stations of the estuary and not observed in other two stations. Both molluscan species were observed throughout the year of investigation at station 1, whereas heteropods were not found during the post-monsoon months at station 2, during post-monsoon months. The maximum number is observed during March 2000, i.e 20/m³ and 16/m³ respectively.

The Decapods were represented by Lucifer species in Aghanashini estuary and was distributed throughout the year at station 1. They were observed during post-monsoon and pre-monsoon months at station 2, whereas they were found only during pre-monsoon period at station 3 and station 4. The maximum number recorded was 42/m³ during May 2000.

The Amphipods, represented by Synopia and Hyperia species, were found in all four stations during post-monsoon months. They were also observed during pre-monsoon months at station 1 and station 2. The maximum number of
Synopia were observed during November 1999 (86/ m³), whereas the Hyperia species found in maximum number during April 2000 (84/ m³) at station 1.

The Appendicularians (Protochordates) of Aghanashini estuary are represented by Doliolum and Oikopleura and were observed during post-monsoon and pre-monsoon months at station 1. At station 2, only Oikopleura was observed during pre-monsoon months. The Appendicularians were not observed at station 3 and 4 throughout the period of investigation. The maximum concentration of Doliolum was observed during March 2000, at station 1 (41/ m³), whereas Oikopleura were found in maximum number during April 2000, at station 2 (16/ m³).

The larval forms are of immense significance and constituted major part of planktonic biomass in estuarine eco-system of Aghanashini estuary. The copepod nauplius dominated the larval composition in all four stations during the period of investigation. The maximum number was observed during May 2000, at station 2 (4890/ m³). The abundance of copepod larvae increased generally after monsoon period and reached the peak during pre-monsoon period. The number of larvae decreased considerably during monsoon period. The other groups of larvae generally distributed in all four stations were Cirripede nauplius, Veliger larvae, Gastropod larvae, Decapod larvae and Cyponac:us larvae. The other larval forms like Nereid larvae, Spionid larvae, Arachnectis larvae, Brachiopod larvae and Trochophore larvae were distributed in few stations only, during the period of
The trochophore larval distribution is restricted to station 1 and station 2. The trochophore, arachnactis, spionid and nereid larval forms were not at all found in station 4, during the period of investigation. At station 4, arachnactis, spionid and nereid larval forms is restricted to pre-monsoon months.

Fish eggs and larvae were found throughout the year in all four stations. The distribution of fish egg and larval forms were generally more in station 1 and station 2 respectively and maximum concentration was observed in pre-monsoon months, especially during March 2000 at station 1 (2250/ m$^3$).

The other miscellaneous groups are also observed in all four stations throughout the period of investigation and the maximum abundance was observed at station 1 during November 1999 (710/ m$^3$). The group wise occurrence of total zooplankton at each station is described below.

**Station 1:**

Copepods constituted major part of the zooplankton representing 59.5 per cent of total zooplankton during monsoon, 47 per cent during post-monsoon and 48.6 per cent during pre-monsoon periods. They dominated the zooplankton throughout the year. The larval forms dominated by copepod nauplius formed the second major constituent by representing 17.7 per cent during monsoon, 32.1 per cent during Post-monsoon and 23.6 per cent of total zooplankton of pre-monsoon period. The larvae and eggs of fishes formed the third major group of
zooplankton by representing 5.9 per cent of total zooplankton during monsoon period, 2.8 per cent during post-monsoon and 19.4 per cent during pre-monsoon period. The protozoans are found throughout the year of investigation with the concentration of 4.1 per cent during monsoon, 6.1 per cent during post-monsoon and 3.6 per cent during pre-monsoon months. The amphipods were 2.2 per cent during post-monsoon and 1.3 per cent during pre-monsoon months and not found during monsoon months. The Hydromedusae, Ctenophores, Polychaetes, Chaetognaths, Planktonic molluscans, Decapods and Protochordates were present in less than 1 per cent during all seasons. The other unidentified species were 17.7 per cent during monsoon, 32.1 per cent during post-monsoon and 23.6 per cent during pre-monsoon periods. The maximum number (9249/ m³) was found during pre-monsoon period (Table 5.1.) (Fig. 5.1).

Station 2:

The copepods constituted the major part of zooplankton, represented by 50 per cent during monsoon, 41.6 per cent during post-monsoon and 34.6 per cent of total zooplankton of pre-monsoon season. The larval forms constitute second major portion of zooplankton with 23.8 per cent during monsoon, 42.2 per cent during post-monsoon and 42.2 per cent during pre-monsoon period. The fish egg and larvae occupy the third position with 14.7 per cent of total zooplankton during monsoon, 4.8 per cent during post-monsoon and 12.5 per cent during pre-monsoon period. The copepod nauplius was the dominant larval form throughout
the period of investigation. The protozoans were observed throughout the period with 2.94 per cent concentration during monsoon, 3.5 per cent during post-monsoon and 1.5 per cent during pre-monsoon period. Other groups of zooplankton were represented by less than 1 per cent of total zooplankton. The maximum number was observed during pre-monsoon period (9450/m³) as in Table 5.2.

Station 3

The zooplankton population was relatively low at station 3 compared to station 1 and 2. The copepods represented the major part of total zooplankton with 49.3 per cent during monsoon, 34.8 per cent during post-monsoon and 52.5 per cent during pre-monsoon periods. The larval forms headed by copepod nauplius constituted the second major group with the concentration of 29.8 per cent during monsoon, 51.1 per cent during post-monsoon and 34.6 per cent during pre-monsoon period. The fish egg and larvae were found throughout the year with the concentration of 9.8 per cent during monsoon, 3.5 per cent during post-monsoon and 2.1 per cent during pre-monsoon season. The planktonic protozoans were observed throughout the period of investigation with 0.6 per cent concentration during monsoon, 7.5 per cent during post-monsoon and 3.8 per cent during pre-monsoon period. The Hydromedusae, Pleurobrachia, Polychaetes, Cheatognaths and Molluscan planktonic forms were not at all observed. The Decapods and Amphipods were observed in some seasons with very low concentrations (less than 1%). The unidentified species represented 11.4
per cent during monsoon, 8.8 per cent during post-monsoon and 6.7 per cent during pre-monsoon. The maximum abundance of zooplankton were observed during pre-monsoon months, i.e. during April-May 2000 (table 5.3.).

Station 4:

The zooplankton population was very poor compared to that of station 1 and 2. The copepods were dominant over other species, with 34.3 per cent concentration during monsoon, 28 per cent during post-monsoon and 49.2 per cent during pre-monsoon months. As usual the larval forms dominated by copepod nauplius constituted second major group with 25 per cent during monsoon, 52 per cent during post-monsoon and 39.9 per cent during pre-monsoon months among total planktonic population. The fish eggs and larvae were found throughout the year of investigation with 16.2 per cent during monsoon, 6.5 per cent during post-monsoon and 2.1 per cent during pre-monsoon months. The planktonic protozoans were observed only during post-monsoon and pre-monsoon months in case of Acanthometron and only during pre-monsoon in case of Tintinnopsis sps, at very low concentration. The Hydromedusae, Pleurobrachia, Polychaetes, Chaetognaths, Molluscan sps. were totally absent throughout the year. Decapods appeared only during pre-monsoon with very low concentration (1.5/m³) whereas amphipods were found only during post monsoon months with the concentration of 0.6 per cent. The unidentified miscellaneous groups were found 24.5 per cent, 12.2 per cent and 8.2 per cent concentration of total zooplankton at this station. The maximum abundance was observed during
pre-monsoon period (3613/m³). The bloom appeared during April – May 2000 (Table 5.4.).

DISCUSSION

The present work was carried out on an estuary situated in the tropics, on the southwest coast of India. It has been known that tropical estuaries show limited fluctuation of temperature but the environment remains vigorous because of change in salinity and thus planktonic species composition in tropical estuaries is fairly distinct from their counterparts of temperate region (Grindly, 1981, Miller, 1983, Madhupratap1987). Therefore in the present study, the distribution of zooplankton of Aghanashini estuary is mainly compared with that of some tropical estuaries, particularly in the adjacent regions, North and South of Aghanashini estuary.

Most of the earlier works on the estuaries situated on the west coast of India have reported the presence of zooplanktonic forms such as Copepods, Ostracoids, Amphipods, Ctenopores, Cladocerans, Chaetognaths, Coelenterates, Sergistids, different larval forms, Protozoans and other form (Rao et.al 1975, Qasim and Sen Gupta 1981, Desai et.al 1983, Nair et.al 1985, Madhupratap 1987, Kusuma et.al 1988). The coastal water contained a more diverse zooplanktonic forms (Ramamurthy, 1965, Marichamy and Siraimetan 1979, Jacob et.al 1981, Goswami 1985, Vijaykumar and Sarma 1988).
The present observation on the zooplankton of Aghanashini estuary is in general agreement with earlier reports on tropical estuaries; although some changes of zooplankton are encountered (Rao et al., 1975, Nair et al., 1985, Sarkar et al., 1986, Kusuma et al., 1988, Srinivasan and Santhanam 1991).

Copepods are generally herbivorous group of zooplanktons feeding on diatoms (Raymont, 1983). Predominance of copepods is reported from the estuaries along the south-west coast of India (Pillai, 1971; Goswamy and Selvakumar, 1977; Gajbihiye et al., 1981; Desai et al., 1983; Kusuma et al., 1988) and from east coast of India (Subburaju and Krishnamurthy, 1972; Chandra Mohan, 1977; Mohamed and Rahaman, 1987; Sarkar et al., 1986; Srinivasan and Santhanam, 1991) and also from Adour estuary France (D’Elbee and Castel, 1982) and Igarassu river estuary, Brazil (Nogueira et al., 1979) and from certain Australian estuaries (Neale and Bayly, 1974). In the present course of investigation copepods were found throughout the year in all four stations observed indicating that their presence was almost throughout the year in Aghanashini estuary being the commonest and dominant group of zooplankton.

There are many reports on the presence of crustacean larvae forming an important group of zooplankton from different estuarine and coastal waters (Rao et al., 1975; Jacob et al., 1981; Suseelan et al., 1985; Sarkar et al., 1986; Nakadi, 1992). In the present study the larval form constitute second major group of zooplankton in Aghanashini estuary dominated by copepod nauplius. They were
found throughout the year in all four stations. This may be due to the presence of considerable population of caridian and penaeid prawns and crabs in Aghanashini estuary.

The dominance of other species, especially carnivores such as Hydomedusae, Ctenopores and Chaetognaths cannot be underestimated. These are large organisms forming significant portions of the biomass even though contributing in smaller numbers. Their utility, whether positive or negative is of considerable importance since they are carnivores in energy transfer in the trophic ecosystem (Madhupratap, 1978).

Chaetognaths are one of the major group of carnivorous zooplankton which is represented by Sagitta sp. in Aghanashini estuary. There are reports on the availability of chaetognaths along estuaries and inshore waters (Srinivasan, 1971, Nair, 1974, Sarkar et al, 1986). The chaetognaths were found throughout the year in station 1 and post monsoon months at station 2. At station 3 and 4 they were not found during the course of study.

Another important group of crustaceans observed during the course of study in all four stations were decapods represented by Lucifers. Even though the contribution of decapods for the total zooplankton of Aghanashini estuary is not more, their number increased during pre-monsoon months when the salinity was high. Bhat and Gupta (1983) report their abundance during high salinity period.
from Netravati – Gurupur estuary. Whereas Sarkar et al; (1986) have reported an abundance during late monsoon months from Hooghly estuary, when the salinity was not high due to rain. Therefore the abundance of lucifers may not depend on salinity alone and some other factors may be involved. The Aghanashini estuary shows the distribution of lucifers throughout the year at station1, whereas the peak was observed during May 2000 (42/m ³). At station 2 and station 3, Lucifers were found during post-monsoon and pre-monsoon months, whereas at station 4, they were found only during pre-monsoon months at very low concentration.

The protochordates represented by Oikopleura sp. and Doliolum sp. were usually found associated with phytoplanktonic abundance. They were able to reproduce rapidly to form dense population (Raymont, 1983). In Aghanashini estuary, Appendicularians were found during post-monsoon and pre-monsoon months at station 1 and during pre-monsoon months at station 2. The peak was observed during April – May 2000. At station 3 and station 4, no Appendicularians were observed during the period of investigation.

Hydromedusae were found in lesser number only at station 1 and station 2. The river mouth (Station 1) showed the presence of hydromedusae throughout the year, but the peak was observed during March 2000(41/m³). At station 2, very low concentration (0.25/m³) was observed only during monsoon; whereas it was not at all observed in other two stations. Rao et al. (1975) have observed large number of ctenophores with hydromedusae during pre-monsoon season from
Cochin backwaters, whereas Naomi (1986) recorded increased number during September – October from Karwar inshore water. However, in the present study they were found comparatively at higher concentration during pre-monsoon months than other seasons of the year.

The distribution of fish eggs and larvae is reported very widely in different waters, estuaries and coastal waters with their presence restricted to certain months (Rao et al., 1975, Jacob et al., 1981, Bhat and Gupta, 1983, Sarkar et al., 1986). In the present study fish eggs and larvae were found throughout the year at all four stations with varying abundance. The peak was observed during March – May and September- November in all four stations. Molluscan and polychaetes larvae are reported by different estuarine waters (Srikrishnadhas and Ramamoorthi 1975; Sarkar et al., 1986, Kusuma et al., 1988; Chandramohan and Chetty, 1988, Nakadi, 1992). In the present study polychaete larvae were restricted to station 1 and station 2. At station 1, these polychaetes were observed during post-monsoon and pre-monsoon months with peak at March (40/M3) at station 1, whereas at station 2, only during pre-monsoon months with very low concentration.

The protozoan planktonic forms found throughout the year of investigation in all four stations with varying abundance. The maximum abundance was observed at station 1 and 2, especially during post-monsoon and
pre-monsoon months. The peak was observed during November 1999 and March 2000.

Other miscellaneous and unidentified forms also contributed considerably to the total zooplankton population of Aghanashini estuary at all four stations throughout the period of investigation. They generally include Mysids, Ostracoids, Herpacticoids and Euphausids. It is relevant to mention here that, the occurrence of all the above-mentioned planktonic animals is considered as a single miscellaneous group; and as such monthly occurrence is reported.

The earlier reports on the annual zooplankton distribution in estuaries and coastal waters along the Indian coast show bimodality with two peak periods, which may vary from region to region. Prasad (1969) reported the higher standing crop of zooplankton in March at Palkbay and lower peak in September – October. In North Kanara coastal waters near Karwar, it has been reported that production of zooplankton showed maximum peak in August—November which coincide with diatom peak (Ramamurthy, 1965). In Bombay coast the volume of total zooplankton showed two peaks in March – April and October – November (Radhakrishna and Pillai, 1978). Raghunathan and Srinivasan (1983) from Ennore estuary have also reported two peaks, during December and February. Subburaju and Krishnamurthy (1972) found the abundance in April and September at Porto – Novo waters. In Hooghly estuary Bhunia and Choudhury (1981) and Baidya and Choudhury (1984) have reported two peaks of
zooplanktons, the first during March – April and the second peak during November – December. In Astamudi estuary a major peak was observed during Monsoon and minor peak during post-monsoon (Divakaran et al., 1982) Kusuma et al., (1988) have reported two peaks in zooplankton population, the first during October and second during February for Kali estuary.

In the present study it has been observed that the production of total zooplankton showed peak in March – May 2000. The percentage of zooplankton were very high in pre-monsoon months, that is 52.8% at station 1, 61% at station 2, 60% at station 3 and 58.1% at station 4 of the total zooplankton (Fig. 5.1). It is relevant to mention here that Bal and Pradhan (1945) have reported that inshore planktons of Bombay area showed an increase in zooplankton concentration after monsoon months. The minor peak was observed during November 1999; after monsoon rains at Aghanashini estuary. It is known that increased rainfall changes a number of physical and chemical parameters (Staples, 1983). In the present work, the heavy monsoon rain has resulted in an appreciable increase in phosphate and silicate concentrations, concomitant with increased dissolved oxygen level and relatively low temperature. These changes might have resulted in an increase in zooplankton during subsequent months. Thus broadly, the total zooplankton occurrence at Aghanashini estuary has shown two peaks; the minor peak during post-monsoon period (November 1999) and major peak during pre-monsoon period (March 2000).
It has been known that, the distribution of zooplankton in estuaries is controlled to a large extent by salinity and river discharge (Subburaju and Krishnamoorthy, 1972, Mohamed and Rahaman 1987) and the zooplankton population is rather abundant in an estuary, particularly in the high salinity region than in low salinity region (Madhupratap 1987, Neelakantan et al., 1988) and the optimum conditions in which most of the estuarine species flourish seems to be middle reaches, somewhat away from the mouth; as reported for Cochin backwaters (Rao et al., 1975). In the present study the zooplankton concentration was higher at station 1 during monsoon and pre-monsoon months, whereas the maximum abundance during post-monsoon months were observed at station 2. In general the station 1 and station 2, recorded somewhat similar concentration, even though the total zooplankton population was slightly higher at station 1. Due to the low salinity, the station 3 and station 4 showed relatively less abundance of zooplankton population.
Table 5.1. Zooplankton abundance (no/m³) at station 1.

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| Taxa                      | JUN | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY |
|---------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Penilia Sps.              | 124 | 201 | 196 | 212 | 71  | 69  | 50  | 61  | 91  | 162 | 84  | 171 |
| Evadne Sps.               | 30  | 29  | 52  | 82  | 12  | 16  | 9   | 11  | 43  | 82  | 46  | 92  |
| Euterpina Sps.            | 12  | 20  | 18  | 46  | 410 | 594 | 370 | 411 | 506 | 621 | 480 | 591 |
| Calanopia Sps.            | 8   | 16  | 12  | 38  | 10  | 16  | 8   | 10  | 16  | 43  | 21  | 56  |
| Eucalanus Sps.            | 0   | 2   | 1   | 2   | 76  | 32  | 19  | 21  | 24  | 41  | 30  | 36  |
| Acrocalanus Sps.          | 10  | 22  | 29  | 46  | 19  | 44  | 16  | 19  | 33  | 71  | 46  | 61  |
| DECAPODA                 |     |     |     |     |     |     |     |     |     |     |     |     |
| Lucifer Sps.              | 5   | 7   | 4   | 15  | 16  | 31  | 15  | 18  | 21  | 39  | 31  | 42  |
| AMPHIPODA                |     |     |     |     |     |     |     |     |     |     |     |     |
| Synopia Sps.              | 2   | 3   | 5   | 8   | 51  | 86  | 61  | 72  | 46  | 39  | 31  | 45  |
| DECAPODA                 |     |     |     |     |     |     |     |     |     |     |     |     |
| Hyperia Sps.              | 0   | 0   | 0   | 0   | 61  | 77  | 57  | 63  | 65  | 84  | 39  | 69  |
| SYNCHORDATA              |     |     |     |     |     |     |     |     |     |     |     |     |
| Dolioolum Sps.            | 0   | 0   | 0   | 0   | 6   | 18  | 9   | 11  | 22  | 41  | 32  | 39  |
| Oikopleura Sps.           | 0   | 0   | 0   | 0   | 5   | 9   | 4   | 7   | 11  | 15  | 10  | 14  |
| LARVAL FORMS              |     |     |     |     |     |     |     |     |     |     |     |     |
| Trochophore larva.        | 0   | 2   | 3   | 3   | 16  | 22  | 17  | 18  | 17  | 28  | 16  | 30  |
| DECAPODA                 |     |     |     |     |     |     |     |     |     |     |     |     |
| Arachnectis larva         | 3   | 7   | 8   | 14  | 18  | 31  | 15  | 19  | 16  | 27  | 14  | 32  |
| DECAPODA                 |     |     |     |     |     |     |     |     |     |     |     |     |
| Spionid larva             | 2   | 6   | 5   | 16  | 71  | 96  | 77  | 81  | 96  | 125 | 86  | 115 |
| DECAPODA                 |     |     |     |     |     |     |     |     |     |     |     |     |
| Nereid larva              | 5   | 4   | 6   | 16  | 32  | 84  | 61  | 70  | 67  | 76  | 51  | 72  |
| DECAPODA                 |     |     |     |     |     |     |     |     |     |     |     |     |
| Gastropod larva           | 26  | 31  | 34  | 56  | 54  | 79  | 48  | 51  | 91  | 126 | 81  | 98  |
| DECAPODA                 |     |     |     |     |     |     |     |     |     |     |     |     |
| Veliger larva             | 31  | 46  | 52  | 71  | 60  | 94  | 32  | 57  | 102 | 122 | 79  | 102 |
| DECAPODA                 |     |     |     |     |     |     |     |     |     |     |     |     |
| Copepod nauplius          | 115 | 130 | 128 | 202 | 920 | 1416| 870 | 980 | 962 | 1660| 848 | 1420|
| DECAPODA                 |     |     |     |     |     |     |     |     |     |     |     |     |
| Decapod larva             | 36  | 44  | 41  | 67  | 78  | 216 | 160 | 210 | 162 | 186 | 101 | 136 |
| DECAPODA                 |     |     |     |     |     |     |     |     |     |     |     |     |
| Cirripede nauplius        | 91  | 102 | 98  | 106 | 81  | 192 | 110 | 120 | 181 | 236 | 141 | 196 |
| DECAPODA                 |     |     |     |     |     |     |     |     |     |     |     |     |
| Brachiopod larva          | 6   | 11  | 17  | 16  | 71  | 182 | 69  | 115 | 86  | 102 | 91  | 108 |
| DECAPODA                 |     |     |     |     |     |     |     |     |     |     |     |     |
| Cyphnoautus larva         | 7   | 9   | 8   | 12  | 112 | 310 | 91  | 131 | 102 | 132 | 101 | 122 |
| DECAPODA                 |     |     |     |     |     |     |     |     |     |     |     |     |
| Fish egg and larva        | 112 | 120 | 126 | 201 | 192 | 234 | 111 | 120 | 1682| 2250| 1356| 1880|
| DECAPODA                 |     |     |     |     |     |     |     |     |     |     |     |     |
| Unidentified Sps.         | 210 | 240 | 230 | 400 | 502 | 710 | 410 | 508 | 705 | 482 | 510 | 610 |
Table 5.2. Zooplakton abundance (no/m^3) at station 2.

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Table 5.5. Seasonal abundance (no/m$^3$) of zooplankton.

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Fig. 5.1. Seasonal abundance of zooplankton at different stations

Fig. 5.2. Total zooplankton concentration at different stations.