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42. SEASONAL ABUNDANCE OF BIVALVE AND GASTROPOD LARVAE IN THE PLANKTON OFF TUTICORIN COAST

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ABSTRACT

Estimation and identification of the commercially important molluscan larvae occurring in the plankton collected from inshore waters off Tuticorin coast during 1976-1985 indicated their abundance in space and time. It is of practical significance to determine the fluctuations in the larval population and settlement of many of the bivalves like the pearl oyster. The occurrence of bivalve and gastropod larvae exhibit two distinct modes during February-April and September-December indicating the peak spawning seasons of these groups. In certain years, another prominent occurrence of molluscan larvae was noticed during June-July. A maximum of 98.5% of bivalve larvae were recorded in February, 1976 and 91.8% of gastropod larvae during June, 1976. The distribution pattern of molluscan larvae and that of other planktonic organisms and the relationship with hydrological factors are discussed. Several larval forms have been identified from the collections indicating the significance of Tuticorin as an important molluscan resources zone.

INTRODUCTION

An accurate appraisal of the relative productivity of the area and the resultant variation in zooplankton stocks which directly support pelagic population might be possible through intensive hydrobiological studies. Such studies help in forecasting the situations developed in the environment that may affect the commercially important resources. Compared to the published information available on hydrobiology of the Gulf of Mannar (Chacko 1950;

Prasad et al 1952; Prasad 1954, 1956, 1958; Jayaraman 1954; Chacko and Malu Pillay 1962; Prasad and Nair 1960). Natarajan (1957) has described the larval development of some prosobranchs from the Palk Bay and Gulf of Mannar. Our knowledge of the plankton of Tuticorin coast is limited to a few preliminary observations by Chidambaram et al (1951); Sambandamurthy (1962); Sudhakar and Chandrasekaran (1968). Recently, Marichamy and Pon Sirameetan (1984) have described the distribution of zooplankton in this region in

relation to hydrological and meteorological features. The present paper attempts to describe the gross qualitative and quantitative variations of bivalve and gastropod larve distributed in the inshore waters with reference to environmental conditions and general inter-relationship of zooplankton based on the data collected during 1975-1985.

MATERIAL AND METHODS

The methods of collection of plankton samples, the area covered and the enumeration of the various components are the same as those described by Marichamy and Pen Siraimetan (1984). Simultaneously, the hydrological factors were studied and the data collected on different sampling dates were pooled month-wise and the trend of seasonal variations were analysed on the basis of combined values of all the years of study. The fluctuations in the plankton are discussed in terms of monthly averages. Facilities enabled recording of some organisms upto generic level only. Measurements of different stages of molluscan larvae were taken using a micrometer scale and the features of larvae were compared with published information. Rainfall data were collected from the meteorological centre, Tuticorin Harbour Project.

ENVIRONMENTAL FEATURES

Among various hydrological parameters examined such as temperature, salinity, dissolved oxygen content, pH and nutrients, the data of highly influencing factors like rainfall, temperature and salinity alone were analysed and presented to examine their probable effect on the distribution of larve. The data collected on these aspects during 1975-85 were pooled monthwise since there was no difference in the trend of seasonal changes between the years. The results are presented in Table 1.

The surface water temperature closely followed the trends of atmospheric temperature and exhibited two peaks in a year. Sea temperature steadily increased from the winter low level and reached the maximum in May (30.5° C) and then declined upto August (27.2° C). The fall in surface temperature in coastal waters was due to the active south west wind. The secondary peak was observed during September-October and subsequently it declined. This observation is in confirmity with the earlier findings in Gulf of Mannar by Chacko (1950), and Marichamy and Pon Siraimetan (1984). The values of salinity also exhibited a clear bimodal oscillation, more or less following the variations of temperature in the course of the year. Two maxima were recorded in April and October. The fall in salinity from November onwards was due to rainfall. However, in certain years the fall in salinity was not so prominent because of the failure of north east monsoon. The data on rainfall give a general picture for the region, but variations were noticed from year to year. Maximum record of 369.5 mm was noticed in November 1982, where as in the corresponding month of 1981 it was 34 mm. The average rainfall was generally high in northeast monsoon period, October-December. In November the average for the entire period was found to be 169 mm. Rainfall was noticed in April in certain years and average recorded was 34 mm.

DISTRIBUTION OF BIVALVE LARVAE

Pubished information on the collection of egg masses of planktonic molluscan larvae in the study of breeding habits are known from the contributions of Hornell (1921), Gravely (1942), Annandale and Kemp (1916), Panikkar and Aiyar (1939), Panikkar and Tampi (1949) and Nataraj (1957). The bivalve larvae were separated from the plankton collections and

TABLE 1. *Seasonal variations of temperature, salinity and rainfall in Tuticorin coast*

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Temperature °C | 25.8 | 27.2 | 29.7 | 31.4 | 30.5 | 29.7 | 29.2 | 27.2 | 28.8 | 28.9 | 27.9 | 27.4 |
| Salinity %. | 32.41 | 33.20 | 33.63 | 34.23 | 33.44 | 34.13 | 34.13 | 34.18 | 33.87 | 34.00 | 32.78 | 32.75 |
| Rainfall mm | 13.6 | 27.4 | 18.7 | 34.0 | 19.5 | 2.2 | 3.9 | 1.3 | 9.3 | 89.0 | 169.5 | 77.8 |

TABLE 2. The percentage composition of bivalve larvae in zooplankton during 1975-85

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1975 | 6.5 | 75.0 | 2.6 | 0.9 | 0.3 | 3.6 | 5.6 | 0.9 | 1.2 | 0.9 | 2.4 | 0.5 |
| 1976 | — | 98.5 | 0.01 | 0.3 | 0.2 | 0.5 | 0.2 | 0.01 | 0.01 | 0.12 | 0.2 | 0.01 |
| 1977 | 0.1 | 0.3 | 98.4 | 0.5 | 0.02 | — | — | 0.03 | 0.02 | — | 0.1 | 0.6 |
| 1978 | 1.0 | 3.2 | 0.5 | 32.1 | 0.5 | 59.0 | 2.1 | — | — | 0.5 | — | 1.1 |
| 1979 | 19.3 | 3.2 | 13.1 | 19.7 | 41.0 | — | 3.2 | 14.8 | — | 20.5 | 1.3 | 0.8 |
| 1980 | 0.1 | 0.2 | 2.5 | 90.5 | — | — | — | 0.2 | 5.5 | 0.1 | 0.1 | 0.7 |
| 1981 | — | — | 20.4 | 25.8 | 3.8 | — | 19.5 | 3.8 | 7.5 | — | 1.2 | 12.0 |
| 1982 | 1.0 | 2.0 | 18.1 | 4.0 | — | 2.0 | 1.0 | 28.2 | — | 34.2 | 8.0 | 1.5 |
| 1983 | — | 14.3 | 16.8 | 1.4 | 9.1 | 5.0 | 21.5 | — | 24.1 | 6.0 | 0.8 | 1.0 |
| 1984 | 0.2 | 0.1 | 0.1 | 2.1 | 4.0 | 1.6 | 3.4 | 44.6 | 2.5 | 24.1 | 15.8 | 1.4 |
| 1985 | 10.5 | 3.1 | 2.4 | 0.1 | — | 0.1 | 0.6 | — | 14.6 | — | 19.3 | 49.3 |

their percentage composition in general zooplankton are presented in Table 2. It may be seen that a very high percentage of bivalve larvae ranging from 75-98.5% was recorded in the period February - April during 1975-1980, although they occur around the year. Maximum bivalve larvae of 59% was the predominant item in June 1978. A secondary peak in the occurrence was noticed during July in 1981 and 1983 whereas this secondary mode of larval occurrence was noticed in the month of October in 1979, 1982 and 1984.

The bivalves occurring in high percentages as well as in most of the samples collected round the year were examined further to see the larval stages and size, and were compared with the data in previous work. The details of this study are presented in Table 4. *Macra mere*.

Avicula vexillum, *Modiolus* sp; *Crassostrea madrasensis* and *Macra* sp were noticed in umbo and spat stages. The larvae of the first two species were found in swarms in the collections during February-March season in most of the years revealing the spawning season of these bivalves. The larvae of *Macra mere* were present throughout the year. The shelled larvae of *Avicula vexillum* resemble those of the pearl oyster *Pinctada fucata* and are known as 'false spat' (Hornell 1922). They were very common in the collections made during December-February and the average size was DVM 280 μ and APM 337 μ in umbo stages and 1588-1648 μ respectively in spat stage. **The larva of *Crassostrea madrasensis* measured at the average size of DVM 351 μ and APM 422 μ were common in the collections made during October. This species is known to breed**

TABLE 4. Larvae of Bivalves

| Name of the species | Stage | Size of larvae | | | | | |
|--------------------------------|-------------|----------------|-----------|-----------|-----------|-----------|-----------|
| | | Minimum | | Maximum | | Average | |
| | | DVM μ | APM μ | DVM μ | APM μ | DVM μ | APM μ |
| <i>Macra mere</i> | Umbo | 200 | 200 | 560 | 590 | 389.2 | 399.2 |
| <i>Avicula vexillum</i> | Umbo | 250 | 290 | 310 | 370 | 280. | 336.7 |
| <i>Modiolus</i> sp | Spat | 1025 | 1025 | 2525 | 2525 | 1775 | 1800 |
| <i>Crassostrea madrasensis</i> | Plantigrade | 350 | 420 | 352 | 424 | 351 | 422 |
| <i>Macra</i> sp | Umbo | 230 | 270 | 300 | 280 | 265 | 275 |
| <i>Avicula vexillum</i> | Spat | 450 | 575 | 2950 | 2975 | 1588 | 1648 |

throughout the year with 2 peaks in April-May and September-October and there are a good number of natural beds in the intertidal regions and creeks along Tuticorin coast.

DISTRIBUTION OF GASTROPOD LARVAE

The percentage composition of gastropod larvae in zooplankton collections are presented in Table 3. It can be seen that gastropod larvae occur in high percentage, 56-82%, during February - April, indicating the spawning season of this group of molluscs. A secondary peak in the occurrence was noticed in December. A swarm of gastropod larvae numbering 92,256 in a 10 mts surface haul, accounted for 92% in

the collection made in June 1976. In the rest of the months, gastropod larvae were noticed but in negligible percentages.

The gastropod larvae were present almost through-out the year as well as in good percentages. They were identified and the details of size of the larvae measured, are given in Table 5. *Murex virgineus*, *Oliva* sp, *Turritella acutangula*, *Turriteia* sp., *Nerita aibicilla* *Potamidides cirgulatus* (*Cerithidea fluviatilis*) were the common forms present in most of the collections. Larvae of *Murex virgineus* was present in the collections round the year with peak in March. Natarajan (1957) observed that the breeding season of this species was during

TABLE 3. The percentage composition of gastropod larvae in zooplankton during 1975-85.

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1975 | 8.2 | 61.1 | 4.0 | 1.0 | 0.8 | 8.6 | 5.0 | 1.3 | 2.2 | 3.0 | 4.0 | 0.8 |
| 1976 | — | 4.4 | 0.7 | 1.1 | 0.3 | 91.6 | 0.3 | 0.2 | 0.5 | 0.2 | 0.6 | 0.1 |
| 1977 | 0.9 | 6.0 | 81.5 | 3.9 | 0.1 | 0.4 | 0.2 | 1.4 | 1.5 | — | 0.5 | 3.6 |
| 1978 | 2.8 | 1.1 | 3.4 | 56.1 | — | 6.8 | 19.5 | — | 2.2 | 2.8 | — | 5.7 |
| 1979 | 22.0 | 10.2 | 12.6 | 4.2 | 6.0 | — | 3.9 | 34.3 | — | 3.6 | 1.2 | 2.0 |
| 1980 | 1.4 | 6.9 | 11.5 | 59.7 | — | 0.5 | — | 0.5 | 5.7 | 2.9 | 3.3 | 7.6 |
| 1981 | — | — | 12.6 | 6.9 | 11.1 | — | 4.1 | 7.6 | 13.3 | — | 0.9 | 43.5 |
| 1982 | 3.0 | 2.3 | 11.1 | 4.1 | 5.8 | 2.6 | 0.6 | 18.1 | — | 16.3 | 33.8 | 2.3 |
| 1983 | 2.7 | 11.0 | 43.4 | 0.1 | 0.5 | 1.0 | 0.7 | — | 3.0 | 27.2 | 5-3 | 5.1 |
| 1984 | 1.9 | 4.9 | 3.0 | 2.9 | 2.5 | 37.2 | 1.5 | 18.4 | 3.5 | 2.7 | 7.9 | 13.6 |
| 1985 | 18.2 | 9.4 | 55.4 | 0.2 | 0.1 | — | 1.8 | 0.4 | 5.7 | — | 1.9 | 6.9 |

TABLE 5. Larvae of gastropods

| Serial No. | Date | Station No. | Depth mt | Name of the species | Stage | Minimum | | Maximum | | Average | |
|------------|----------|-------------|----------|-------------------------------|------------------|------------------|--------|---------|-------|---------|-------|
| | | | | | | DVM [^] | APM(X) | DVM(JI) | APMJa | DVM (i) | APMfx |
| 1 | 30.3.77 | 6C | 20 | <i>Murex virgineus</i> | Advanced veliger | 375 | 225 | 2125 | 1525 | 746.9 | 493.8 |
| 2 | // | 6C | // | <i>Oliva</i> sp | , | 2500 | 1050 | 2500 | 1050 | 2500 | 1050 |
| 3 | 11.4.80 | 4C | 24 | <i>Turritella acutangula</i> | " | 350 | 225 | 700 | 325 | 557.5 | 292.5 |
| 4 | " | " | " | <i>Turritella</i> sp | " | 425 | 200 | 475 | 275 | 450 | 237.5 |
| 5 | 19.11.82 | 58 | 12 | <i>Nerita aibicilla</i> | veliger | 275 | 225 | 875 | 625 | 543.8 | 437.5 |
| 6 | 31.3.83 | 60 | 20 | <i>Cerithidea fluviatilis</i> | // | 275 | 200 | 475 | 350 | 427.8 | 309.7 |

November-March and May-July and also stated the likelihood of continuous breeding round the year. The descriptions given for the various stages of larval development are comparable with the larvae examined in the present study. The average size of the larvae was DVM 747 μ m and APM 494 μ m. *Oliva* sp in slightly advanced stage was also recorded in March. *Potamides cingulatus* (*Certithidea fluviatilis*) larvae were next in importance in abundance round the year with peaks in March and June. The larvae measured 275-475 μ m in DVM and 200-350 μ m in APM. Sadasivan (1949) has made detailed studies on the rate of growth, duration of breeding period etc. from Madras. Natarajan (1957) has recorded the spawn masses of this species during January-September and the present observations indicate that the spawning season of this species in Tuticorin coast is also the same as in Mandapam area. The maximum concentration of gastropod larvae noticed in April 1980 was due to the presence of *Turritella acutangula* and *Turritella* sp, and the larvae with average size of DVM 557 μ m and DVM 450 μ m respectively were examined. *Epitonium scalare* were found in a few samples. The larvae of *Nerita albicilla* measuring 544 μ m in DVM, were noticed round the year, with a peak in November indicating the spawning season. Natarajan (1957) has given the descriptions for the newly hatched veliger of this species and the features of the larvae of present collections are in conformity with the descriptions.

DISCUSSION

The richness of molluscan fauna in Gulf of Mannar has been recognized by several earlier workers. Natarajan (1957) had identified 33 species of prosobranchs and studied their early larval history from Mandapam area. Seasonal variations in the surface temperature and salinity show similarity in general trends. A bimodal cycle in the distribution of these major factors was noticed. Two maxima were observed during April-May and September-October and the minima during August and January. The same trend has been noticed by a number of earlier workers from this region (Malu piliay, 1962; Freda Chandrasekaran and Sudhakar 1968; Marichamy and Ron Siraimet-

tan 1984). Thorson (1940) opined that in the reproduction of prosobranchs of all oceans there is a tendency for the pelagic development to be totally suspended in the deep sea and is restricted to shelf fauna and that starting from the Arctic and Antarctic where the pelagic development is suppressed there is a gradual increase of the same towards the trophic shelves where it is the highest. Panikkar and Aiyar (1939) and Paul (1942) have observed different types of both continuous and discontinuous breeding in marine and brackish water animals of Madras area. Natarajan (1957), Marichamy and Pon Siraimetan (1984) observed the same trend of breeding habits from the Gulf of Mannar. No direct effect of temperature and salinity on breeding activity was found since most of the molluscan groups breed intermittently in an extended period. However, Rao (1951) observed the influence of salinity and temperature on the intensity of breeding in *Ostrea* (= *Crassostrea*) *madrasensis*. The monthly averages of the diurnal variations in the minimum and maximum temperature were observed to have a direct influence to the gonadal development, spawning and setting of edible oyster spat (Rajapandian and Rajan 1983). The maintenance of larval population in a given region depends upon a balance of dynamic factors, the drift of the water and its interaction with the environment as well as upon the rate of reproduction and mortality of population under the environmental conditions (Prasad, 1954). Alagarwami and Chellam (1976) observed a seasonal trend in the setting of the *Avicula vexillum* during April-June and *Crassostrea* sp during May-June. The occurrence of the above two bivalve larvae in the plankton collected from this zone was noticed more or less in the same period confirming the spawning seasons of the species. Similarly, they have observed the occurrence *Modiolus* sp in large numbers during July and in the present observation, the larvae of this species was recorded in June. The determination of breeding seasons of the gastropods examined in the present study is in agreement with the findings of Natarajan (1957). In general, the occurrence of bivalve and gastropod larvae exhibit two distinct modes during February-April and September-December

indicating the peak spawning seasons. Copepods and Lucifers were noticed in negligible percentages when molluscan larvae were predominant in the collections.

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