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ECOLOGICAL ASPECTS OF COPEPOD COMPONENT OF ZOOPLANKTON PRODUCTION IN THE ESTUARINE SYSTEM OF LOWER WEST BENGAL

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ABSTRACT

Distribution of zooplankton with special reference to copepods at two stations in the lower reach of Hooghly estuary was studied over a period of one year (1980-1981). The annual fluctuations in temperature at Station I (Kachuberia, north point) and at Station II (South Sagar, south point) were within the range of 10°C. However, salinity regime varied from 1.01-24.93% at Station I and 3.73-32.03‰ at Station II. Biomass values in terms of displacement volume and wet weight were higher (3.18 ml/m³ and 1,190 mg/m³) at Station II than at Station I (1.01 ml/m³ and 366 mg/m³). The faunastic composition was more diverse at Station II. Quantitative and qualitative variation in copepod species were well pronounced at these two stations. Forty two species of planktonic copepods belonging to 18 families were recorded at Station II, whereas 18 species belonging to 5 families were recorded at Station I. Correlation among the hydrological parameters and correlation of copepod species in relation to salinity and temperature documented at both the stations have been discussed.

INTRODUCTION

Zooplankton is an important indicator of the nature of watermass as it forms an important link in the food chain of the aquatic subsystem.

The hydrobiological studies in Indian waters have been made by several authors from different parts of India, Jayarama (1951) on Bay of Bengal ; Ramamurthy (1953) on Madras coastal waters and Cheriyan (1963) on cochin water. More recently a considerable addition to this aspect was made by Pillai (1971) and Madhupratap (1976) from Cochin backwater ; Goswami and Selvakumar (1977) from Mandovi and Zuari estuaries ; Chandra Mohan (1977) from Godavari estuary and Raghunathan and Srinivasan (1983) from Ennore estuary. But the studies on plankton ecology of Hooghly estuary are still rather meagre. Dutta *et. al.*, (1954) studied the seasonal fluctuation of plankton between Palta and Diamond Harbour. Roy (1955) has given an account of plankton for small region of Hooghly, at Palta. Shetty *et at.*, (1961) studied the plankton and hydrology between Nabadwip and Frazergangue. Very recently Bhunia and Choudhury (1981, 1982) have also reported the abundance and biomass of zooplankton in the Mooriganga and Chemaguri creek of Hooghly estuary.

Sagar Island, the largest delta in the Hooghly-Matla estuarine complex embracing the Western Sector of famous deltaic Sundarbans is situated at the confluence of the river Ganga and the sea, Bay of Bengal, between 21.56 and 21.88°N latitudes and 88.08 and 88.16°E meridians.

Station I (Kachuberia, north point) is

located at the north point of Sagar Island facing Moorigana river, branching off the river Hooghly and Station II (South Sagar, South point) represents the southern extreme of the Island facing the Bay water (Fig. 1). The seasons here are well recognised, each of four months duration. The premonsoon period (March to June) is the dry season with considerably higher temperature. The South-West monsoon (July to October) is accom-

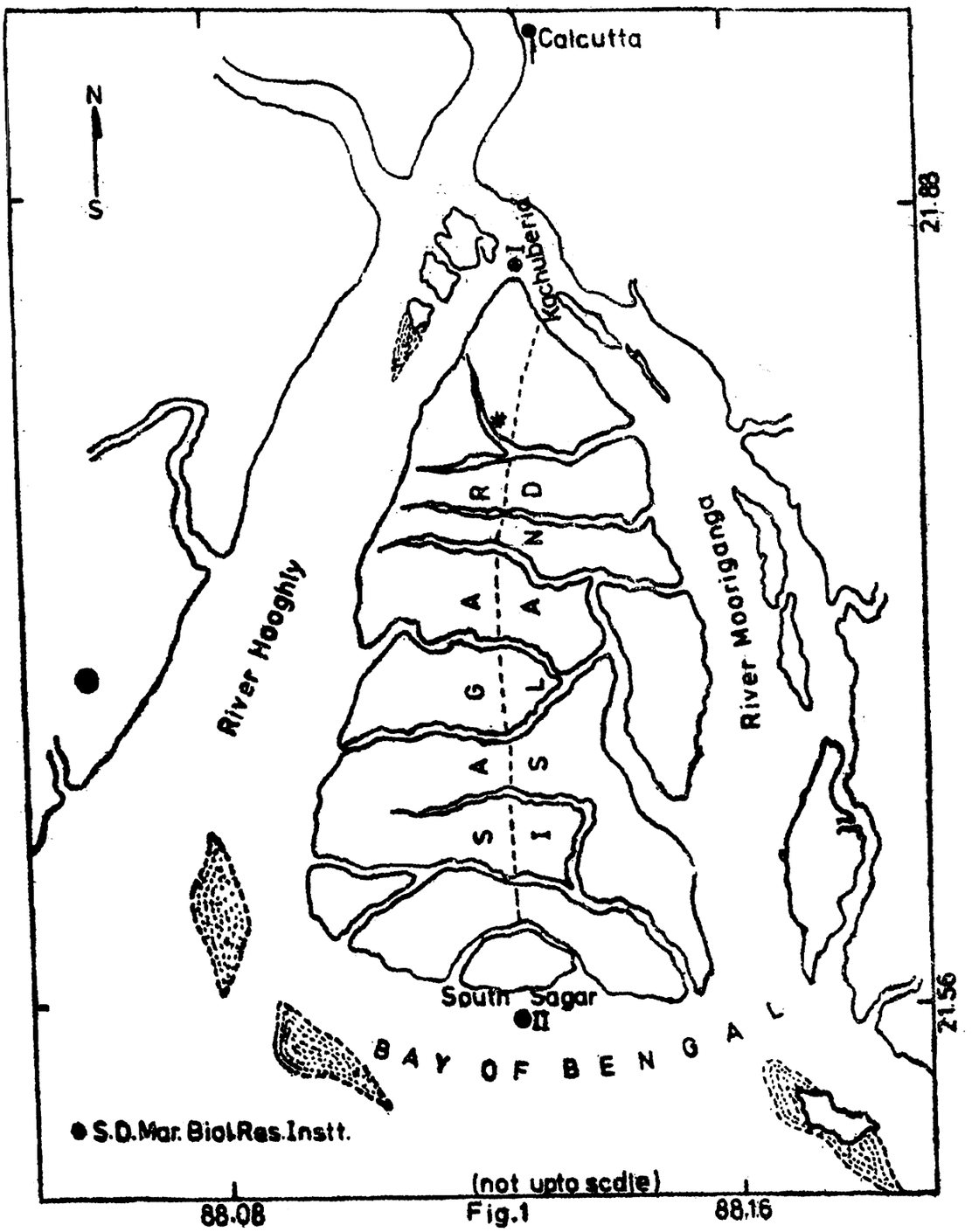

Fig.1

panied by heavy rainfall and the postmonsoon (November to February) comparises partly the winter season with comparatively lower temperature and less precipitation.

MATERIAL AND METHODS

Water samplings were made fortnightly for hydrological studies from two specified stations in the forenoon hours during flow tide from March 1980 to February 1981. The temperature (air and water) were recorded in degree centrigrade in the field. The salinity of the sample water was estimated by 'Mohr-Knudsen' method. Winkler's method was followed to estimate dissolved oxygen content, and for pH, the colour comparator disc was used in the field. Secchi disc was used to measure the transparency of water. For zooplankton sampling, plankton net, made of bolting silk no. 20 (mesh 75 μm) was used. Two hundred literes of surface water was filtered to estimate the plankton biomass. The filtered material was preserved in 4% buffered formaldehyde in sea water. Depending on the size of the sample, sub-samples were often made. When the sample was small, the whole sample was placed for counting under 'Utermohl' microscope and expressed in no/m^3. For estimating the plankton volume the displacement method was used and expressed in ml/m^3. Wet weight of the sample was estimated by absorbing all interstitial fluids with absorbent paper and then measured directly with single pan electric balance and expressed in mg/m^3.

RESULTS

Hydrology :

The temperature range were more or less same in both the stations. Higher and lower values were recorded during premonsoon season (March to June) and postmonsoon season (November to February) respectively. The fluctuation of salinity was pronounced (28.27‰) at Station II than Station I (23.9‰). The salinity values were quite high 21.89-32.03‰ at Station II while Station I showed 16.87-24.93‰ during premonsoon season, but during the monsoon period sudden decrease could be seen in salinity and minimum values were estimated 1.01-11.06‰ at Station I and 3.73-14.52‰ at Station II. The postmonsoon season showed an intermediate, 5.20-15.48‰ at Station I and 13.79-22.07‰ at Station II (Table 1).

The concentration of dissolved oxygen showed a variation range of 2.5-4.1 ml/l at Station I and 1.7-3.8 ml/l at Station II. The maximum values (4.1 ml/l and 3.8 ml/l) were observed in the same month (August) in both the stations respectively.

The pH value remained more or less stable during postmonsoon to premonsoon period, i.e., in November to June (8.1-8.3) but dropped down to 7.3 and 7.6 at Station I and II respectively during monsoon season. Secchi disc readings showed that the water was turbid almost all the time with a little exception in the postmonsoon months. Maximum readings (26 cm) was noted in the month of December at Station II and (10.5 cm) at Station I in the month of February. The correlation among the hydrological parameters showed that the salinity was negatively correlated (at 1% level) with dissolved oxygen and positively correlated (at 1% level) with pH. The relationship of dissolved oxygen with pH was also significantly high (at 1% level) and negative. The relationship between Secchi disc transparency and pH was 5% in Station I and 1% in Station II (Table 2).

TABLE 1. Monthly range of the hydrological parameters of Station I (Kachuberia) during March 1980 to February 1981.

Months	Water temp. °C	Salinity %	Dissolved oxygen ml/1	pH	Transparency cm.
March	26.0-28.2	17.05-18.48	2.5-2.7	8.0-8.1	5-10
April	29.0-30.0	18.66-23.68	2.7-2.9	8.1-8.2	5- 9
May	30.0-30.5	23.50-24.93	2.5-2.8	8.3-8.3	8- 8.5
June	31.0-31.0	16.87-17.94	2.5-2.5	8.3-8.3	4- 8
July	29.0-30.8	3.21- 9.42	3.3-3.7	7.7-8.0	4.9- 6.8
August	29.2-30.3	1.48- 2.81	3.4-4.1	7.3-7.6	8- 6
September	28.8-30.6	1.01- 6.12	3.3-3.6	7.6-7.6	4- 6
October	28.5-31.0	4.47-11.06	3.2-3.5	7.6-7.9	4- 6
November	25.8-27.0	5.20- 6.12	2.9-3.1	8.1-8.1	4.5- 9.0
December	22.9-25.0	6.49- 7.23	3.0-3.2	8.1-8.1	5- 8
January	20.0-23.0	7.77- 8.14	3.2-3.3	8.1-8.2	4- 8
February	22.0-24.5	9.06-15.48	2.9-3.1	8.2-8.2	10.5-10.0

TABLE 1. (*Contd.*) Monthly range of the hydrological parameters of Station II (South-Sagar) during March 1980 to February 1981.

March	26.5-26.8	22.43-26.36	2.5-2.7	8.2-8.3	11-16
April	27.1-29.1	23.32-27 79	1.7-2.7	8.3-8.3	9-14
May	30.1-30.1	28.68-32.03	1.9-2.8	8.3-8.3	6-14
June	30.9-31.5	21.89-31.85	2.9-3.1	8.3-8.3	8-10
July	29.8-30.5	9.32-14.52	2.9-3.3	7.9-8.1	4-10
August	29.7-30.9	3.75- 8.14	3.1-3.8	7.6-7.8	5- 7
September	31.3-31.5	4.65- 8.87	3.1-3.4	7.9-8.0	6- 7
October	29.9-31.5	11.06-11.97	3.5-3.7	7.9-8.0	4- 8
November	26.8-26.8	13.79-14.70	3.0-3.0	8.1-8.1	12-20
December	22.0-23.0	16.51-17.94	3.1-3.3	8.1-8.1	12-26
January	20.0-21.0	17.05-19.20	3.2-3.4	8.1-8.2	10-20
February	22.0-23.6	20.28-22.07	2.9-3.2	8.2-8.3	8-20

TABLE 2. Correlation among the hydrological parameters in two specified Stations.

	Station I (Kachuberia)				Station II (South Sagar)			
	Salinity	Dissolved oxygen	Transparency	pH	Salinity	Dissolved oxygen	Transparency	pH
Water temperature	0.14	-0.25	-0.49*	-0.20	0.01	-0.30	-0.74**	-0.20
Salinity		-0.95***	0.40	0.85**		-0.88**	0.37	0.95**
Dissolved oxygen			-0.30	-0.84**			-0.02	-0.77**
Transparency				0.48*				0.82**

* Significant at 5% level.

**Significant at 1% level.

Zooplankton Biomass :

The density of zooplankton during high saline premonsoon season 2,650-9,455/m^3 at Station I and 9,210-33,730 no/m^3 at Station II ; and during monsoon season 1,255-2,800 no/m^3 at Station I and 3,450-8,410 on/m^3 at Station II were encountered. During the postmonsoon the population showed an intermediate value, 2,975-5,820 no/m^3 at Station I and 10,470-18,215 no/m^3 at Station II. Biomass values in terms of displacement volume and wet weight were higher at Station II (3.18 ml/m^3 and 1,190 mg/m^3) than at Station I (1.01 ml/m^3 and 366 mg/m^3). The zooplankton showed two peaks, the primary peak was recorded during March-April and the secondary in November-December in both the stations. Among the zooplankton component copeped constituted the most predominant portion sharing 73.57-88.23% at Station I and 83.69-94.91% at Station II (Table 3).

Forty two species of planktonic copepod were observed in the surface collection from Station II and only 18 species were recorded from Station I throughout the study period.

The copepod species identified in the present investigation have been classified into four categories depending upon the salinity preference. The marine species, marine to brackish water species and brackish to fresh water species. Of the 42 species found at both the stations, 19 belonged to first category, 3 to the second category, 16 to the third category and 4 to the last category

TABLE 3. Quantitative estimation of zooplankton and copepod comprising total population, percentage (in parenthesis) and the biomass value in two different stations.

	Station I (Kachuberia)				Station II (South Sagar)			
Months	Tolal Zooplankton No/m^3	Total Copepod No/m^3 & %	Displacement Vol. ml/m^3	Wet weight mg/m^3	Total Zooplankton No/m^3	Total Copepod No/m^3 & %	Displacement Vol. ml/m^3	Wet weight mg/m^3
March	7,800	6,675 (85.57)	0.98	315	32,080	30,450 (94.91)	3.08	1,125
April	9,455	8,075 (85.40)	1.01	366	33,730	31,225 (92.57)	3.18	1,190
May	4,680	3,950 (84.40)	0.85	249	16,355	14,925 (91.25)	1.50	677
June	2,650	2,150 (81.13)	0.58	182	9,210	8,275 (89.84)	1.12	426
July	1,490	1,100 (73.57)	0.74	130	4,660	3,900 (83.69)	0.83	268
August	1,255	9, 50 (75.69)	0.76	134	3,450	3,075 (89.13)	0.87	299
September	1,310	1,025 (78.24)	0.20	87	4,015	3,700 (92.15)	0.77	156
October	2,800	2,300 (82.14)	0.72	124	8,410	7,425 (88.28)	1.01	400
November	5,820	5,125 (88.06)	0.90	288	15,945	14,400 (90.31)	1.58	674
December	5,325	4,625 (86.85)	0.86	215	18,215	16,390 (89.76)	1.68	741
January	3,595	3,125 (86.92)	0.73	133	11,005	9,750 (88.59)	1.19	465
February	2,975	2,625 (88.23)	0.69	198	10,470	9,325 (89.06)	1.10	435

TABLE 4. Grouping of the copepod species at the two stations under different salinity gradients.

Marine	Marine—Brackish	Brackish	Brackish—Freshwater
Calanus tenuicornis	*Eucalanus elongatus*	*Paracalanus parvus*	*Pseudodiaptomus annandalei*
Nannocalanus minor	*Acrocalanus gibber*	*P. dubia*	*P. binghami*
Canthocalanus pauper	*A. inermis*	*P. serratipes*	*Acartiella sewelli*
Undinula vulgaris		*Pseudodiaptomus aurivilli*	*Oithona brevicornis*
Eucalanus monachus			
Acrocalanus similis		*P. tollingeri*	
Euchaeta marina		*Labidocera acuta*	
Centropages dorsispinatus		*L. minuta*	
Pseudodiaptomus serricaudatus		*L. euchaeta*	
Temora turbinata		*L. sinilobata*	
T. stylifera		*Pontella andersoni*	
Acartia erythraea		*Acartia spinicauda*	
Tortanus gracilis		*A. centrura*	
Macrosetella gracilis		*A. plumosa*	
M. oculata		*Microsetella rosea*	
Longipedia weberi		*Oithona rigida*	
Euterpina acutifrons		*Corycaeus danae*	
Cladorostrata brevipoda			
Oncaea venusta			

(Table-4). Nineteen species of the first category were recorded mostly from Station II where high saline condition prevail almost throughout the year except the monsoon season. They migrate into estuaries during high saline conditions. Significant correlation coefficient values were worked out for copepod species in relation to salinity and temperature (Table-5). The relationship between most of the species and salinity was positive and high (significant at 5% or 1% level). *Pseudodiaptomus annandalei* and *Acartiella sewelli* showed negative correlation at Station II and were recorded in large numbers during low salinity regime. In general, most of the species showed negative correlation with water temperature. Consequently, with the increase of temperature the population density generally decreases.

Discussion

Hooghly estuary is regarded as the largest estuary in India with a dynamic ecosystems undergoing considerable variations in its physico-chemical characteristics owing to ever fluctuating salinity regime and sediment load is concerned. The spectacular influence of the South-West monsoon which brings about an erratic change both in the meteorological and hydrological conditions is an important feature.

A wide fluctuation in annual water temperature of about 10°C was encountered in this estuary and the salinity was mainly influenced by the monsoon rains and surface run off. The salinity varied from 1.01 to 32.03‰. It seems that both temperature and salinity are the important factors which

TABLE 5. Correlation of population densities of different species with water temperature and salinity at two stations.

	Station I		Station II	
	Water Temperature	Salinity	Water Temperature	Salinity
Calanus tenuicornis	—	—	-0.25	0.45*
Nannocalanus minor	—	—	-0.15	0.71**
Canthocalanus pauper	—	—	0.08	0.60**
Undinula vulgaris	—	—	-0.29	0.53**
Eucalanus elongatus	-0.40*	0.46*	-0.48*	0.45*
E. monachus	—	—	-0.14	0.60**
Paracalanus parvus	-0.24	0.53**	0.11	0.48*
P. dubia	-0.30	0.52**	0.001	0.45*
P. serratipes	-0.26	0.46*	0.16	0.46*
Acrocalanus gibber	-0.21	0.38	-0.10	0.57**
A. similis	—	—	-0.56**	0.18
A. inermis	-0.14	0.40*	-0.50*	0.42*
Euchaeta marina	—	—	0.04	0.37
Centropages dorsispinatus	—	—	-0.08	0.69**
Pseudodiaptomus aurivilli	-0.31	0.51**	0.23	0.52**
P. serricaudatus	—	—	-0.12	0.67**
P. annandalei	-0.48*	0.42*	-0.28	-0.56**
P. tollingeri	0.24	0.52**	-0.59**	0.37
P. binghami	0.22	0.50*	0.008	0.38
Temora turbinata	—	—	-0.22	0.66**
T. stylifera	—	—	0.43*	0.39
Labidocera acuta	-0.03	0.43*	0.12	0.52**
L. minuta	-0.17	0.47*	0.28	0.36
L. euchaeta	—	—	-0.18	0.33
L. sinilobata	—	—	-0.28	0.46*
Pontella andersoni	-0.34	0.45*	-0.38	0.42*
Acartia spinicauda	-0.44*	0.48*	-0.23	0.54**
A. erythraea	—	—	0.005	0.62**
A. centrura	—	—	0.19	0.46*
A. plumosa	-0.15	0.54**	0.10	0.52**
Acartiella sewelli	0.24	0.47*	-0.16	-0.43*
Tortanus gracilis	—	—	-0.17	0.38
Microsetella rosea	0.01	0.49*	-0.37	0.50*
Macrosetella gracilis	—	—	-0.36	0.56**
M. oculata	—	—	-0.26	0.34
Longipedia weberi	—	—	0.27	0.36
Euterpina acutifrons	—	—	-0.46*	0.36
Cladocalanus brevipoda	—	—	0.12	0.41*
Oithona rigida	0.11	0.50*	0.09	0.72**
O. brevicornis	—	—	0.03	0.38
Oncaea venusta	—	—	-0.23	0.49*
Corycaeus danae	—	—	-0.28	0.42*

* Significant at 5% level
** Significant at 1% level

influence the seasonal distribution of different groups of zooplankton in this area.

The water temperature and salinity range in the Hooghly estuarine system around Sagar Island varied from 20.0-31.5°C and 1.01-32.03%. respectively, but the recruitment of maximum population was recorded when the temperature range was 22.0-30.0°C and salinity of the environment was 5.00-27.79‰. Bhunia and Chowdhury (1981) from Hooghly estuary also reported maximum copepod population when the salinity was high and temperature was low.

During the present study, a total of 42 copepod species have been recorded, bulk of which were from Station II. Pillai (1971) in his account on the estuarine copepods of India has recorded 41 species from Cochin backwater and Goswami and Selvakumar (1977) recorded 49 copepods from estuarine system of Goa.

Significant correlation was found out between the number of copepod species and salinity at both the stations indicating presence of several species of marine origin. During the premonsoon months when the salinity was high in this estuarine system, neritic species viz., *Calanus tenuicornis*, *Nannocalanus minor*, *Canthocalanus pauper*, *Undinula vulgaris*, *Eucalanus monachus*, *Acrocalanus similis*, *Euchaeta marina*, *Centropages dorsispinatus*, *pseudodiaptomus serricaudatus*, *Temora turbinata*, *T. stylifera*, *Acartia erythraea*, *Tortanus gracilis*, *Macrosetella gracillis*, *M. oculata*, *Longipedia weberi*, *Euterpina acutifrons*, *Cladorostrata brevipoda*, *Oncea venusta* were recorded at Station II. Pillai *et al.*, (1973) also stated the similar findings from Cochin backwater. During monsoon months, the hydrological conditions changed and consequently the copepod species were different. *Acartiella sewelli*, *Pseudodiaptomus annandalei* were recorded as monsoonal species. Kasturirangan (1963) reported *Acartiella sewelli* preferred low saline condition. Madhupratap (1976) contends that *Pseudodiaptomus annandalei* has a wide range of salinity tolerance (0-35%.) and occur throughout the year in Cochin backwater. *Paracalanus parvus*, *P dubia*, *P. serratipes*, *Pseudodiaptomus aurivilli*, *P tollingeri*, *Labidocera acuta*, *L. minuta*, *L. euchaeta*, *L. sinilobata*, *Pontella andersoni*, *Acartia spinicauda*, *A. centrura*, *A. plumosa*, *Microsetella rosea*, *Oithona rigida*, *Corycaeus danae* were recorded as typical estuarine copepods.

One of the major features of zooplankton distribution in the tropical estuary is the contrast in abundance of zooplankton between high and the low saline periods. Comparatively a poor fauna exist during the low saline seasons when the surface run off due to heavy precipitation flood the estuaries (Rao, *et al.*, 1981). Population was diverse and abundant during high salinity regime and was comprised of estuarine, estuarine and marine and euryhaline marine forms in addition to adventitious immigrants.

The zooplankton production showed two peaks in their abundance at different places of Indian waters. Subbaraju and Krishnamurthy (1972) found the abundance in April and September at Portonovo water. Raghunathan and Srinivasan (1983) recorded two peaks (December and February) for copepod population from Ennore estuary. In the lower reaches of Hooghly estuary, Bhunia and Choudhury (1982) recorded two peaks, one in March-April and the other in November-December. The present observation also endorses the preceding report.

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