Mahasagar-Bulletin of the National Institute of Oceanography, *14*(3), 1981, 215-219.

CLADOCERA IN THE ESTUARINE AND COASTAL WATERS OF SOUTH-WEST COAST OF INDIA

M. MADHUPRATAP

National Institute of Oceanography, Dona Paula, Goa-403 004

ABSTRACT

Occurrence and abundance of marine Cladocera in several estuaries along the south-west coast of India is presented and compared with their distribution in the coastal waters. One peculiar feature observed was their absence in the estuaries during high saline premonsoon period and tolerance to low salinity. Since the resting eggs of cladocera can be successfully hatched in the laboratory and reproduce at a very high rate, they form ideal organisms for mass culture.

Cladocera are unique in being the only planktonic crustaceans able to reproduce parthenogenetically. This capacity renders them with a high rate of reproductive ability and their population often abruptly flowers into large swarms. Essentially neritic, they form the food of many planktonivorous fishes and the relation of their swarms to the mackeral fisheries of west coast of India has been reported (Selvakumar, 1970). Distribution of Cladocera in the Indian Ocean has been studied by Della Croce and Venugopal, 1972. Biology of the cladoceran *Penilia avirostris* has been discussed by Vijayalakshmi and Venugopal (1972) and Della Croce and Venugopal (1973). However, information regarding their ecology in the Indian waters is mostly scattered. The present paper attempts to draw the pattern of the occurrence of cladocera based on observations conducted at the mouth of several estuaries along the south-west coast of India and relate it to their distribution along the coastal waters.

Cladocera were counted to species level from collections taken every month in 1972 at the mouth of the Cochin backwaters in oblique hauls using a Heron-Tranter net (Mesh size 300 μ) with a flow meter attached. Data of their abundance similarly collected in 1978 from seven other estuaries along the southwest coast of India (Fig. 1) are also incorporated.

Two species, viz. *Evadne tergestina* Claus and *Penilia avirostris* Dana occurred in the Cochin backwater (Fig. 2). Another species *Podon polyphemoides* (Leuckart) was recorded in some other estuaries although in low numbers (Table I). The striking feature in the distribution was the seasonality in their occurrences. Cladocerans were usually not observed in the estuaries during the high saline premonsoon months (January-April). They occurred during the monsoon or postmonsoon months and tolerated a wide range of salinity, surprisingly thriving in very low salinities for a typically neritic group (Fig. 2). Their survival in low salinity was confirmed by their presence in the surface waters of the estuary during monsoon period. Cladocera were present in the interior parts of the Cochin backwaters during the low saline monsoon period albeit their distribution being discontinuous both in space and time (Madhupratap

and Haridas, 1975). Peak abundance was observed in August at the mouth of the Cochin backwaters (*E. tergestina* 170/m³, *P. avirostris* 179/m³).

High salinity conditions (30 to 35‰) are attained in the estuaries along southwest coast of India during the premonsoon months (January–April). The exclusion of cladocerans inside the estuaries during this season is surprising. Other studies from Cochin backwaters (Nair and Tranter, 1971) and Mandovi–Zuari estuaries of Goa (Goswami and Selvakumar, 1977) also confirm these results. Hence it would be of interest to consider reasons that may lead to this.

Della Croce and Venugopal (1972) observed that *E. tergestina* occurs discontinuously throughout the year in the coastal waters of the Arabian Sea and attains population peak in November, while *P. avirostris* is found mainly at two different periods, March/May and November/December.

Cladocerans are filter feeders and their association to phytoplankton especially diatoms is fairly well known. Along the west coast of India there is a general outburst of phytoplankton with the outbreak of monsoon and associated decrease of salinity (Qasim, Bhattathiri and Devassy, 1972). Peak populations of cladocerans have been recorded along south-west coast of India during south-west monsoon (Haridas, Menon and Madhupratap, 1980). Selvakumar (1970) observed cladoceran swarm off Goa in October to be associated with setoid diatoms such as *Chaetoceros, Thalassiothrix* and *Nitzschia* and dinoflagellate *Ceratium*.

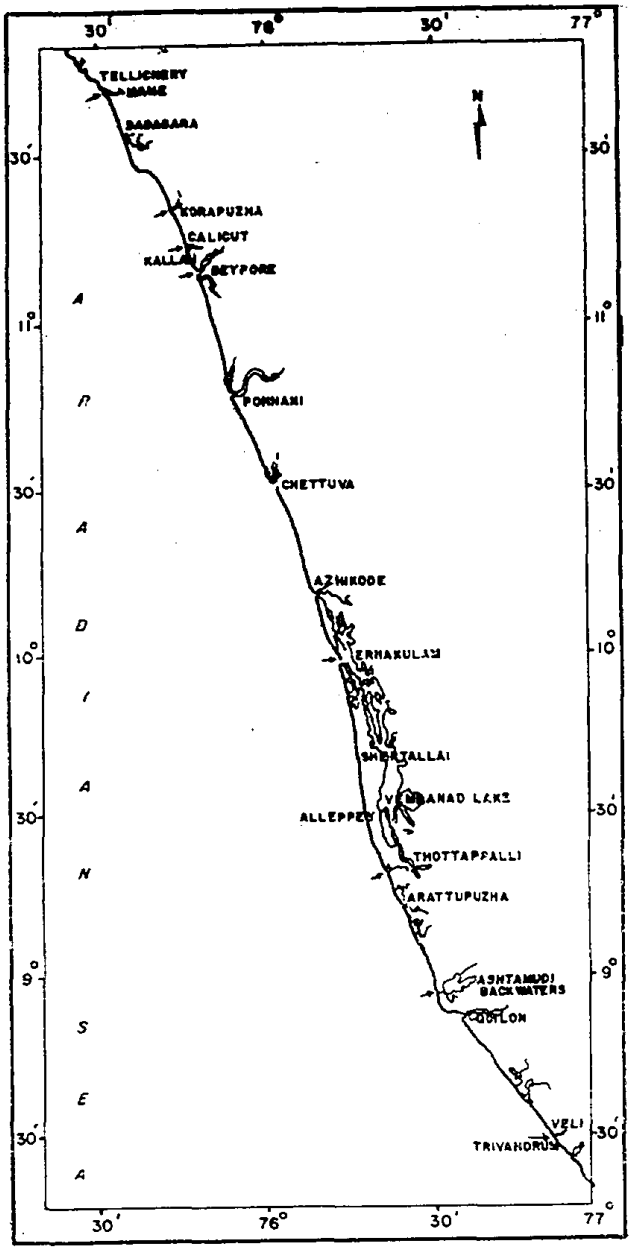

Fig. 1. Map showing station positions.

Cladoceran abundance in coastal waters along west coast is, however, not restricted to the monsoon period. Devassy, Bhattathiri and Qasim (1979) have recorded swarming conditions of Cladocera off Goa in April associated with the successional sequence of organisms following the decay of a bloom of the blue green alga *Trichodesmium* and subsequent to an increase of diatoms. Purushan, Balachandran and Sakthivel (1974) have observed cladocerans to be abundant along south-west coast of India in February–April. A swarm of *P. avirostris* associated with *Trichodesmium* and Pteropod *Creseis* has been reported off Cochin in March (Sakthivel and Haridas, 1974).

Along the east coast in the Madras waters maxima of *E. tergestina* occurred

Table I. Period of occurrence of Cladocera (No./m^3 in parenthesis) at the estuaries (other than Cochin backwaters) in 1978.

Estuary	*Evadne tergestina*	*Penilia avirostris*	*Podon polyphemoides*
Mahe	November (2)	November (1)	—
Korapuzha	June (3)	August (11)	—
	August (6)		
Kallai	—	—	October (1)
Beypore	August (92)	August (70)	October (2)
	October (11)	October (2)	
Thottapalli	August (3)	—	October (3)
Neendakara	February (1)	August (35)	—
(Ashtamudi)	August (7)	September (7)	
	September (1)		
	December (32)		
Veli	December (1)	—	January (1)

between March and May following diatom abundance. A relation of diatom cycle and population of *P. Avirostris* has been reported from Porto Novo waters (Vijayalakshmi and Venugopal, 1972).

It could well be assumed that the cladocera occurring in the estuaries during monsoon and postmonsoon periods were the extensions of the population which existed in the inshore waters. However, reasons for their absence in the estuaries during high saline season is not easily explicable, since their populations exist in the coastal waters during this period also. Wickstead (1963) suggested that an increase in number of diatoms coincident with the population 'explosion' of *P. avirostris* maintains the oxygen and carbon dioxide concentration at an acceptable level for cladocerans in relation to oxygen and carbon dioxide produced by zooplankton. The disappearance of diatoms will destroy the balance between zooplankton, oxygen and carbon dioxide. Lowering the oxygen or raising the carbon dioxide in the water causes parthenogenetic females to produce both resting eggs and males.

It may be possible that the carbon dioxide produced by large numbers of zooplankton present in the estuaries during premonsoon (Rao, 1977) may affect the

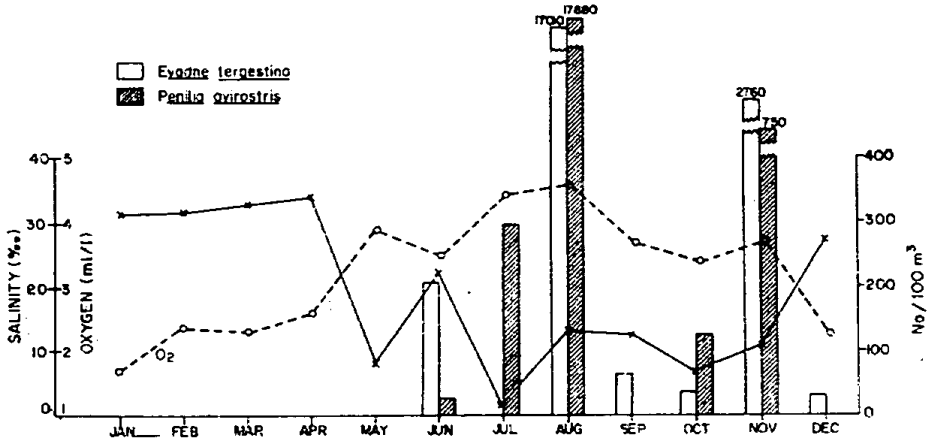

Fig. 2. Distribution of salinity, oxygen and species of cladocera at the mouth of Cochin backwaters in 1972.

oxygen level required by cladocerans. Severe competition (predation) from other organisms (zooplankton) may be another factor restricting the occurrence of cladocerans in the estuaries during high saline premonsoon period although they occur in higher salinities in marine waters. But during the monsoon period oxygen in the surface layers increases (Fig. 2) and there is a drastic decrease in the zooplankton abundance in the estuaries (Haridas, Madhupratap and Rao, 1973). This and a general increase in phytoplankton population during this period (Devassy and Bhattathiri, 1974) may facilitate the entry and viability of cladocerans during the low saline period.

Occurrence of large number of resting egg of *E. tergestina* and *P. avirostris* in the sea bottom to tide over adverse environmental conditions has been confirmed and these eggs have been successfully hatched under laboratory conditions (Onbe, 1973). Cladocera are of considerable importance in the economy of the sea because of their relation to pelagic fisheries, and are believed to play an important role in the phosphorus regeneration (Barlow and Bishop, 1965). Since their resting eggs can be collected and hatched in the laboratory and they reproduce at a very high rate and withstand considerable variations of salinity, cladocerans are ideal organisms for mass culture as living food for fishes and their larvae. A proper study of their seasonal variations, biology and resting eggs from Indian waters is imperative.

ACKNOWLEDGEMENTS

The author wishes to thank Dr. S. Z. Qasim and Dr. T. S. S. Rao for the facilities and encouragement given to the study.

REFERENCES

Barlow, P. J and W. J. Bishop, 1965. Phosphate regeneration by zooplankton in Cayuga lake. *Limnology and Oceanography*, **10**: 15–24.

Della Croce, N. and P. Venugopal, 1972. Distribution of marine cladocerans in the Indian Ocean. *Marine Biology*, **15**: 132–138.

Della Croce, N. and P. Venugopal, 1973. *Penilia avirostris* Dana in the Indian Ocean. *Internationale Revue der Gesamten Hydrobiologie*, **58**: 713–821.

Devassy, V. P. and P.M.A. Bhattathiri, 1974. Phytoplankton ecology of the Cochin backwater. *Indian Journal of Marine Sciences*, **3**: 46-50.

Devassy, V P., P.M.A. Bhattathiri and S.Z. Qasim, 1979. Succession of organisms following *Trichodesmium* phenomenon. *Indian Journal of Marine Sciences*, **8**: 89–93.

Goswami, S. C. and R. A. Selvakumar, 1977. Plankton studies in the estuarine system of Goa. *Proceedings of the Symposium on Warm Water Zooplankton*, Special Publication, N.I.O., Goa, 226–241.

Haridas, P., M. Madhupratap and T.S.S. Rao, 1973. Salinity, temperature, oxygen and zooplankton biomass of the backwaters from Cochin to Alleppey. *Indian Journal of Marine Sciences*, **2**: 94–102.

Haridas, P., P.G. Menon and M. Madhupratap, 1980. Annual variations in zooplankton from a polluted coastal environment. *Mahasagar–Bulletin of the National Institute of Oceanography*, **13**: 239-248.

Madhupratap, M. and P. Haridas, 1975. Composition and variations in the abundance of zooplankton of the backwaters from Cochin to Alleppey. *Indian Journal of Marine Sciences*. **4**: 77–85.

Nair, K. K C. and D. J. Tranter, 1971. Zooplankton distribution along salinity gradient in the Cochin backwater before and after the monsoon. *Journal of the Marine Biological Association of India*, **13**: 203–210.

Onbe, T, 1973. Preliminary notes on the biology of the resting eggs of marine cladocerans. *Bulletin of the Plankton Society of Japan*, **20**: 74–77.

Purushan, K. S., T. Balachandran and M. Sakthivel, 1974. Zooplankton abundance off the Kerala coast during February and April, 1970. *Mahasagar–Bulletin of the National Institute of Oceanography*, **7**: 165–175.

Qasim, S. Z., P. M. A. Bhattathiri and V. P. Devassy, 1972. The influence of salinity on the rate of photosynthesis and abundance of some tropical zooplankton. *Marine Biology*, **12**: 200-206.

Rao, T. S. S., 1977. Salinity and distribution of brackish water zooplankton in Indian estuaries. *Proceedings of the Symposium on Warm Water Zooplankton*, Special Publication, NIO, Goa, 196-204.

Sakthivel, M. and P. Haridas, 1974. Synchronisation in the occurrence of *Trichodesmium* bloom and swarming of *Creseis acicula* Rang (Pteropoda) and *Penilia avirostris* Dana (Cladocera) in the area off Cocchin. *Mahasagar–Bulletin of the National Institute of Oceanography*, **7**: 61–67.

Selvakumar, R. A., 1970. Cladocera swarm in relation to mackeral fishery along the west coast of India. *Current Science*, **39**: 481–482

Vijayalakshmi, G. S. and V. K. Venugopal, 1972. Occurrence and fertility of *Penilia avirostris* Dana (Cladocera) in Porto Novo waters. *Indian Journal of Marine Sciences*, **1**: 125–127.

Wickstead, J. H, 1963. The cladocera of the Zanzibar area of the Indian Ocean, with a note on the comparative catches of two plankton nets. *East African Agricultural and Forest Research Journal*, **29**: 164-172.