

Benthos of Cochin backwaters receiving industrial effluents

K Sarala Devi & P Venugopal

National Institute of Oceanography, Regional Centre, Cochin 682 018, India

Received 11 July 1988; revised 8 May 1989

Faunal composition of benthos and its spatial and temporal distribution at 9 stations in the northern limb of the Cochin backwaters are studied. An industrial belt is located about 18 km upstream of barmouth, and the effluents are discharged into the river. This stretch with a station 2 km further upstream forms the area of study. Faunal groups/species are rich at barmouth (st 1), gradually decline upstream and record lowest density at the effluent discharge point (st 8). Five major and 26 other groups or organisms are encountered during the study. Polychaetes and molluscs are the only major groups present at all stations. Amphipods rank third being present at sts 1-7; followed by isopods and tanaidaceans. Polychaetes are the most common and constitute the largest assemblage of benthic forms in the study area. The polychaete species *Capitella capitata* which is present in enormous numbers at or near the discharge site can be considered to be an indicator species of industrial pollution. Substrate characteristics and hydrographic features of the area are also discussed.

Benthic studies in the Cochin backwaters have been reported by several workers¹⁻¹². However, no work has been undertaken on the benthic fauna of the backwaters in and around the industrial belt at Eloor. The present work pertains to the faunal composition and distribution of macrofauna from 9 stations in Cochin backwaters upstream and downstream of the effluent discharge point at Eloor.

Materials and Methods

Monthly observations were made at 9 stations (Fig. 1) in the study area covering 21 km upstream from barmouth (st 1) during January 1981 to December 1981 except during February, when data could not be collected due to technical difficulties.

Benthos were collected using a van Veen grab (0.048 m²). All organisms retained by a 0.5 mm mesh sieve¹³ were collected and preserved in 5% neutral formalin mixed with rose bengal for subsequent identification. The actual number of organisms were converted to number per m². Sediment samples were also collected and subjected to grain size analysis by pipette method¹⁴.

Results and Discussion

Faunal composition and occurrence—Figs 2 and 3 depict respectively the total number of benthic organisms and their percentage composition at the 9 stations. Benthic fauna of 9 stations consisted of 5 major groups (amphipods, polychaetes, isopods, tanaidaceans and molluscs) which were abundant and also

other organisms (including individual species and groups) which were less significant due to their oc-

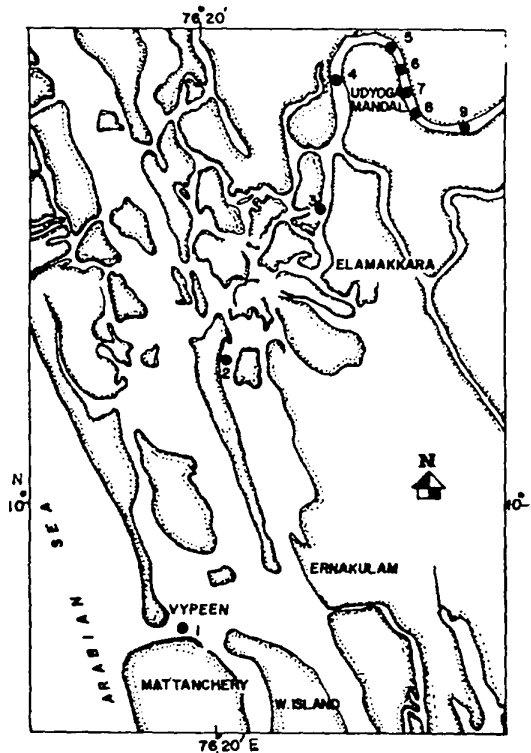


Fig. 1—Location of stations in Cochin backwaters

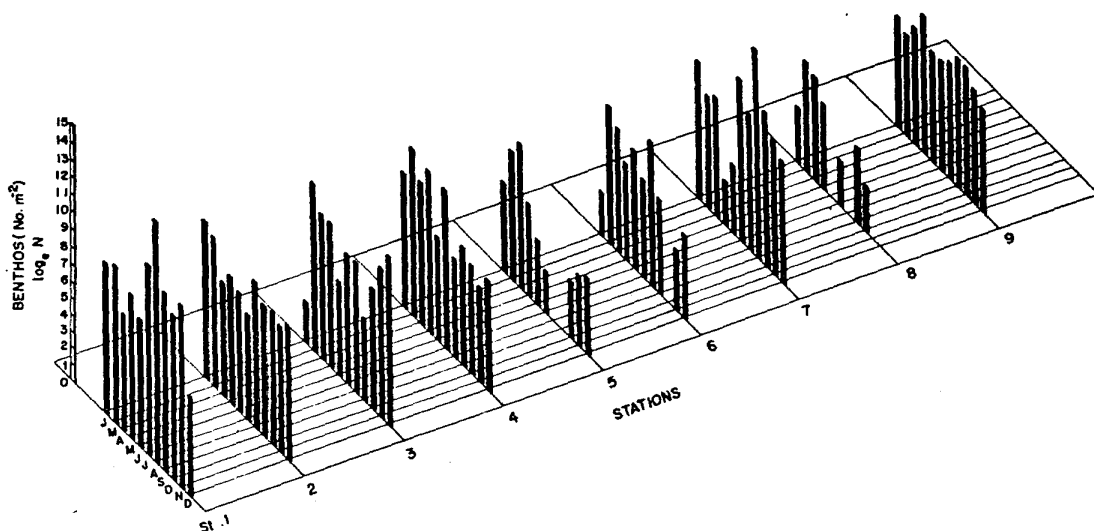


Fig. 2—Distribution of total number of Benthos at 9 stations

sional occurrence. Among the other organisms including 13 riverine forms, chironomid larvae a pollution indicator species¹⁵ were present at 7 stations except at sts 1 and 6. Next in occurrence was insect larvae being present at 6 stations except sts 3, 4 and 8. Decapods occurred at sts 1, 2, 4 and 5 and *Tanytarsus* sp. at sts 2, 3, 5 and 9. The other groups occurred at different stations; nematodes (sts 1-4), sipunculoides and juveniles of fishes (sts 1-3), *Ephydra* sp. (sts 3, 6 and 9), *Plectronemia* sp. (sts 2, 3 and 9), *Cumacea* sp. (sts 2-4), *Anatopynia* sp. (sts 6 and 9), *Diamesa* sp. (sts 7 and 9) and Echinoderms (sts 1 and 2).

Faunal density—Spatial variations: Polychaetes were the most common group present at all the stations constituting the largest assemblage of the benthic organisms. Station-wise variations showed their maximum density at st 7 ($23 \times 10^4 \text{ m}^{-2}$) comprising mainly *Capitella capitata*. St 8 recorded the lowest value of 947 m^{-2} .

Molluscs, the second most common group were present at all the stations. The peak density of $27 \times 10^3 \text{ m}^{-2}$ was at st 4 and composed of *Villorita cyprinoides*. The lowest density was observed at st 7 (147 m^{-2}).

Amphipods ranked third in occurrence and they were absent at sts 8 and 9. The peak abundance of amphipods ($2.04 \times 10^6 \text{ m}^{-2}$) occurred at st 1. Subsequently they exhibited a substantial reduction towards sts 6 and 7 with counts of 182 m^{-2} and 627 m^{-2} respectively, thereafter they were totally absent at sts 8 and 9.

Isopods ranking fourth in occurrence were recorded at 5 stations only. Their peak abundance

($41 \times 10^3 \text{ m}^{-2}$) was at st 1. However, the other 4 stations recorded considerably lower densities ranging from $241\text{--}501 \text{ m}^{-2}$. But for a very low density of 14 m^{-2} at st 6 they were totally absent at sts 5, 7, 8 and 9.

Tanaidaceans, like isopods were seen at the same 5 stations with a peak value of 4073 m^{-2} at st 1. As is the case with isopods low densities ranging from 42 m^{-2} to 140 m^{-2} were recorded at sts 2-4. They were absent in the rest of the stations except for a scanty presence at st 6 (14 m^{-2}). The other organisms did not exhibit any definite pattern in their distribution. But some of the riverine forms among these namely *Baetis* sp., Mayfly larvae, water beetle and *Platambus* sp. were endemic to st 9.

Temporal variations: Amphipods predominated the benthic fauna (Fig. 3) comprising over 92% from August to November at st 1. Polychaetes constituted 60-90% at sts 1-6 and 9; 77-100% at sts 7 and 8 during the different months. Molluscs formed 100% during January at st 3 and during March at st 7. Only polychaetes were present during April and August at st 2, molluscs during January at st 3, insect larvae during July at st 5, *Ephydra* sp. during January at st 6 and chironomid larvae during January at st 8.

Benthic fauna were totally absent during August and September at st 5, during October at st 6 and during June, August, November and December at st 8.

Above results clearly indicated faunal succession at all stations during the period of study. Even indicator species (chironomid and *Capitella capitata*) were not present in polluted stations during all months. The above facts clearly indicated that the presence of benthic organisms depend, in addition to pollu-

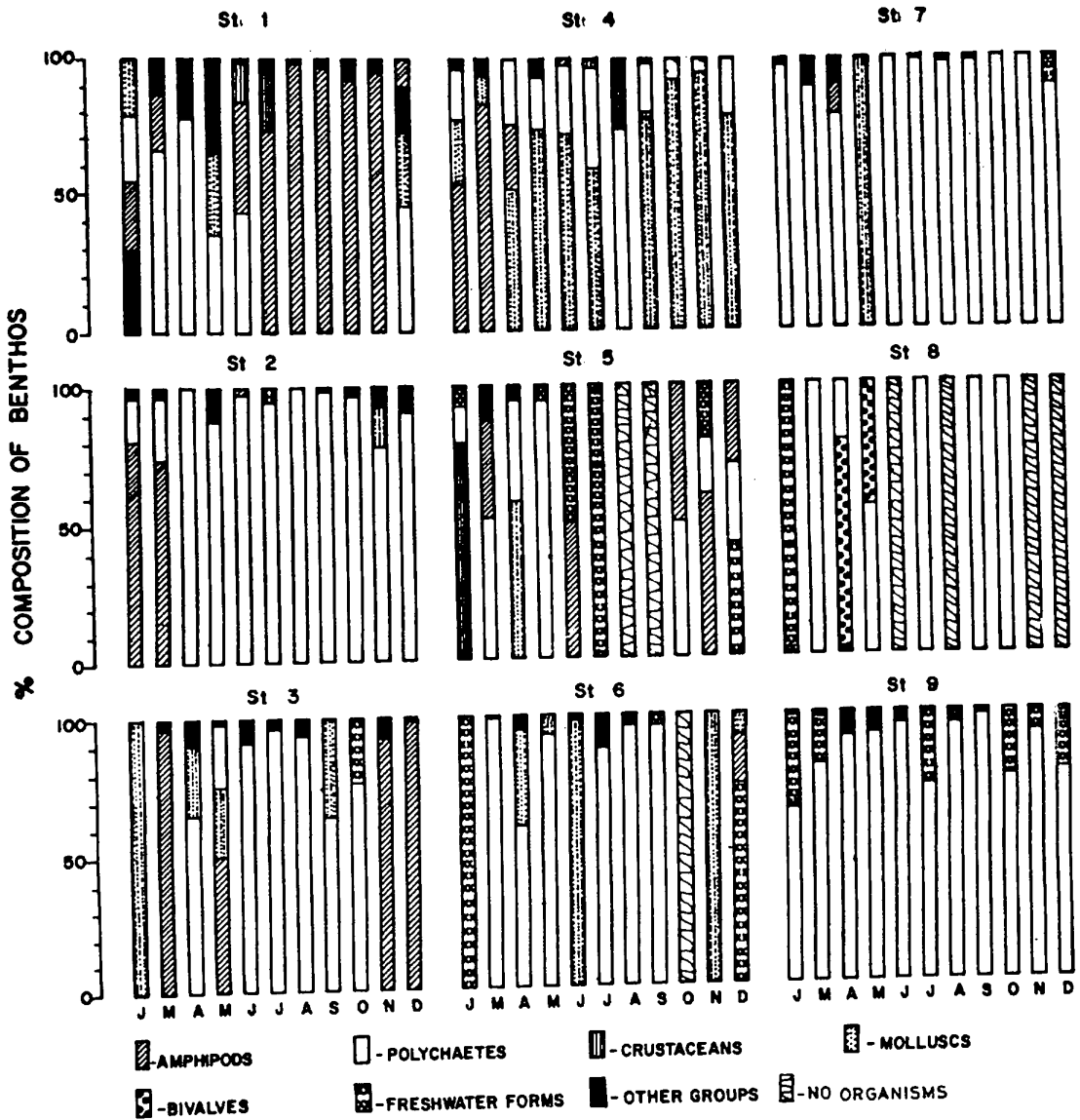


Fig. 3.—Distribution of major groups of Benthos at 9 stations

tion effects, on a number of other environmental parameters¹⁶.

Faunal diversity—Of the total faunal groups and species identified, 16 were present at sts 1 and 2 followed by 14 at sts 3 and 9, 9 at sts 4, 5 and 6, 7 at st 7 and only 3 at st 8. This clearly indicated a reduction in faunal diversity and a progressive reduction in the number of faunal groups and species from the mouth of the estuary upstream up to the discharge point (st 8).

Density of benthic fauna was high during summer

months except at barmouth (st 1) and sts 6 and 7. Maximum density was recorded at st 1 ($1.86 \times 10^6 \text{ m}^{-2}$) in August. Of this 98.7% was constituted by the amphipod species *Corophium triaenonyx* which can tolerate lower salinities¹. Abundance of fauna near barmouth region may be attributed to favourable conditions for the marine and estuarine life as reported earlier^{2,4,7}. Desai and Krishnan Kutty² have also noticed a progressive decrease in the annual population from the lower part of the Cochin backwaters towards the upper reaches. Variations in salinity has been indicated

as a major factor in limiting the distribution of benthic fauna in coastal waters^{4,17}. The low density during monsoon (June to October) may be due to the fall in salinity. Devassy and Gopinathan¹⁸ however have noted an increase in benthic biomass from marine to fresh water region during monsoon in Cochin backwaters. The high levels of primary food available in tropical estuaries is known. Qasim *et al.*¹⁹ have reported that excess food is available in Cochin estuary. Studies on particulate matter also corroborate this¹⁶. Thus food available to bottom communities not being limited, abiotic factors especially salinity seem to control their distribution, in the absence of other perturbations. The latter was relevant only at and immediately below the discharge site (st 8). Of the six species of amphipods collected most are euryhaline and hence their presence upstream. Sts 6 and 7 showed higher abundance of benthos during the monsoon season comprising mainly *Capitella capitata*. It shows a peak abundance in September ($1.9 \times 10^5 \cdot m^{-2}$) indicating conducive conditions. This need not necessarily be salinity dependent as optimum threshold levels of pollutants that cause stress to other species could also have encouraged their proliferation.

Diversity was low at the discharge site (st 8) indicating prevalence of stress conditions. Number of individuals was also low showing it up as a rigorous environment. Jayapalan *et al.*²⁰ have reported the deleterious effect of effluents on the plankton productivity of the area. Fish mortality due to ammonia content was noted by Unnithan *et al.*²¹. Sarala Devi *et al.*²² have noticed the absence of benthic fauna at this effluent discharge point. To sum up it can be stated that the low density of benthic fauna at the effluent discharge point may be due to cumulative toxic effects.

That the nature of substrate greatly influences benthic communities is well accepted²³⁻²⁶. Sediments at sts 1 and 2 were silty clay and rich in organic matter. Abundant and diverse fauna thrived here. Sts 7 and 8 having similar sediments however were different. St 8 had poor population and poor biomass while st 7 had high biomass contributed by a single polychaete species. Diversity at both stations were low. St 9 further upstream also had organic rich sediments but the texture was more sandy. This station showed a total of 21 faunal groups and species as against 6 and 16 at sts 8 and 7 respectively. The more sandy substrate further down stream at sts 6, 5, 4 and 3 supported more healthy populations dominated by *Villorita cyprinoides*. Thus the nature of substrate also influenced the variation in quality and quantity of benthos in the study area.

Like other estuaries the major variable in the study area too was salinity which established a continuous

gradient of 0.2 to 30.4×10^{-3} between (st 1) bar-mouth and fresh river water (st 9). This gradient was found moving up and down the estuary influenced by the monsoonal river runoff and tides. Thus at st 9 almost fresh water prevailed throughout the year except during March and April ($2.59 - 3.55 \times 10^{-3}$). As a result the spatial distribution of macrobenthos was found controlled by its ability to withstand wide fluctuations in salinity. Instead of low values, oxygen recorded nearly fully saturated conditions (4.8 to 5.6 ml.l^{-1}) at the effluent discharge site (St 8). Surprisingly inspite of discharge of large amount of effluents, anoxic condition never prevailed. The one advantage of this estuary to the benthos is the shallow depth by which suspended food particles are readily available for them through sinking as well as through downward transport by turbulent water movements as noted by Wolf *et al.*²⁷.

Acknowledgement

Authors express their gratitude to the Director and the Scientist-in-Charge, Regional Centre for encouragement and facilities.

References

- 1 Nair K K C, Gopalakrishnan T C, Venugopal P, George Peter M, Jayalakshmy K V & Rao T S S, *Mar Ecol Prog Ser*, 10 (1983) 289.
- 2 Desai B N & Krishnan Kutty M, *Proc Indian Acad Sci*, 66 (1967) 123.
- 3 Kurian C V, *Bull Nat Inst Sci India*, 38 (1967) 649.
- 4 Kurian C V, *Proc Indian Natn Sci Acad*, 38 (1972) 156.
- 5 Kurian C V, Damodaran R & Antony A, *Bull Dept Mar Sci Univ Cochin*, 7 (1975) 987.
- 6 Damodaran R, *Bull Dept Mar Sci Univ Cochin*, 6 (1973) 1.
- 7 Ansari Z A, *Mahasagar-Bull Natn Inst Oceanogr*, 7 (1974) 197.
- 8 Ansari Z A, *Mahasagar-Bull Natn Inst Oceanogr*, 10 (1977) 169.
- 9 Pillai N G K, *Macrobenthos of a tropical estuary*, Ph D thesis, University of Cochin, 1978.
- 10 Anvar Bacha S M, *Bottom fauna of the north Vembanad lake*, Ph D thesis, University of Cochin, 1984.
- 11 Remani K N, *Studies on the effect of pollution with special reference to benthos*, Ph D thesis, University of Cochin, 1979.
- 12 Remani K N, Sarala Devi K, Venugopal P & Unnithan R V, *Mahasagar-Bull Natn Inst Oceanogr*, 16 (1983) 199.
- 13 Birkett L & McIntyre A D, *Methods for the study of marine benthos*, (Blackwell Sci Publ, Oxford) 1971, pp 157.
- 14 Krumbein W C & Petti John F J, *Manual of sedimentary petrography*, (Appleton Century Crofts, New York) 1938, pp 549.
- 15 Hynes H N B, *The biology of polluted waters*, (Liverpool University Press) 1966, pp 202.
- 16 Sarala Devi K, *Effect of industrial pollution on the benthic communities of a tropical estuary*, Ph D thesis, Cochin University of Science & Technology, 1986.
- 17 Seshappa G, *Proc Natn Inst Sci India*, 19 (1953) 257.
- 18 Devassy V P & Gopinathan C K, *Fish Technol*, 7 (1970) 190.
- 19 Qasim S Z & Reddy C V G, *Bull Mar Sci*, 17 (1967) 95.

SARALA DEVI & VENUGOPAL: BENTHOS OF COCHIN BACKWATERS

- 20 Jayapalan A P, Sasidharan K M & Achuthan Nair A, *Bull Dept Fish Kerala*, 1 (1976) 47.
- 21 Unnithan R V, Vijayan M, Radhakrishnan E V & Remani K N, *Indian J Mar Sci*, 6 (1977) 81.
- 22 Sarala Devi K, Venugopal P, Remani K N, Lalitha S & Unnithan R V, *Indian J Mar Sci*, 8 (1979) 141.
- 23 Sanders H L, *Limnol Oceanogr*, 3 (1958) 245.
- 24 Bloom S A, Simon V L & Hunter V D, *Mar Biol*, 13 (1972) 43.
- 25 Bordovskiy O K, *Mar Geol*, 3 (1964) 34.
- 26 Bordovskiy O K, *Mar Geol*, 3 (1965) 1.
- 27 Wolff W J, Vegter F, Mulder H G & Meijs T, *Proc 10th European Symp Mar Biol Vol 2, Population dynamics*, edited by G Persoone & W Jaspers (Universa Press, Wetteren)1976, 653.