

## Soft sediment dwelling macro-invertebrates of Rajapur bay, central west coast of India

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Thirtyfour species of soft sediment dwelling macro-invertebrates were recorded in Rajapur bay at the proposed effluent discharge location of nuclear power plant. The fauna mainly composed of polychaetes (42.52%), molluscs (39.03%), crustaceans (7.86%), sipunculids (1.23%), echiurids (7.86%) and cephalochordates (1.5%). Deposit feeder spionidae—*Prionospio pinnata* and filter feeder bivalve—*Pecten* sp. formed the dominant and co-dominant species respectively. Maximum population density and wet biomass recorded were  $2,675 \text{ m}^{-2}$  ( $\bar{X} = 445 \pm 507$ ) and  $26.5 \text{ g m}^{-2}$  ( $\bar{X} = 6.01 \pm 6.21$ ) respectively. Annual benthic production was estimated to be  $12.02 \text{ g.m}^{-2}.\text{y}^{-1}$ . Species diversity varied from 0.91 to 3.61 ( $\bar{X} = 2.21 \pm 0.75$ ). High species diversity value showed the stability of the environment. Dominance diversity curve showed evenness of benthic fauna. This was reflected on the competition equilibrium period of the population. Species similarity cluster of different stations were formed largely due to habitat specific and feeding behaviour of the species. The spatio-temporal variations and community structure fluctuations of macro-invertebrates are mainly due to the effect of southwest monsoon and the impact of localized biotic and abiotic factors. Benthic fauna in this bay is in natural ecological balance and free from an apparent effect of environmental imbalances. The base line data generated here can be used to assess the impact of pollution, if any, in future.

The present paper deals with population dynamics, biomass production and analysis of community structure of soft sediment dwelling macro-invertebrates of the shallow waters of Rajapur bay in relation to certain environmental parameters. This investigation was carried out during March 1989 (premonsoon), September 1989 (southwest monsoon) and January 1980 (post-monsoon) which represent different seasons of the year. So far, there is no such information available in this area except that of Tulaskar *et al.*<sup>1</sup> which deals with particulate organic matter. The present study is relevant in view of the fact that this area has been chosen as an effluent discharge point for the proposed nuclear power plant.

### Materials and Methods

Sediment samples were taken in duplicate using a van Veen grab ( $0.04 \text{ m}^2$ ) for benthic studies at 9 stations in Rajapur bay (Fig. 1) along the 3 transects across the depth contours of 5, 10 and 15 m. Sediment sub-samples were removed for the grain size and organic carbon content analyses before sieving. Sediment samples were sieved through 0.05 mm mesh for investigating benthic fauna. Population density of organisms is expressed as  $\text{no.m}^{-2}$  while biomass is expressed as wet weight  $\text{g.m}^{-2}$  after removing hard

parts. Shanon-Wiener species diversity index ( $H'$ ), evenness as Heip's J, species richness as Margalef's SR were computed. Stations were classified using Soren's similarity index<sup>2</sup>. Group average clustering strategy was used<sup>3</sup> to group dendrograms. Dendrograms derived from the normal analyses were evaluated using variable stopping group<sup>4</sup>. Dominance diversity curves were plotted for each station plotting the log of relative abundance expressed as percentage against the rank of species

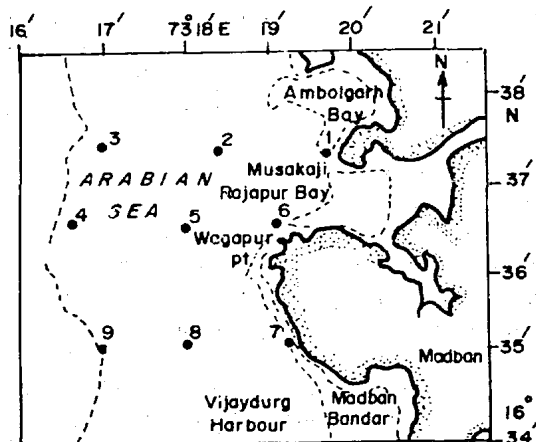


Fig. 1—Location of the study area

(most least abundant). Two way ANOVA was made to establish the level of significance of faunal data. Near bottom waters were collected by means of Nansen bottle and environmental parameters like salinity, dissolved oxygen, pH and temperature were quantified as per standard methods.

### Results and Discussion

Table 1 shows sediment characteristic and organic carbon values in the study area. Sediments were mostly silty sand, sandy silt and sand silt and clay. Organic carbon values ranged from 1.65 to 2.43 ( $\bar{X} = 1.94 \pm 0.22$ ). The salinity, temperature, dissolved oxygen and pH varied from 20.50 – 33.64  $\times 10^{-3}$  ( $\bar{X} = 31.84 \pm 2.55$ ), 24 – 28.8°C ( $\bar{X} = 26.66 \pm 23$ ), 0.15 – 5.21 ml l<sup>-1</sup> ( $\bar{X} = 2.78 \pm 0.24$ ) and 7.32 – 7.6 ( $\bar{X} = 7.37 \pm 0.07$ ) respectively in the study area. These parameters were within range of normal values and reflect a typical shallow water undisturbed coastal ecosystem along the central west coast of India.

Thirtyfour species belonging to polychaetes [(41.68%) – *Pisionedense* sp., *Hesion* sp., *Dendronereis arborifera*, *Lumbriconereis latreilli*, *Nereis* sp., *Nephtys* sp., *Onuphis* sp., *Lysidice* sp., *Glycera alba*, *Gonida* sp., *prionospio pinnata*, *Prionospio* sp., *Polydora* sp., *Nerine* sp., *Cirratulus* sp., *Axiothella obockensis*, *Euclymene* sp. and *Sabella* sp.]; molluscs [(39.03%) – *Nassa* sp., *Dentalium elpis*, *Donax* sp., *Dosenia* sp. and *Pecten* sp.]; crustaceans [(7.86%) – *Scotollana* sp., *Bodotria* sp., *Eurydice* sp., *Parhyalella* sp., *Perioculodes* sp., *Metaprotella* sp., *Ampelisca* sp., *Gastrosacus simulans* and other groups including sipunculoidea [(1.23%) – *Dentrostomum* sp.] echiuridae [(7.86%) – *Ochestoma* sp.] and cephalochordata [(1.5%) – *Branchiostoma lanceolatum*] were recorded. Figure 2 illustrates the seasonal spatio-temporal variability of population density, biomass and faunal composition. The population density (no.m<sup>-2</sup>) varied from 25 in September 1989 at st. 5 to 2657.m<sup>-2</sup> in January 1990 at st. 9 ( $\bar{X} = 445 \pm 507$ ). These values are very similar to earlier report along Konkan coast<sup>5</sup>. Dense population in January at st. 9 is largely due to recruitment of juvenile bivalve *Pecten* sp. indicating the reproductive period of the species. Two way ANOVA of population density data between stations and period showed significant difference only between months ( $F = 4.5$ ;  $P < 0.05$ ). Variation in faunal composition was observed mainly in polychaetes and molluscs. Molluscan contribution was high in January 1990 mainly due to high abundance of *Pecten* sp. Dominance of polychaeta deposit feeder *Prionospio pinnata* and bivalve-filter

feeder *Pecten* sp. in all 3 months suggests that these are more competitive species. Biomass varied from 1.2 (September 1989 at st. 5) to 26.5 g.m<sup>-2</sup> (September 1989 at st. 7) with mean value of  $6.01 \pm 6.21$ . The annual benthic production works out to be 12.02 g.m<sup>-2</sup>.y<sup>-1</sup>, assuming Sander's<sup>6</sup> conversion factor from mean wet biomass of 6.01 g.m<sup>-2</sup> or dry weight of 1.83 g.m<sup>-2</sup> or 0.183 g C.m<sup>-2</sup> y<sup>-1</sup>. The annual carbon requirement by the benthic organisms is 1.83 g.C.m<sup>-2</sup>.y<sup>-1</sup> considering the Odum's<sup>7</sup> 10% ecological efficiency. The average particulate organic carbon<sup>8</sup> (POC) was 581 mgC.m<sup>-3</sup> which is well within the requirement of benthic community<sup>7</sup>.

The Shannon-Wiener species diversity, evenness and richness indices varied from 0.92 to 3.61 ( $\bar{X} = 2.21 \pm 0.75$ ), 0.48 to 0.99 ( $\bar{X} = 0.87 \pm 0.14$ ) and richness 0.29 to 1.96 ( $\bar{X} = 0.96 \pm 0.50$ ) respectively in the study area

Table 1—Sediment characteristics and organic carbon values

Sl. No.	Sand (%)	Silt (%)	Clay (%)	Sediment texture	Org. carbon (%)
1	35.15	41.00	23.60	Sandy silt	1.93
2	26.50	48.50	25.00	Sand silt and clay	1.65
3	35.16	41.00	23.60	Sandy silt	1.93
4	50.00	45.00	5.00	Silty sand	2.43
5	50.00	45.00	5.00	Silty sand	2.43
6	26.50	48.50	25.00	Sand silt and clay	1.65
7	26.50	48.50	25.00	Sand silt and clay	1.65
8	35.15	41.00	23.60	Sandy silt	1.93
9	35.15	41.00	23.60	Sandy silt	1.93

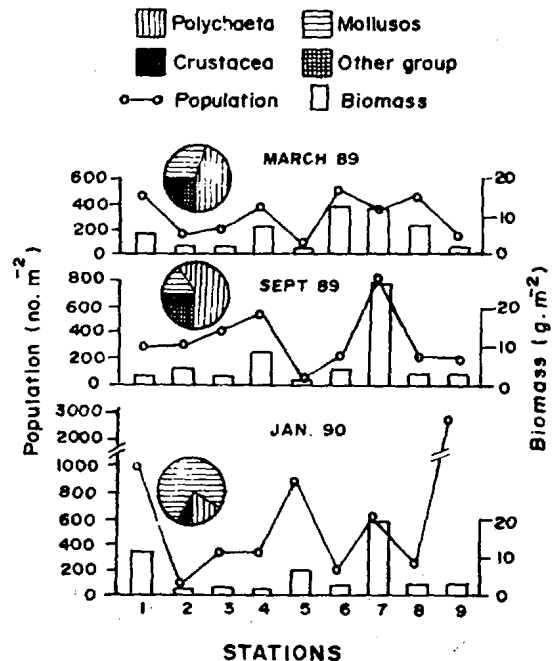


Fig. 2—Fluctuation of population density, biomass and benthic faunal composition

(Table 2). The species diversity values reported here were close to the values of an earlier report<sup>5</sup>. High species diversity values reflect on the stability of the environment<sup>9</sup>. Two way ANOVA of species diversity values between the stations and period (assumed as premonsoon, monsoon and post monsoon seasons) showed significant difference only between seasons ( $F = 3.54; P < 0.05$ ). High species diversity and dense population were observed in March 1989 and January 1990 respectively. Replenishment of benthic fauna, seasonality and high species diversity observed after the southwest monsoon (June-September) is consonant with earlier report from Konkan coast<sup>5,10</sup>. Hence, southwest monsoon plays an important role in the distribution and abundance of benthic fauna in the coastal waters. Dominance diversity curve illustrates component of diversity, richness on ordinate axis and evenness by the slope of the curve (Fig. 3). They are graded from most diverse (shallowest curve) to least diverse (steepest curve). This curve showed most of the time even distribution and thus possibly suggests competition equilibrium

period of the population<sup>9</sup>. However, overlap of curve as observed at st. 9 in January 1990, was largely due to high population of single species associated with the reproductive periodicity. This is mainly caused due to competition exclusion principle associated with localized impact of environmental parameters like salinity, dissolved oxygen, pH, bottom current regime and grain size of the sediment.

Cluster analyses of species (Fig. 4) shows the extent and magnitude of faunal similarity of stations during different months. Such a cluster is largely attributed to interaction of biotic and abiotic factors like reproductive periodicity of the species and recruitment of the population e.g. *Pecten* sp., habitat specific and feeding behaviour of the species [e.g. deposit feeder polychaeta *Prionospio pinnata* was found in sand, silt and clay substrata whereas filter feeder bivalve *Pecten* in silty sand] reproductive periodicity of the species and larval recruitment (e.g. *Pecten* sp.), prey and predatory relationship (e.g.

Table 2—Indices of species diversity ( $H'$ ), evenness ( $J$ ) and richness ( $R$ )

Sl. No.	March, 1989		
	$H'$	$J$	SR
1	3.61	0.97	1.96
2	1.88	0.94	0.59
3	1.50	0.58	0.94
4	2.52	0.89	1.02
5	0.91	0.92	0.23
6	3.36	0.97	1.60
7	2.62	0.79	1.51
8	3.39	0.98	1.63
9	1.58	0.99	0.39
Sl. No.	September 1989		
	$H'$	$J$	SR
1	2.91	0.92	1.22
2	1.90	0.95	0.59
3	2.21	0.69	1.32
4	2.96	0.93	1.26
5	—	—	—
6	1.83	0.91	0.55
7	3.45	0.93	1.78
8	2.28	0.98	0.73
9	1.50	0.94	0.37
Sl. No.	January 1990		
	$H'$	$J$	SR
1	2.07	0.60	1.44
2	1.50	0.94	0.43
3	2.55	0.98	0.89
4	2.41	0.93	0.89
5	1.32	0.83	0.29
6	1.93	0.96	0.56
7	1.51	0.65	0.62
8	2.50	0.96	0.90
9	1.13	0.48	0.51

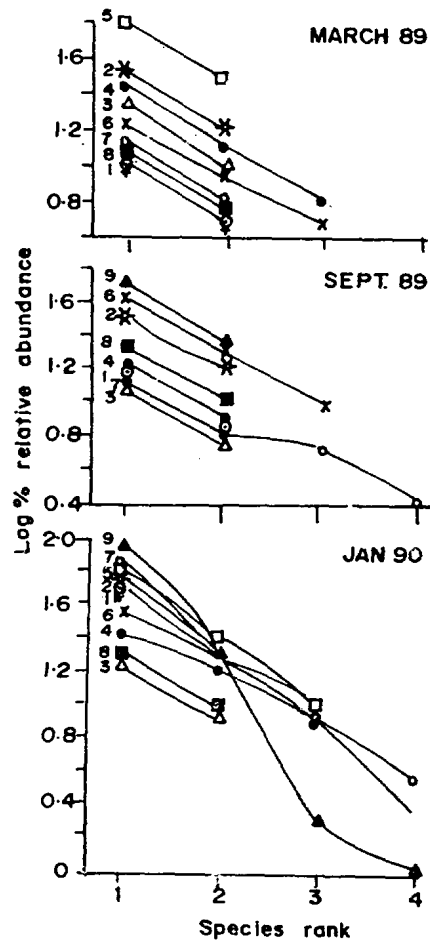


Fig. 3—Dominance diversity curve for stations during different months

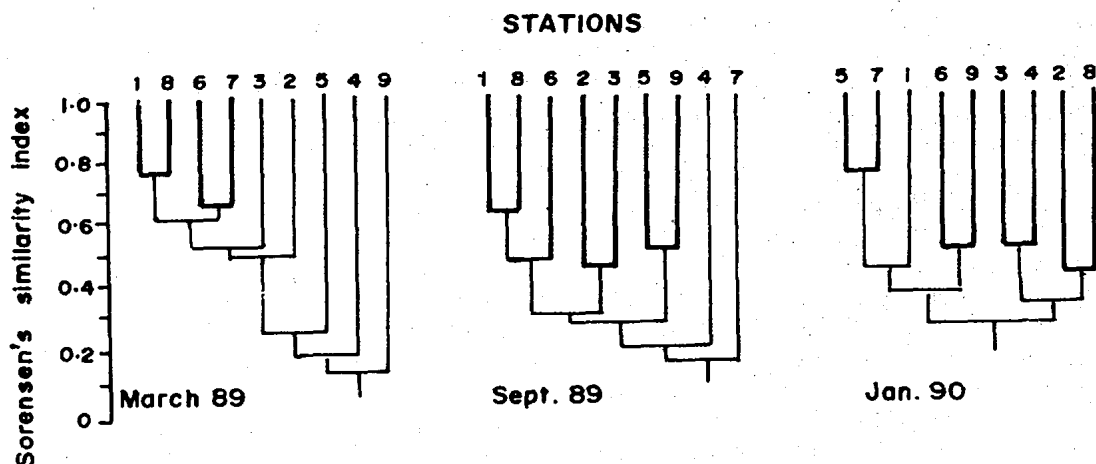


Fig. 4—Species similarity dendrograms illustrating relation between stations 1-9 during different months

*Glycera alba*) and other abiotic factors as mentioned earlier. There are number of biotic and abiotic factors responsible for the observed spatio-temporal variation of benthic population, biomass and community structure<sup>9</sup>. Large scale seasonal fluctuations are largely reflection of seasonal spawning, habitat specific and feeding types. Physiological tolerance also plays an important role in decline of some of species e.g. *Pisionodense* sp., *Glycera alba*, *Branchiostama lanceolatum*, during southwest monsoon when salinity and dissolved oxygen decrease considerably apart from competition and predation<sup>11</sup>. This small scale spatio-temporal variations and community structure fluctuation of macro-invertebrates (Figs 2-4, Table 2) are mainly attributed to the effect of southwest monsoon and impact of localized biotic and abiotic factors as discussed earlier. Thus the soft sediment dwelling biota is in natural ecological balance and thus free from the effect of environmental imbalances. The baseline data generated here can be used to assess the impact of pollution, if any, in future.

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