

Benthic harpacticoid copepod community of Saphala salt marsh along the west coast of India

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Distribution of meiobenthic harpacticoid copepod species was studied from a low tidal marsh area during August to October 1984. The copepod species density was moderately high. The mean highest density was recorded at a station having highest organic content in the sediment. Among 21 species recorded only *Stenhelia longifurca* and *Halectinosoma curticorne* were recorded from all stations. The pattern of abundance of benthic copepod species and poor diversity in the present study area indicate a constant time scale fluctuation of the environment. Physical environmental parameters are suggested to be more important in controlling the community of the harpacticoids in the Saphala salt marsh.

The control of salt marsh invertebrate assemblage structure has received considerable attention in the recent past¹. However, the tidal marshes of tropical India are poorly studied and there is a significant gap about the organization of salt marsh community in general and meiofaunal assemblage in particular. Ingole *et al.*² have studied the general composition of meiofauna from this area.

Saphala salt marsh (lat. 19° 40' N, long. 72° 37' E) is a shallow creek and gets exposed during low tide, thus creating low salt marsh. Unlike other salt marshes the sediment of Saphala is characterised by the absence of rooted vegetation except mangroves along the borders. In the present paper description of harpacticoid copepod species assemblage and their zonation pattern from the same area is reported.

Details of the physical environmental conditions and geographical features of the study area are given by Ingole *et al.*². Samples were taken at monthly interval with the help of a plastic core tube of 4.5 cm inner diameter. Three replicate cores were taken per station on each sampling date from August to October 1984 during low tide. Harpacticoid copepods were sorted out and identified to species level. Faunal similarity was calculated by Kendall's coefficient of association Tau and species diversity (H) and evenness (J) by Shannon and Weaver index³.

Species composition—The harpacticoid copepods constituted about 18.5% of the total meiofauna and were second most abundant group after nematodes. The harpacticoid population showed wide fluctuation and their density (no. 10 cm⁻²) varied between 13

and 4039. The average density of harpacticoid of the study area was 66 in August, 309 in September and 1950 in October.

Of the 21 species, only *Stenhelia longifurca*, *Halectinosoma curticorne* and *Cletocamptus confluense* were most dominant, accounting for > 60% of the total harpacticoid population on an average basis (Table 1). *S. longifurca* and *H. curticorne* were recorded at all the stations. Next in the order of abundance were *Amphiascoides subdebilis* and *Nitocra spinipes*. Other species were rare and present in insignificant number. Fluctuation of the individual species in this limited period of study was less than overall density.

Faunal similarity—Faunal similarity was estimated using a 2 × 2 contingency table and the values were tested by $T_e = (\chi^2, 0.05/s)^{1/2}$ with one degree of freedom. The coefficient of Kendall's Tau values are given in Table 2. Similarity among stations was poor indicating occurrence of different species at the different stations in this salt marsh area. Occurrence of dominant species at these stations accounted for high similarity indices. Poor association among stations is due to fewer species occurring at those stations as a result of heterogeneity in the microhabitat and extreme conditions at the stations to which benthic copepod species are exposed.

Dominance—Communities are normally characterised by one or more dominant species⁴. Biological indices for most dominant species were calculated by rank analysis. At each station 5 most common species were ranked in order of decreasing abundance (Table 3). *S. longifurca*, had the highest biological index.

Table 1—Percent composition of Harpacticoid species

| Species | Stations | | | | |
|----------------------------------|----------|-------|-------|-------|-------|
| | 1 | 2 | 3 | 4 | 5 |
| <i>Stenhelia longifurca</i> | 18.9 | 24.19 | 37.65 | 15.65 | 07.89 |
| <i>Halectinosoma curticorne</i> | 20.6 | 29.02 | 16.30 | 24.34 | 05.79 |
| <i>Cletocamptus confluae</i> | 13.7 | 19.35 | 10.86 | 14.78 | — |
| <i>Amphiascoides subdebilis</i> | 13.10 | 07.56 | — | 14.78 | 22.22 |
| <i>Mesochra meridionalis</i> | — | 09.67 | 05.43 | — | 02.87 |
| <i>Nitocra spinipes</i> | 04.94 | — | — | 30.43 | 14.03 |
| <i>Mesochra pygmaea</i> | 04.73 | — | 00.61 | — | 12.86 |
| <i>Limnocletodes</i> sp. | — | 08.94 | — | — | — |
| <i>Onychocamptus bengalensis</i> | 04.57 | — | 03.62 | — | 01.29 |
| <i>Nannocletodes palustris</i> | 03.74 | — | — | — | 02.22 |
| <i>Laophotopsis secunda</i> | — | 01.01 | 03.83 | — | 02.05 |
| <i>Halectinosoma gothiceps</i> | — | — | — | — | 10.52 |
| <i>Hastigerella</i> sp. | 00.89 | — | 02.80 | — | 01.52 |
| <i>Mesochra wolskii</i> | 07.49 | — | 13.15 | — | 04.97 |
| <i>Pseudostenhelia secunda</i> | 03.48 | 00.25 | 00.92 | — | 00.76 |
| <i>Robertsonia propinqua</i> | — | — | 01.37 | — | 00.88 |
| <i>Tachidius discipes</i> | 00.82 | — | 00.58 | — | 03.27 |
| <i>Scottolana bulbifera</i> | 01.74 | — | 01.19 | — | 01.05 |
| <i>Enhydrosoma longifurcatum</i> | — | — | 00.61 | — | 02.05 |
| <i>Longipedia coronata</i> | 00.66 | — | 00.58 | — | 04.74 |
| <i>Ectinosoma</i> sp. | 00.57 | — | 00.48 | — | — |

Table 2—Matrix of Kendall's coefficient of association Tau

| Sts | 1 | 2 | 3 | 4 | 5 |
|-----|---|------|--------|---------|--------|
| 1 | — | 0.35 | -0.12* | 0.57 | 0.158 |
| 2 | — | — | 0.179 | 0.353 | -0.447 |
| 3 | — | — | — | -0.119* | 0.076* |
| 4 | — | — | — | — | 0.15* |

* = shows lack of association at the 5% level

Table 3—Rank analysis for six dominant species

| Species | Mean biological index | Frequency (in 45 samples) |
|---------------------------------|-----------------------|---------------------------|
| <i>Stenhelia longifurca</i> | 5.7 | 38 |
| <i>Halectinosoma curticorne</i> | 4.4 | 28 |
| <i>Cletocamptus confluae</i> | 3.0 | 23 |
| <i>Amphiascoides subdebilis</i> | 2.6 | 32 |
| <i>Mesochra meridionalis</i> | 1.6 | 38 |
| <i>Nitocra spinipes</i> | 2.2 | 34 |

H. curticorne and *C. confluae* also had high mean biological index but low frequency of occurrence which implies that these species are limited in their distribution although their density was maximum at some stations. On the other hand *N. spinipes*, *M. meridionalis*

and *A. subdebilis* had wide range of distribution as was evident from high frequency of occurrence.

Diversity—Maximum diversity was at st 5 and minimum at st 4 (Table 4). Species evenness strongly reflected the dominance of one or two species, a characteristic feature of low marsh estuarine environment. The mean values for diversity (H), evenness (J) and species richness (SR) in the present study area were 0.34, 0.04 and 1.18 respectively.

Low tidal marsh harpacticoid community was dominated by high tolerant and burrowing species. Although the copepod species composition of this salt marsh area was unique to the tidal salt marsh, having one or two dominant species, the average density was lower than those reported from subtidal estuarine habitats^{5,6}. This reduction in number may be due to various factors, such as increased exposure, higher temperature and unpredictable conditions⁷. There are however, other factors such as reduced current velocity in salt marshes and mangrove vegetation which may have beneficial effect on these metazoans in the low salt marsh area of Saphala.

Generally harpacticoids become numerically dominant as the particle size of the sediment increases⁸. Sediment of Saphala salt marsh is loose, characterized by high percentage of silt and clay fraction and

was accompanied by high meiofaunal density. Maximum density was recorded at station 2 located in the creek where the sediment is mostly submerged. Poorest density was at st 4 in the salt producing area. Such variation in the density of copepod species may be due to factors such as exposure time, desiccation, availability of food, sediment granulometry and interstitial water quality⁷. Periodicity is most characteristic of species in physically unstable areas such as salt marsh and this may account for wide variation in the species occurring in different months. Some of the species showed spatial heterogeneity. Heterogeneity of environment, clumped food resources and intra specific behaviour are some of the mechanisms responsible for such aggregated microdistribution pattern in meiobenthic copepods⁹. Generally the quantity of organic deposition in the salt marsh is high, the main contributor being the dead and decaying macrophytic vegetation and the decomposing mangrove foliage. However, the absence of macrophytic vegetation and comparatively low organic content in the sediment do not suggest high organic input in this area. This is in contrast to the reported high values of sediment organic matter in the mangrove environment of Goa¹⁰.

Copepod species density showed high fluctuation during the short study period. Others have also reported fluctuating trend, on short and long term basis, in meiobenthic copepod density of salt marsh area^{7,11}. However, Heip and Engels¹² have reported that harpacticoid species have smaller spatial variability and this may account for low diversity indices in the present study area. Lowest number (5 species) among recorded species is at st 4 and highest (17 species) at st 5. However, the sub-dominant species differ widely from sample to sample. The dominance of *S. longifurca* and *H. curticornis* in the present study was also recorded from the swamps of Gautami-Godavari estuarine system⁶ and estuaries in Goa¹³.

Meiobenthic copepods were represented by forms that are common in muddy detrital sediment. The diversity indices of Saphala salt marsh were much lower than other similar areas (Table 5). This is perhaps because of the limited number of observations taken at a time when the environmental conditions are not stable. Ansari¹³ has reported low diversity of meiobenthic copepod in the estuaries of Goa during the monsoon period. No singular factor is considered to universally control spatial and/or temporal distribution of meiobenthic community in a salt marsh area⁷. This is also true of the harpacticoids of Saphala salt marsh. Since the salt marsh areas are continuously exposed to the physical elements, the influence of such factors should not be discounted as an important control of meiobenthic community structure⁷.

Table 4—Mean values of diversity (H), evenness (J) and species richness (SR) at the five stations

| Sts | H | J | SR |
|-----|-------|-------|-------|
| 1 | 0.527 | 0.050 | 1.478 |
| 2 | 0.523 | 0.116 | 0.634 |
| 3 | 0.226 | 0.018 | 1.478 |
| 4 | 0.060 | 0.012 | 0.528 |
| 5 | 0.386 | 0.028 | 1.780 |

Table 5—Mean copepod diversity (H), evenness (J) and species richness (SR) values from different estuarine habitats

| Habitat (Reference) | H | J | SR |
|--|------|------|------|
| High marsh (Bell ⁷) | 1.61 | 0.66 | 11.5 |
| Low marsh (Fleeger ¹⁵) | 1.50 | 0.63 | 11.2 |
| Subtidal mud (Coull & Fleeger ¹¹) | 1.57 | 0.68 | 11.0 |
| Subtidal mud (Ansari ¹³) | 1.93 | 0.53 | 1.74 |
| Present study | 0.34 | 0.04 | 1.18 |

Changes in the diversity and the trend of species richness indicate a somewhat unstable copepod community and suggest that this environment is constantly fluctuating on the time scale. The community of meiobenthic copepod of Saphala salt marsh was characterised by *S. longifurca* and *H. curticornis* assemblage. In the estuarine complex of Goa¹³ a similar harpacticoid assemblage dominated by *S. longifurca* in the fine sandy silt is reported. Similarly Kondalarao and Murty¹⁴ reported *P. secunda* and *S. longifurca* in the mangrove clayey silty bottom of Kakinada bay. This similarity in the faunal assemblage of the two environments is perhaps coincidental and needs descriptive long-term study to delineate community dynamic and its organizing forces.

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References

- 1 Orth R J, in *Indian Ocean—Biology of benthic marine organisms*, edited by M F Thompson, R Sarojini & R Nagabhushanam (Oxford & IBH Publishing Company, New Delhi) 1986, 167.
- 2 Ingole B S, Ansari Z A & Parulekar A H, *Indian J Mar Sci*, 16 (1987) 110.
- 3 Pielou E C, *An introduction to mathematical ecology*, (John Wiley & Sons, New York) 1969, pp 286.

- 4 Orth R J, *Chesapeak Sci*, 14 (1973) 258.
- 5 Coull B C. in *Estuarine microbial ecology* edited by H Stevenson & R R Colwell (University of South Carolina Press, Columbia) 1973, 499.
- 6 Kondalarao B, *Indian J Mar Sci*, 13 (1984) 80.
- 7 Bell S S, *Estuar Coast Mar Sci*, 9 (1979) 331.
- 8 Coull B C, *Oecologia (Berl)*, 4 (1970) 325.
- 9 Hicks G R F, *J Exp Mar Biol Ecol*, 81 (1984) 47.
- 10 Jagtap T G, *Indian J Mar Sci*, 16 (1987) 103.
- 11 Coull B C & Fleeger J W, *Ecology*, 58 (1977) 1136.
- 12 Heip C & Engels P, *J Exp Mar Biol Ecol*, 26 (1977) 77.
- 13 Ansari Z A, *Ecology of meiobenthos in two estuaries of Goa*, Ph D thesis, University of Bombay, 1988.
- 14 Kondalarao B & Murty R, *Indian J Mar Sci*, 17 (1988) 40.
- 15 Fleeger J W, *Population dynamics and community structure of an estuarine meiobenthic copepod assemblage*, Ph D thesis, University of South Carolina, USA, 1977.