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MEIOBENTHOS IN THE SEDIMENTS OF SEAGRASS MEADOWS OF LAKSHADWEEP ATOLLS, ARABIAN SEA

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ABONDANCE
MÉIOFAUNE
PHANÉROGAMES MARINES
LAKSHADWEEP

RÉSUMÉ – L'abondance du méiobenthos de la communauté de Phanérogames marines *Thalassia hemprichii* des cinq atolls de Lakshadweep s'échelonne entre 554 et 1 351/10 cm². L'ensemble des taxons de l'épifaune et de l'endofaune se compose de quatre groupes majeurs. Les Nématodes et les Copépodes dépassent 70 % du nombre total des taxons. Des différences significatives de méiofaune totale et des groupes majeurs traités par ANOVA selon les stations et les habitats sont mises en évidence. Il existe une corrélation positive entre l'abondance méiofaunique et la biomasse macrophytique. 29 espèces de Copépodes Harpacticoïdes ont été dénombrées. La diversité des Copépodes benthiques est maximum dans les lagunes où la biomasse des macrophytes est plus élevée. La complexité des biotopes influence le peuplement de la méiofaune. Celle-ci est plus abondante que la macrofaune et sa contribution, dans la production benthique est aussi importante que celles des autres constituants les plus contributifs du benthos.

ABUNDANCE
MEIOFAUNA
SEAGRASS HABITAT
LAKSHADWEEP

ABSTRACT – Meiofaunal abundance of the seagrass, *Thalassia hemprichii* community in the five Lakshadweep atolls ranged from 554 – 1 351/10 cm². Total number of epifaunal and infaunal meiofauna taxa, were comprised of four dominant groups. Nematodes and copepods constituted over 70 % of the fauna numerically. Significant differences in total meiofauna and some major groups were noted by ANOVA, among sites and habitats. Meiofaunal abundance was positively correlated with macrophytic biomass. 29 species of harpacticoid copepod were recorded from the study sites. Benthic copepod diversity was maximum in those lagoons having higher macrophytic biomass. Influence of habitat complexity on meiofaunal assemblage was observed. Meiofauna were more abundant than macrofauna and their contribution in benthic production was similar to their larger counterparts.

INTRODUCTION

Seagrass habitats are conspicuous features of coastal and oceanic areas, the world over. Studies on the fauna of seagrass meadows have attracted research attention in recent years because of the rich production unique to such habitats (Wood *et al.*, 1969). However, little effort has been made to study the meiofauna components of this specialized ecosystem (Bell *et al.*, 1984 a). To understand the functional and structural role of meiofauna in seagrass ecosystem, the pattern of meiofaunal abundance and their interaction with larger forms should provide basis for further evaluation.

Apart from a report by Ansari (1984) nothing is known of the meiofauna of seagrass community of the oceanic atolls of lakshadweep in the Arabian sea. During a cruise of the *R.V. Gaveshani* in March and April 1987 to the Lakshadweep islands, sediment dwelling meiofauna of the seagrass community was studied. The present paper reports the meiofaunal density and harpacticoid copepod species diversity from five lagoons having varied seagrass vegetation. Spatial differences in meiofauna with respect to different sediment types and seagrass heterogeneity were also investigated.

MATERIALS AND METHODS

Study sites were located in the lagoons of Agatti, Bingaram, Kavaratti, Kalpeni and Kadmat of Lakshadweep sea (Fig. 1), which have stable sediment and luxuriant growth of seagrasses and algae dominated by *Thalassia hemprichii, Cymodocea sp., Halodule sp.* and *Halimeda sp.* (Jagtap, 1987). Five random sediment samples were collected from five predetermined locations in each lagoon using a corer of 4.5 cm diameter

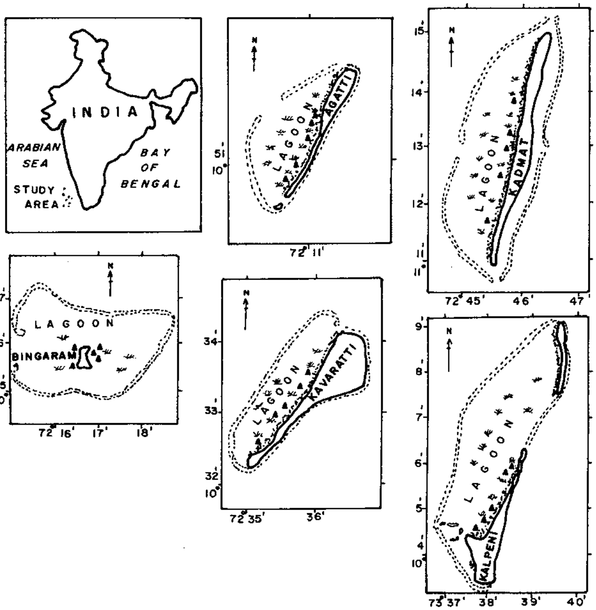

Fig. 1. – Map of the five atolls in the Lakshadweep sea showing the lagoon and the study stations (Δ).

driven to a depth of 5 cm as described by Bell *et al.* (1984 b) for faunal and sediment analysis. Samples for meiofauna were fixed in 5 % formalin-Rose Bengal solution pending analysis in the laboratory. To separate the fauna contained in, the sediment was passed through sieves of 0.5 mm and 0.062 mm mesh, the former to collect macrobenthos and the latter to meiobenthos. Animals were identified to major taxonomic categories and counted under binocular microscope. Harpacticoid copepods were identified to species. Sediment analysis was carried out on all samples and organic content estimated. Biomass of seagrass was estimated simultaneously by randomly placing three quadrants (25 cm^2 area). Seagrass blade of each quadrant was collected and wet weight taken.

To determine if significant differences in meiofaunal density existed between areas, a one way ANOVA was performed on the density data of all principal taxa after log transformation. Diversity was calculated for harpacticoid species using Margalef index (Margalef, 1968). Bray-Curtis similarity coefficient (Clifford and Stephenson, 1975), based on least percentage composition, was performed on harpacticoid species data to establish the degree of affinity between sites (lagoons).

RESULTS AND DISCUSSION

A high tidal range is characteristic of these islands resulting in a wide exposure of intertidal zone at low tide, the spring ranging from 0.3 to 2 m. The lagoons are westerly located on most of these islands and the atolls have north-south orientation. There are thick patches of seagrass bounded by adjacent patches of barren sand in the lagoons. At the time of sampling the sites in the lagoons had salinity ranging from 26 ppt at Kavaratti to 34 ppt at Kalpeni and water temperature from 22°C at Agatti to 30°C at Kadmat, depending on the time of sampling. Dissolved oxygen ranged from 3.5 ml/l at Agatti to 4.1 ml/l at Bingaram and pH from 7.2 at Kalpeni to 7.9 at Kadmat.

The lagoon sediment consisted of medium sand and silt derived from the fragmentation of coral lime, shells and foraminiferans. The mean grain size varied from 0.42 mm at Kalpeni to 0.74 mm at Kadmat. Sediment organic content varied from 3.9 % at Kadmat to 12.8 % at Agatti by weight, the value increasing with increased decomposing vegetation. Small scale pattern of variation occurred in macrophytic vegetation in broad sedi-

Table I. – Above, Sedimentary properties and macrophytic biomass at the study sites. Below, Abundance (No./10 cm²) and percentage contribution of major meiofaunal taxa in the seagrass meadows of five atolls of Lakshadweep. Values are mean (SD) of fifteen samples.

Site	Mean grain size (mm)	Sorting (Φ)	Organics (% dry wt.)	Seagrass biomass (g wet wt./m²)
Agatti	0.62	1.2	12.8	895
Bingaram	0.63	0.7	4.8	560
Kavaratti	0.56	1.1	6.4	720
Kalpeni	0.42	0.6	8.3	770
Kadmat	0.74	0.8	3.9	405

Taxa	Agatti		Bingaram		Kavaratti		Kalpeni		Kadmat	
	Nos.	%	Nos.	%	Nos.	%	Nos.	%	Nos.	%
Nematoda	673±105	57.4	375±59	61.5	606±127	65.0	793±128	58.7	353±39	63.8
Harpacticoida	188±42	16.1	52±12	8.5	107±21	11.5	225±68	16.6	35±4	6.3
Polychaeta	142±28	12.1	23±8	3.8	25±7	2.7	150±23	11.1	41±7	7.4
Tubellaria	37±6	3.1	43±8	7.0	53±14	5.6	51±12	3.8	35±9	6.3
Ostracoda	12±4	1.0	35±6	5.8	67±12	[illegible]	53±6	4.0	16±3	2.8
Nauplii	44±9	3.8	23±4	3.8	38±7	4.1	18±5	1.3	28±9	5.1
Others	76±8	6.5	59±12	9.6	36±5	3.9	61±4	4.5	46±4	8.3
Total density	1172±214		610±118		932±194		1351±253		554±112	

Table II. – Analysis of variance of the distribution of major taxa among habitats and among sites. Data were transformed using log (n + 1) to stabilize variance. df, degree of freedom ; ms, mean square ; ns, non-significant.

Source of variation	df	Nematoda			Copepoda			Polychaeta			Turbellaria		
		ms	F ratio	p	ms	F ratio	p	ms	F ratio	p	ms	F ratio	p
Habitats	4	0.2484	39.42	**	0.1355	42.34	**	0.1307	25.13	**	0.1144	1.28	ns
Sites	14	0.0082	1.30	ns	0.0068	2.12	*	0.0079	1.51	ns	0.092	1.03	ns
Residual	56	0.0062			0.0032			0.0052			0.089		

* p <0.05; ** p <0.01

ment zone (Ansari *et al.*, 1991). The macrophytic biomass (wet weight) ranged from 405 g · m^{-2} (Kadmat) to 895 g · m^{-2} (Agatti) and the seagrass coverage varied with blade size ranging from 15 cm at Kadmat to 30 cm at Agatti and Kalpeni (Table I). The abundance of macrophytic vegetation varied significantly (ANOVA, $P < 0.05$) between habitats (lagoons).

The analysis of major taxa from sediment cores showed the dominance of nematodes and harpacticoid copepods (Table I), as is the case elsewhere (Coull & Bell, 1979). Polychaetes, turbellarians ostracods and crustacean nauplii contributed the rest. The other group had oligochaete, gastrotrich and tardigrade. Rao and Misra (1983) reported the dominance of nematodes, copepods and annelids in the meiofauna of Lakshadweep. Moderately dense population inhabited the seagrass meadows and mean density ranged from 554/10 cm² at Kadmat to 1 351/10 cm² at Kalpeni. The composition and abundance of different groups varied in different lagoons, depending on the nature of substratum and macrophytic vegetation. Nematodes were more consistent (50-60 %) than other groups and showed high ratio with copepods. Significant differences were found in the total density of meiofauna of the five lagoons when counts were subjected to ANOVA with logarithmic transformation. However, as the present data were collected only during March and April, these results are subject to seasonal variation in the abundance of the meiofauna. Comparatively low density was reported by Rao and Misra (1983) from the same area during December and January.

The dominant taxa varied in abundance at two spatial scale (habitat. site). The abundance of nematodes differed significantly among habitats, but very little at different locations within a given habitat (Table II). For harpacticoid copepods the abundance differed significantly, both among the different habitats and among different locations within a habitat. Polychaetes were also significantly different among habitats but were distributed fairly homogeneously within habitats. In contrast, turbellarians were homogeneous in distribution, both at the habitat and within habitat level.

Phillips and Fleeger (1985) have reported significant differences in abundance of nematodes and copepods, both among sites within habitats and among habitats in seagrass system.

The qualitative analysis of harpacticoid copepod is given in Table III. 29 species were identified from the five lagoons studied. Only two species, *Longipedia sp.* and *Laophonte cornuta* were observed in the samples of all stations while *Tisbe furcata, Amphiascoides subdebilis, Diosaccus monardi, Robertsonia propinqua, Mesochra pygmaea* and *Enhydrosoma sp.* were recorded from a single station. Out of seventeen species in Agatti eight dominant species constituted over 60 % of the population. Similarly eight species were most dominant at Kalpeni and five species at Kavaratti. However at Bingaram and Kadmat there was no clear dominance by any species. This is perhaps the feature of tropical oceanic lagoons where a number of species become abundant and co-dominate the community. However, it is subject to seasonal changes due to change in the environmental condition. The composition and abundance of genera and species of harpacticoids are similar to other tropical regions (Ansari & Parulekar, 1993).

In general, the diversity of copepod was high in those lagoons having dense growth of macrophytic vegetation (Table III). Accordingly maximum number of species were recorded at Kalpeni and minimum at Kadmat. Some of the species recorded in this study have been recorded earlier from Lakshadweep (Rao and Misra, 1983) and temperate regions (Novak, 1982). Two species namely, *Longipedia sp.* and *Metis jousseamei* have also been reported in the zooplankton samples of the lagoons of Agatti and Kalpeni (Achuthankutty *et al.*, 1989). This was possibly due to their diurnal migration. Benthic copepods have been observed to migrate in the water column of seagrass habitats (Bell *et al.*, 1984 b) and in the atolls of Lakshadweep, as a consequence of emergence and diurnal migration (Madhupratap *et al.*, 1991).

Table III. – Density of harpacticoid copepod species recorded in the seagrass sediment of five lagoons.

Species	Agatti	Bingaram	Kavaratti	Kalpeni	Kadmat
Longipedia sp.	26	8	4	22	5
Hastigerella sp.	0	0	4	12	0
Ectinosoma melaniceps	12	7	0	9	0
Ectinosoma sp.	0	0	16	0	5
Arenosetella germanica	14	6	0	15	8
Halectinosoma sp.	0	0	5	7	0
Harpacticus sp.	12	0	4	0	0
Harpacticus gracilis	10	5	0	11	3
Tisbe furcata	0	8	0	5	0
Amphiascus provinqvus	0	0	0	8	3
Eudactilopus andrewi	16	6	0	12	0
Amphiascoides subdebilis	0	0	13	0	0
Paramphiascella robinsoni	7	3	0	25	2
Diosaccus monardi	0	0	0	10	0
Parastenhelia hornbelli	2	0	6	0	0
Parastenhelia sp.	0	3	9	0	6
Robertsonia propinqua	0	0	0	17	0
Robertsonia knoxi	12	4	0	28	4
Stenhelia sp.	0	4	12	0	0
Macrosetella gracilis	10	0	11	0	0
Metis jousseaumei	6	0	0	9	0
Ameira parvula	9	0	7	0	0
Nitocra affinis	24	8	0	12	0
Paramesochra sp.	8	3	0	7	3
Kaliopsyllus sp.	0	0	12	6	0
Mesochra pygmaea	12	0	0	0	0
Enhydrosoma sp.	0	0	5	0	0
Heterolaophonte sp.	3	0	3	0	0
Laophonte cornuta	10	4	4	7	3
Total No. individuals	193	64	107	222	42
Total species	17	12	14	18	10
Diversity	3.04	2.69	2.78	3.15	2.4

Table IV. – Matrix of percent similarity showing the affinity between stations, based on harpacticoid copepod species.

	Bingaram	Kavaratti	Kalpeni	Kadmat
Agatti	42	25	58	25
Bingaram	-	31	39	55
Kavaratti	-	-	25	22
Kalpeni	-	-	-	23

The percent similarity index presented in Table IV showed that the copepod assemblage of the five atolls was different. The affinity values were high for Agatti-Kalpeni and Bingaram-Kadmat, thus showing strong similarity in the occurrence of copepod species at these stations. Other stations showed diverse fauna as the affinity values were

Table V. – Mean density (No/10 cm^2) of nematodes and harpacticoids recorded from other seagrass habitats.

Taxa	Density	Habitat	Reference
Nematoda	264-1074	Bay seagrass	Hopper & Meyers (1967)
	955-3906	Estuarine seagrass	Bell *et al.* (1984b)
	1000-4811	Estuarine seagrass	Tietjen (1969)
	462-941	Lagoon seagrass	Ansari (1984)
	353-793	Lagoon seagrass	Present study
Copepoda	47-478	Estuarine seagrass	Tietjen (1969)
	36.3-603.9	Estuarine seagrass	Bell *et al.* (1984b)
	232-365	Lagoon seagrass	Ansari (1984)
	35-225	Lagoon seagrass	Present study

low. This is indicative of varying degree of heterogeneity of seagrass system in the study area. Hicks (1980) also observed the influence of habitat complexity on phytal harpacticoid copepod assemblage. The density of meiofauna and diversity of copepod species in these isolated atolls show similarity with the coastal areas (Ingole *et al.*, 1990; Ansari & Parulekar, 1993) and suggest that these habitats can colonize rich meiofauna (as was inferred by Rao and Misra, 1983).

The seagrass habitats of Lakshadweep, when considering the macrofauna, had higher abundance of organisms in seagrass meadows having higher macrophytic biomass (Ansari *et al.*, 1991). A similar pattern was observed with regard to meiofaunal abundance. Novak (1982) and others have shown that the abundance and diversity of meiofauna in areas of macrophytic vegetation has a positive correlation with the complexity of the habitat. In seagrass system the complexity is dependent upon the intensity of the macrophytic growth that provides shelter and nourishment in the form of detritus and epiphytic algae. A significant and positive correlation ($r = 0.82$, $P < 0.05$) has been noticed between meiofaunal abundance and biomass of seagrass in this study. Sediment organic content was also found to be positively correlated with the total meiofaunal abundance. Similarly mean grain size indicated that finer particles and higher density of meiofauna in these atolls. However other environmental parameters did not show any correlation. This could be due to the fact that only limited number of samples were collected in a short time.

A comparison of densities of dominant meiofaunal taxa (nematodes, copepods) collected from sediments of seagrass beds of different geographical areas and habitats are given in Table V. The densities of nematodes observed in the present study are lower than those reported from the estuarine and coastal seagrass beds of subtropical and temperate zone (Tietjen, 1969; Bell *et al.*, 1984 a) but are similar to those reported from Minicoy, Ladshadweep (Ansari, 1984). In contrast the harpacticoid density was of similar magnitude in all habitats except Minicoy which had higher density. Comparative variations in abundance of meiofauna of geographically different habitats could be due to the habitat heterogeneity and sediment textural properties, although methodology can give rise to large discrepancies in total counts.

Table VI. – Comparison of biological parameters of macrofauna : meiofauna. a, macrofauna C values estimated from Parulekar *et al.* (1980) and meiofauna C values from Rudnick *et al.* (1985). b, production estimates were by multiplying a turnover of 10 for meiofauna (McIntyre, 1964) and 2.5 for macrofauna (McLachlan, 1977).

Parameters	Agatti	Bingaram	Kavaratti	Kalpeni	Kadmat
Density (m^{-2})	1:140	1:240	1:250	1:307	1:535
Biomass (g C m^{-2})[a]	14:1	8:1	7:1	4:1	5:1
Production (g C m^{-2})[b]	2.1:1	2:1	1.3:1	1:1	1:1

A comparison of the density of macro and meiofauna of the five lagoons indicated the meiofaunal dominance (Table VI). Due to smaller size the contribution of meiofauna towards biomass was less. However, in terms of standing crop production the contribution of meiofauna was almost equal to that of macrofauna, which reemphasize the importance of meiobenthos in the energetics of shallow areas (Gerlach, 1971).

CONCLUSION

The present study emphasize the need for quantitative meiofaunal estimates in the complex seagrass ecosystems. The isolated oceanic atolls of Lakshadweep can be as rich in meiofaunal abundance as those of coastal waters. The distribution of copepods represent the diverse picture among the closely situated lagoons and suggest their adaptability in different environment situated geographically apart. The meiofaunal community structure in the tropical seagrass systems are governed by environmental heterogeneity of the habitat, sediment stability and its granulometric properties.

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