Indian J. Fish., 44(4) : 345-352, Oct.-Dec., 1997

Macrofaunal density along the intertidal region of three atolls of Lakshadweep, Arabian Sea

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ABSTRACT

The present study describes the benthic production in terms of macrofaunal density, biomass (dry weight) and production along Agatti, Kalpeni and Kavaratti atolls of Lakshadweep in relation with physico-chemical parameters. The macrofauna comprised of Polychaeta, Amphipoda, Decapoda, Bivalvia, Isopoda, Pelecypoda, burrowing fish and other groups. Total faunal density ranged from 448 to 1,852 per square metre with higher values at Agatti and lower values at Kavaratti. Polychaeta (41.85 %) were the most dominant, whereas Amphipoda (2.68 %) contributed least to the total population density. Among the three atolls, Agatti was found to be the most productive.

Introduction

Coral reef ecosystems are known for their high productivity and increased species diversity (Done, 1982). These ecosystems are very sensitive to minor fluctuations in physico-chemical and environmental parameters. About 60 % of world's fish catch is taken from coastal ecosystem (Lie, 1983) and is determined by the productivity, among which the benthic production is more stable and supports demersal fish biomass.

The Lakshadweep atolls support a rich and varied fauna associated with coral reef. Available information (Ansari, *et al.*, 1990; Ansell, *et al.*, 1972; Namboodiri and Sivadas, 1979; Narayanan and Sivadas, 1986) suggest that the variations in the density of bentic organisms are largely known to be influenced by the season. In the present study, an attempt has been made to elucidate the variation in density and biomass (dry weight basis) of major macrofaunal groups during the postmonsoon season.

Materials and methods

The Lakshadweep archipelago comprises of a group of coral atolls enclosing lagoons and submerged reefs approximately 200-300 km southwest of India (Fig. 1). Sampling sites were located along the lagoon side of Agatti (0.05 km^2) (Fig. 2), Kalpeni (0.20 km^2) (Fig. 3) and Kavaratti (0.34 km^2) (Fig. 4) atolls each with 10 transects running from high tide level (HTL) to low tide level (LTL) covering the complete stretch of sandy beach on the windward side of

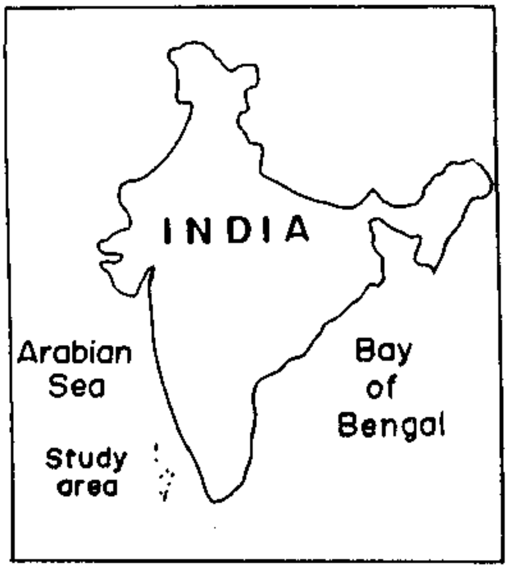

Fig. 1. Study area with reference to mainland of India.

each atoll. The sandy shores selected in the present study were well protected from the wave action by the reef.

Macrobenthic samples were collected using an iron corer (8.5 cm diameter) to a depth of 10 cm to ensure adequate sampling (Stoner, 1980). A 1 m ^{2} grid was located in a homogenous area and five replicate cores were obtained by using random number method. Sampling was undertaken in November, 1993.

Macrofauna samples were sieved through a 0.5 mm screen and preserved in 5 % buffered formalin. Benthic samples were sorted out and animals identified to major group levels only. Total wet weight biomass (without shell) of each group was taken and the assorted groups were kept separately, dried in an oven at 60^0 C for 48 hours and the dry weight was taken. The faunal density, biomass and dry weight were computed for 1 m^2 area and converted to production by using the factors described by Day and Fruftenburg (1981).

Sediment grain size and organic carbon analysis were done by the method of Folk (1968) and Folk and Ward (1957) respectively. Salinity of interstitial waters was estimated by following standard method.

Total macrofaunal density and the tide levels as habitats were tested for their abundance using 2-way ANOVA analysis at different atolls.

Results and discussion

The median particle size ranged from 0.315 ± 0.075 in Kalpeni to 0.54 ± 0.13 mm in Agatti (Table 1), which suggests that there is dominance of median coralline particles. Abundance of coarser particles enable the organisms to colonise and establish them-

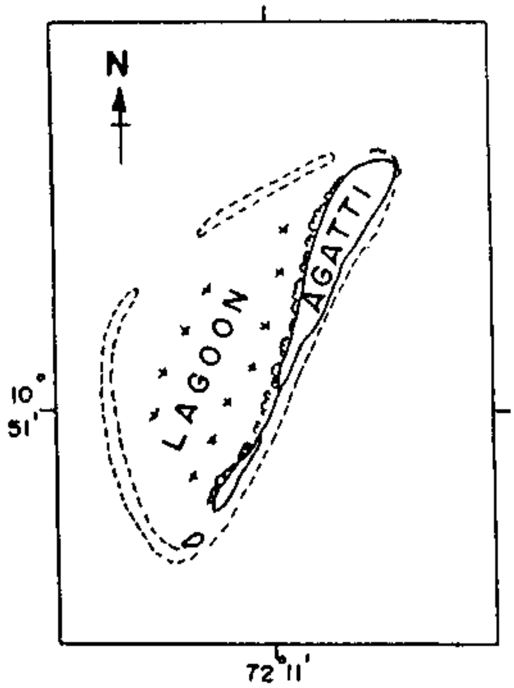

Fig. 2. Agatti atoll.

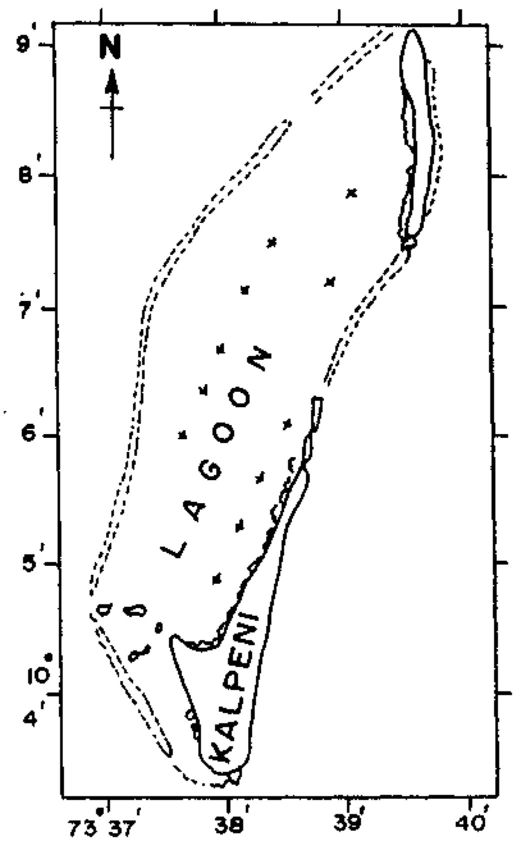

Fig. 3. Kalpeni atoll.

selves in higher densities. Ansari *et al.* (1990) reported median particle size in the range of 0.27 to 0.55 mm with low values along Kavaratti and high values along Agatti atolls of Lakshadweep. Low values of phi quartile deviation (Qd ϕ) and skewness (Sk ϕ) indicate that all the beaches harvest high proportion of sand particles that fall in narrow range. It is evident fron Table 1 that the median particle size of the sand at high tide level has low values as compared to low tide level. This infers that the water retention capacity of these beaches is high at low tide level.

The organic carbon in the sediment was moderate, being in the range of 0.28 to 0.49 % with maximum values recorded at Agatti and minimum at Kavaratti. As in similar ecosystem elsewhere (Young and Young, 1982), the sources of organic carbon in Lakshadweep atolls are limited, the main contribution coming from dead and decaying seagrasses and seaweeds, stranded along the shore which support high epiphytic population (Heck, 1977).

The macrofaunal density and biomass (dry weight basis) of individual group showed that the polychaetes were the major group in occurrence at Agatti and Kalpeni (Tables 2 and 3) whereas, at Kavaratti, maximum density was represented by the burrowing fish (Table 4). In terms of total density observed along the three atolls the percentage composition of polychaetes was 41.85, while

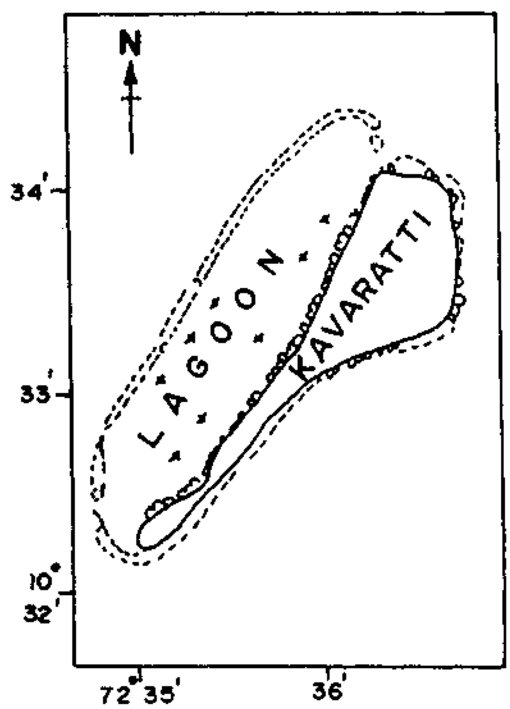

Fig. 4. Kavaratti atoll.

TABLE 1. *Abiotic factors during post-monsoon season at the study area*

Island	Tidal level	Md (mm)	Qd (ϕ)	Sk (ϕ)	Mean Md (mm)	Mean org.C (mg)	Salinity (ppt)
Agatti	HTL	0.41	0.69	-0.07	0.54±0.13	0.49±0.024	35.2±0.25
	LTL	0.67	0.77	-0.09	-	-	34.2±0.15
Kalpeni	HTL	0.24	0.46	+0.02	0.315±0.075	0.36±0.019	33.4±0.25
	LTL	0.39	0.39	+0.07	-	-	31.1±0.30
Kavaratti	HTL	0.26	0.55	-0.09	0.32±0.06	0.28±0.027	35.5±0.30
	LTL	0.38	0.62	-0.06	-	-	32.3±0.15

HTL - High tide level; LTL - Low tide level.

their contribution to the total standing crop was less significant (16.94 %) due to their smaller size. In an earlier study, Ansari *et al*. (1991) reported Polychaeta as the major group in terms of density, however, their contribution to biomass was marginally low as compared to gastropods (*Trochus* sp. and *Hipponix* sp.) and decapods. Polychaeta was the most numerically abundant group from the other similar areas (Ansari, 1984; Ansari *et al*., 1990; Ansell *et al*., 1972; Narayanan and Sivadas, 1986). On the other hand, bivalves and decapods although lesser in number contributed significantly to biomass due to their larger size along Agatti and Kavaratti atolls (Table 2 and 4), whereas, at Kalpeni (Table 3) the maximum component of the biomass was mainly the bivalves. Thomassin and Vitiello (1976) reported dominance of molluscan biomass in the coralline sediments of Polynesian atoll. They suggested that dominance of molluscan biomass is mainly dependent on grain size, organic

TABLE 2. *Macrofaunal density and biomass (dry weight) at different levels at Agatti atoll*

Groups	Unit of expression	LTL	HTL	Total
Polychaeta	(no m^{-2})	680±65	384±46	1064±111
	(g m^{-2})	0.60±0.22	0.12±0.09	0.72±0.29
Amphipoda	(no m^{-2})	-	60±12	60±12
	(g m^{-2})	-	0.02±0.01	0.02±0.01
Decapoda	(no m^{-2})	36±11	28±9	64±20
	(g m^{-2})	1.00±0.64	0.24±0.08	1.24±0.72
Bivalvia	(no m^{-2})	88±27	56±17	144±44
	(g m^{-2})	0.96±0.32	0.31±0.11	1.27±0.43
Isopoda	(no m^{-2})	40±9	24±7	64±16
	(g m^{-2})	0.28±0.14	0.04±0.02	0.32±0.16
Pelecypoda	(no m^{-2})	116±26	100±27	216±55
	(g m^{-2})	0.82±0.48	0.21±0.08	1.03±0.56
Other	(no m^{-2})	168±38	72±19	240±47
	(g m^{-2})	1.40±0.92	0.34±0.12	1.74±1.04

HTL - High tide level; LTL - Low tide level.

TABLE 3. *Macrofaunal density and biomass (dry weight) at different levels at Kalpeni atoll*

Group	Unit of expression	LTL	HTL	Total
Polychaeta	(no m^{-2})	344±38	200±31	544±69
	(g m^{-2})	0.71±0.45	0.50±0.15	1.21±0.29
Amphipoda	(no m^{-2})	28±9	16±5	44±14
	(g m^{-2})	0.26±0.12	0.09±0.02	0.35±0.14
Decapoda	(no m^{-2})	216±26	168±19	384±45
	(g m^{-2})	0.62±0.18	0.31±0.11	0.93±0.29
Bivalvia	(no m^{-2})	128±24	64±9	192±33
	(g m^{-2})	1.04±0.87	0.54±0.14	1.58±1.01
Isopoda	(no m^{-2})	12±4	4±2	16±6
	(g m^{-2})	0.21±0.15	0.20±0.01	0.41±0.16
Burrowing fish	(no m^{-2})	32±7	8±3	40±10
	(g m^{-2})	0.07±0.04	0.02±0.01	0.09±0.05
Pelecypoda	(no m^{-2})	20±5	12±2	32±7
	(g m^{-2})	0.12±0.09	0.15±0.72	0.27±0.81
Others	(no m^{-2})	224±38	104±16	328±56
	(g m^{-2})	0.41±0.2	0.24±0.15	0.65±0.35

HTL - High tide level; LTL - Low tide level.

matter and oxygen in the surrounding water. Other groups of significant importance were Pelecypoda, Decapoda and burrowing fish.

At Agatti, the maximum density was contributed mainly by Polychaeta (1,064+111) followed by other groups (240+47), Pelecypoda (216+55) and Bivalvia (144+44). The abundance of macrofauna in the present study compared with the earlier data (Ansari *et al.*, 1990, 1991) showed a significant decrease in the density as in the case of polychaetes. However, the density of

TABLE 4. *Macrofaunal density and biomass (dry weight) at different levels at Kavaratti atoll*

Group	Unit of expression	LTL	HTL	Total
Polychaeta	(no m^{-2})	12±5	4±2	16±8
	(g m^{-2})	0.36±0.12	0.08±0.02	0.44±0.14
Decapoda	(no m^{-2})	72±18	24±7	96±25
	(g m^{-2})	0.92±0.18	0.19±0.10	1.11±0.34
Bivalvia	(no m^{-2})	44±11	28±6	72±18
	(g m^{-2})	0.61±0.20	0.26±0.17	0.87±0.37
Isopoda	(no m^{-2})	32±9	16±9	48±20
	(g m^{-2})	0.22±0.15	0.15±0.08	0.37±0.23
Burrowing fish	(no m^{-2})	96±23	64±19	160±44
	(g m^{-2})	0.87±0.44	0.98±0.05	1.85±0.59
Others	(no m^{-2})	32±14	24±7	56±25
	(g m^{-2})	0.40±0.22	0.24±0.09	0.64±0.31

HTL - High tide level; LTL - Low tide level.

Pelecypoda was comparatively high.

An analysis of macrofaunal density and biomass at low and high tide revealed high production at low tide level as compared to high tide evel. This has been reported earlier by Kondalarao and Murty (1988). This is largely because of greater exchange of water and replenishment of considerable amount of nutrients to the biotic components of the area. Relatively stable conditions at low tide level in terms of temperature fluctuations and dessication may also contribute to the faunal richness at that level. Such differences are also attributed to tidal exposure and beach profile (Eleftheriou and Nicholson, 1975).

The faunal density, biomass and production values calculated per metre transect of beach (Table 5) were the highest at Agatti and the lowest at Kavaratti. The faunal biomass on wet and dry weight basis varied between 64.50 and 123.04 g per m^2 and 10.56 and 12.68 g per m^2 respectively . It can be noted from Table 5, that although the differences in the density are large, there are minute differences in biomass (dry weight basis). This was mainly due to the presence of bivalves (*Donax* sp. and *Mesodesma* sp.) and burrowing fish in the area of study. Ansell *et al.* (1972) found maximum wet weight biomass values of 500 g per m^2 from Kavaratti beach, whereas, Ansari *et al.* (1991) reported the total biomass values of 112.96, 53.52 and 48.25 g per m^2 from the vegetated areas of Agatti, Kalpeni and Kavaratti. A significant reduction in the total biomass is being reported which can be attributed to the possible influence of increased mechanisation of fising vessels in these areas.

The production estimates computed indicate that the productivity was maximum at Agatti followed by Kalpeni and minimum at Kavaratti (Table 5). Coral reef ecosytems support high biomass of benthic fauna due to suitable environmental parameters, abundant food supply and greater turnover of nutrients (Sheppard, 1987). Among these atolls the maximum productivity at Agatti might be due to higher organic carbon content. Ansari and Parulekar (1994) observed maximum organic carbon content in the sediments along Agatti and stated that the higher organic carbon values were mainly due to the increased decomposition of vegetation.

ANOVA analyses (Table 6) were conducted using the data on faunal density at low tide and high tide level to find any significant differences in the macrofaunal density of the two levels. Among the five faunal groups, Polychaeta ($F=25.9$; $p=0.0001$), Amphipoda ($F=8.8$; $p=0.0142$) Decapoda ($F=9.2$; $p=0.008$) and Isopod ($F=4.6$; $p=0.047$) showed significant differences in the mean density at different levels

TABLE 5. *Total density (no/m^2 transect), biomass (g/m^2 transect) and production (g/m^2 transect) of macrofuna at three coralline beaches of Lakshadweep*

Island	Density	Biomass		Production	
		Wet wt.	Dry wt.	Wet wt.	Dry wt.
Agatti	3,704	123.04	12.68	306.76	31.70
Kalpeni	3,160	89.98	11.82	224.94	29.54
Kavaratti	896	64.50	10.56	162.26	26.40

TABLE 6. *Analysis of variance between density of different faunal groups at low and high tide levels along Lakshadweep islands*

Groups	F-ratio	Level of significance (p value)
Polychaeta	25.9	0.0001
Amphipoda	8.8	0.0142
Decapoda	9.2	0.0080
Isopoda	4.6	0.0470
Pelecypoda	2.8	0.1268
Total	16.4	0.0009

with the exception of Pelecypoda. It was also observed from the ANOVA analyses that there does not exist any significant difference in the pelecypod density ($F = 2.8$; $p = 0.1268$) which indicates that the population structure of this group was not altered significantly with the time.

Acknowledgments

The research is supported by grant BT/R&D/11/22/'91- '92 from the Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Authors are thankful to The Director, National institute of Oceanography, for permission to participate on a cruise of R.V. *Gaveshani* to the Lakshadweep.

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