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Zooplankton abundance and distribution at Minicoy lagoon, Lakshadweep

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The environmental parameters such as water temperature, salinity, cloud cover, wind force, rainfall and tide that influence the distribution and abundance of zooplankton at two sites in Minicoy lagoon were studied from August 1994 to July 1995. The northern part of the lagoon with more live corals had better abundance of zooplankton when compared to the southern area. Zooplankton from different lagoon bottoms namely coralline, sandy and seagrass bed did not show significant variation between sites. Copepods, amphipods and decapod larvae were the dominant groups.

Zooplankton play an important role in coral reef ecosystems. They serve as food for corals, a variety of other invertebrates and reef fishes. From the fishery point of view, zooplankton form food of important baitfishes belonging to the families Clupeidae, Caesionidae and Apogonidae. Some fishes are exclusively zooplankton feeders and therefore their abundance is directly linked to the presence of zooplankton[1,2]. Zooplankton in the seas around Lakshadweep is influenced by environmental parameters such as circulatory movements (eddies) and vertical turbulent mixing[3]. But there is little information as to whether these factors effect the production in the island lagoons. Previous studies[4-6] indicate a higher abundance of zooplankton in the surrounding sea compared to the lagoons. However, spatial variation of zooplankton within the lagoon has not been reported. This paper deals with the influence of environmental parameters on zooplankton and their spatial variation at Minicoy Atoll.

Materials and Methods

Minicoy (08°17'N, 73°04'E), the southernmost island of Lakshadweep, is located 215 nautical miles southwest off Kochi (Fig. 1). The lagoon with an area of about 25 km^2 has two ecologically distinct habitats - the coral shoals which occupy about 75% of the area and the sand-flats in the southern part of the lagoon. The average depth is 4 m with maximum depth of about 15 m.

Two stations were selected based on the availability of live coral (Fig. 1). Station I with high coral cover is situated in the northeastern part of the lagoon. There is a well developed coral shoal 100 m away from the shore, about 600 m long and about 40 to 60 m wide. Live coral cover constituted 60% with *Goniastrea retiformis* and *Diplostrea heliopora* as the predominant forms. Station II with low coral cover is on the southern part of the lagoon between the main island and the

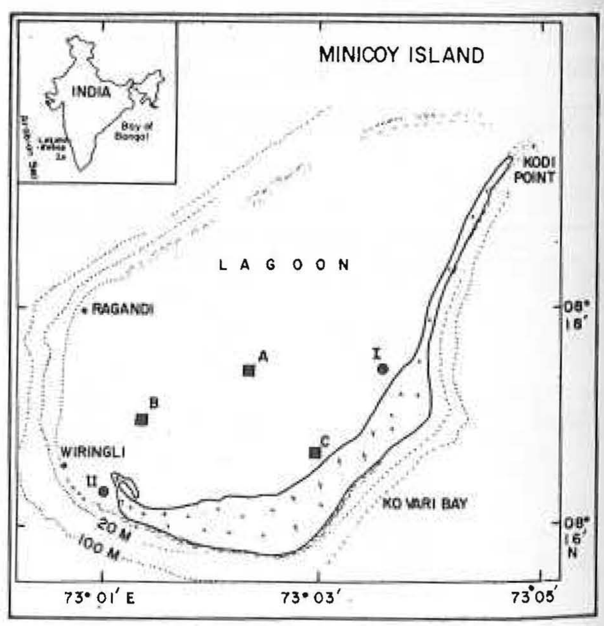

Fig. 1—Map of Minicoy island showing the sampling stations

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islet of Wringli. The average live coral cover constituted only 11% with *Porites lutea* and *Pocillopora damicornis* as the major forms. Apart from these two stations, three locations were identified based on the nature of lagoon bottom. These locations were representative of the different areas of the lagoon with coral bottom (location A), sandy bottom (location B) and seagrass bed (location C).

Hand-tows were made in replicate at sts I and II for 20 minutes between 0700 and 0730 hrs covering a distance of about 200 m at 10 days interval from August 1994 to July 1995. The zooplankton net was 1.2 m long with a circular mouth diameter of 0.5 m and mesh size of 0.3 mm.A total of 18 boat tows were also made at locations A, B and C during January to April using the same net. Plankton collected were fixed in 5% formalin, counted and identified into major groups. Temperature was measured at the site itself and water samples were collected at sts I and II to analyse salinity by the Mohr titration method and dissolved oxygen by Winkler method. Cloud cover and wind force were also recorded[7]. Rainfall data was collected from the meteorological station at Minicoy and tidal height at the time of sampling was calculated from the tide Tables. The software package MStatC was used to carry out the Principle Component Analysis (PCA) on the 72 observations from sts I and II.

Results

Separate analyses were carried out for the environmental parameters (Table 1) at sts I and II. The temperature and salinity accounted for 51.0% of the total variability among the six variables at st I and 54.2% for st II (Table 2). By comparing the projections of variables (correlations),periodical and single fluctuations may be identified. The first factor of st I was correlated with 4 variables viz. water temperature, cloud cover, wind force and rainfall while the second factor was correlated with salinity and tide (Fig. 2, Table 3). At st II, the first factor was related to salinity, cloud cover and wind force while the second correlated with water temperature, rainfall and tide (Fig. 3, Table 3). The projections of observations on the plane (Fig. 4) did not show difference between areas. Although a decrease in zooplankton number was noticed from coral bottom to seagrass bed (Table 4), analyses of variance did not show significant change between locations. Copepod was the important holoplankton at sts I and II (Table 5). Meroplankton, mostly represented by larvae and juveniles of reef forms were more abundant at st I. Amphipod was the dominant benthic plankton at both the stations.

Table 1—Mean and standard deviation of environmental parameters and zooplankton abundance at stations I and II (n = 36)

Parameters	Station I		Station II	
	Mean	SD	Mean	SD
Water temperature (°C)	28.0	1.23	27.6	1.25
Salinity (ppt)	34.6	0.81	35.3	0.64
Cloud cover (Okta)	2.4	0.60	2.7	0.90
Wind force (Beaufort)	2.0	0.69	2.2	0.53
Rainfall (mm)	29.6	27.44	29.0	26.48
Tide height (m)	0.9	0.17	0.9	0.12
Zooplankton (no/m^3)	24.6	26.02	17.1	23.28

Table 2—Eigenvalues and percentage of variance explained by the principal axes of PCA of the two stations

	Station I		Station II	
	Eigen-value	%	Eigen-value	%
Water temperature	1.81	30.1	1.81	30.1
Salinity	1.25	20.9	1.44	24.1
Cloud cover	0.96	16.1	0.90	14.9
Wind force	0.79	13.1	0.74	12.3
Rainfall	0.64	10.7	0.71	11.8
Tide	0.55	9.1	0.41	6.8

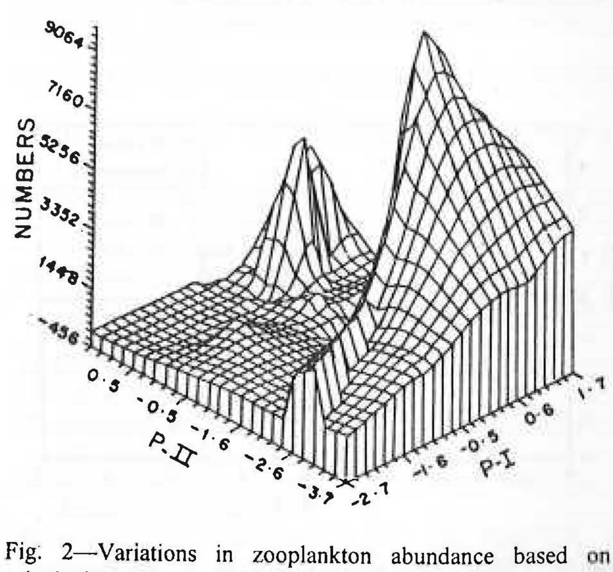

Fig. 2—Variations in zooplankton abundance based on principal components (P I and P II) at station I

Table 3—Correlations between environmental variables and principal axes

	Station I		Station II	
	Factor 1	Factor 2	Factor 1	Factor 2
Water temp.	0.70**	0.18	0.47*	-0.52**
Salinity	0.19	0.82**	0.61**	0.37
Cloud cover	0.39*	-0.02	0.77**	-0.02
Wind force	-0.67**	0.06	-0.66**	0.23
Rainfall	-0.76**	0.18	-0.14	-0.75**
Tide	-0.27	-0.73**	-0.14	-0.77**

*$P < 0.05$, **$P < 0.01$

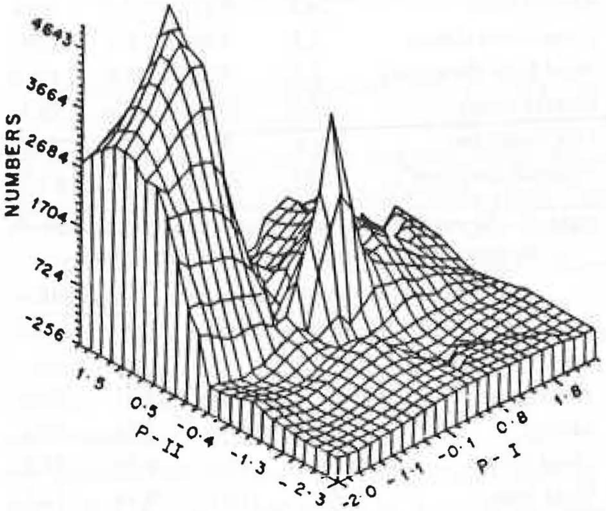

Fig. 3—Variations in zooplankton abundance based on principal components (P I and P II) at station II

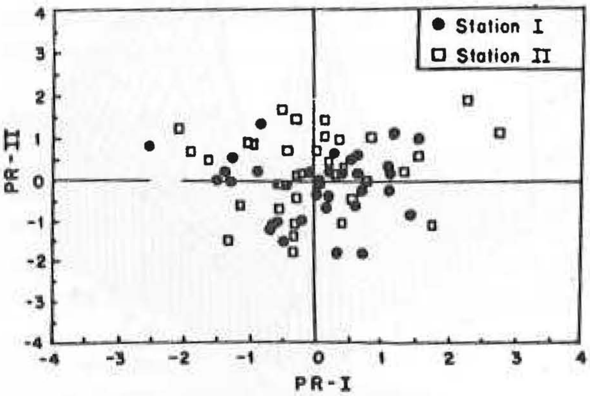

Fig. 4—Principal components analysis of environmental factors projections of observations in the plane

Table 4—Average number of zooplankton at three locations of Minicoy lagoon

Month	Number of tows	Zooplankton (no/m³) Coral	Sandy	Seagrass
Jan.	6	46.54	27.15	7.80
Feb.	2	26.48	17.25	7.33
March	5	60.93	37.36	61.74
April	5	26.02	62.00	37.38
	Mean	39.99	35.94	28.56

Discussion

A negative relation between water temperature and zooplankton abundance has been reported[8]. High incident illumination and temperature may force the plankton to take refuge in the thick growth of seagrasses[6]. Present study also indicates that temperature is an important factor affecting the abundance of zooplankton in Minicoy lagoon. However, among the three areas studied, seagrass beds, on an average, showed the least zooplankton abundance. This may be because the surface tows did not sample the zooplankton present at the bottom.

Rainfall affects zooplankton abundance at Minicoy in two ways. Firstly, the production of particulate organic matter which may serve as a source of food for zooplankton[9] is adversely affected. Secondly, environmental factors such as low light intensity, high current velocity and high rate of sediment resuspension create less favourable conditions for growth of coral during monsoon[10]. Since greater abundance of zooplankton in lagoons with better coral growth has been reported[5], these adverse conditions on coral growth may also influence the abundance of zooplankton.

Tides also influence zooplankton abundance by bringing oceanic plankton into the lagoon from surrounding sea[8]. Renon[11] found greater abundance of copepod in regions of atoll lagoons with higher oceanic input. The plankton are then retained in the lagoon by an interaction of wind and tidal currents with coral reef morphology[12]. There is little information on the water circulation in lagoons of Lakshadweep. Circulation within a lagoon may be a consequence of flow over the reef, of flow through passes due to ocean currents or tidal action, wind stress and evaporation[13]. The available information on the currents in the lagoons of Lakshadweep[4,14]

Table 5—Percentage occurrence of major groups at two stations in Minicoy lagoon

Groups	Station I	Station II
Holoplankton		
Siphonophores	0.08	8.06
Chaetognaths	0.33	7.81
Copepods	11.91	17.24
Ostracods	1.71	0.13
Meroplankton		
Fish eggs	7.07	2.05
Fish larvae	1.32	2.47
Decapod larvae	13.77	15.17
Echinoderm larvae	0.14	0.67
Gastropod juveniles	13.22	6.93
Megalopae	0.11	0.06
Polychaete juveniles	0.50	2.31
Stomatopod larvae	0.31	0.30
Bivalve juveniles	2.78	1.30
Crab juveniles	0.10	0.17
Demersal plankton		
Amphipods	22.86	19.35
Mysids	0.82	10.86
Foraminifers	2.67	3.56
Isopods	0.22	0.50
Others		
Leucifers	0.12	0.15
Pteropods	0.08	Nil
Euphausids	6.83	Nil

indicates that they are unidirectional, towards the entrance, irrespective of the tidal state. At Minicoy lagoon, the flow pattern may be the same as described by Qasim & Sankaranarayanan[9] for Kavaratti atoll, with tidal influence felt in areas even far away from the reef. Studies on emergence rate of zooplankton in the lagoons of Lakshadweep[14,15] indicate day emergence to be very poor. The sampling time in this study (0700 to 0730 hrs) coincides with the time reported[15] for maximum density in sandy substrate samples collected using a corer. This is also probably one of the reasons for the low amount of zooplankton collected by the surface net tows.

There is no spatial variation in zooplankton in relation to the presence of live coral or the nature of lagoon bottom. The occurrence of meroplankton is greater at st I when compared to st II. This may be due to the presence of the live coral shoal at st I which harbours a variety of invertebrates and the lagoon may be an ideal ground for settlement of crustaceans[16]. However, the abundance at location A seems to be a function of the water depth rather than the presence of live coral. Deeper waters are characterised by greater zooplankton density than shallow areas[17,18]. Although previous studies[19] indicate significant differences in zooplankton between sites, Minicoy lagoon appears to be homogeneous.

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