

Zooplankton composition of the Kalpeni and Agatti atolls, Lakshadweep archipelago

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Composition of zooplankton in the lagoons was quite different from that of the sea and to a large extent, was independent of oceanic influence. While copepods were dominant in the sea, meroplankton, particularly brachyuran zoeae constituted the largest group in the lagoons. Zooplankton standing stock was lower in the lagoons as compared to the sea. Among copepods, calanoids showed higher abundance in the sea whereas harpacticoids and cyclopoids dominated the Kalpeni and Agatti lagoons respectively. Several striking similarities were observed in the zooplankton composition between the coral and coastal lagoons.

Ecology of zooplankton of the coral lagoons has received considerable attention¹⁻⁶ mainly because of its unique fauna and its role in the energy transfer in coral ecosystem. Among the atoll lagoons of the Lakshadweep archipelago, zooplankton composition of the Kavaratti lagoon has been fairly well studied⁷⁻¹¹. Other lagoons like Kalpeni and Agatti however, have received very little attention. Zooplankton composition in and around these atolls was studied and is compared with similar studies from other areas.

Materials and Methods

During the 153rd cruise of *R V Gaveshani* (20 April - 4 May 1985), studies were undertaken in and around some atolls of the Lakshadweep archipelago in order to understand the biological productivity. Zooplankton samples were collected from 6 stations each outside the Kalpeni and Agatti atolls, 4 stations in Kalpeni lagoon and 3 stations in Agatti lagoon (Fig.1). All samples were collected by making surface tows using a HT net (mouth area 0.25 m², mesh width 0.3 mm) equipped with a calibrated flowmeter. As variations in zooplankton composition and abundance between the stations were not found to be significant ($P > 0.05$) within each study area, average value for each area is presented.

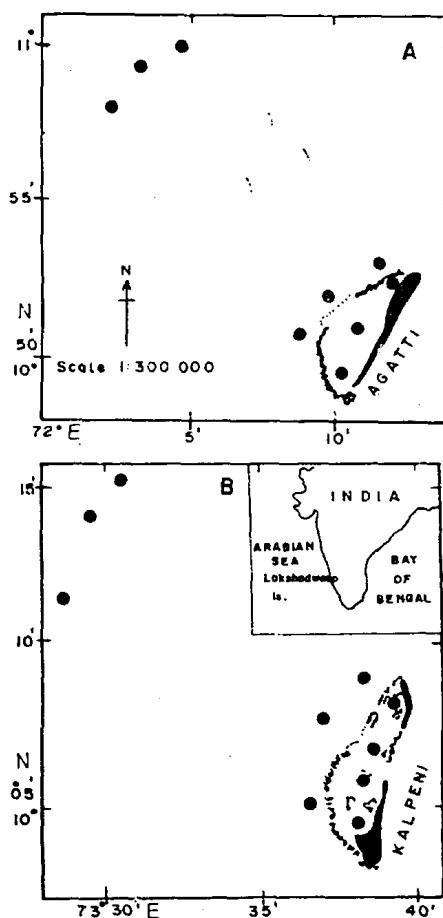


Fig. 1—Station positions inside and outside the Agatti (A) and Kalpeni (B) atolls

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Results

Zooplankton biomass and composition—A comparison of the mean biomass showed that the sea outside Kalpeni and Agatti atolls was 3 to 10 times richer [1.3 and 3.3 ml (100 m³)⁻¹] than the respective lagoon [0.13 and 1.03 ml (100 m³)⁻¹]. Corresponding numerical abundances were 1363, 3828, 305 and 5776 (100 m³)⁻¹.

Various taxonomical groups of holo- and meroplankton identified from the 4 areas are given in Table 1. Copepods formed the dominant component outside Kalpeni (75.5%) and Agatti (74.6%) atolls. On the contrary, larval decapod crustaceans dominated (71.1 and 68.2% respectively) in the lagoons. Here copepods were only the second abundant group (12.8 and 25%).

An important feature noticed in the zooplankton composition was the dominance of meroplankton in the lagoons. This formed as much as 73.8 and 74.6% of the total zooplankton counts in the Kalpeni and Agatti lagoons whereas it was only 2.8 and 6.2% respectively in the sea outside the lagoons. Among the meroplankton, larval de-

capod crustaceans dominated in the lagoons (96.3% at Kalpeni and 91.4% at Agatti). Brachyuran zoeae were the most abundant among them (>90%). Larval stages of sergestids, palaemonids, alpheid pagurids and callianassids constituted the remaining.

Among the holoplankton, Copepoda was, by far, the biggest group both in the sea and the lagoons. Its contribution was 98.4% in Agatti lagoon, but was reduced to 48.9% in Kalpeni lagoon where amphipods and cumaceans also occurred in considerable numbers (22.1 and 18.7%). Carnivores such as chaetognaths (14%) and siphonophores (8.5%) respectively formed the second largest group in the sea outside the Agatti and Kalpeni atolls.

Composition and distribution of copepods—Among copepods, calanoids were dominant in the sea (82.7 and 93.2% outside the Kalpeni and Agatti atolls) whereas harpacticoids formed 75.5% in the Kalpeni lagoon and cyclopoids formed 78% in the Agatti lagoon. Calanoids were represented by 6 families in the Kalpeni lagoon, 8 families in the Agatti lagoon and 10 families in the open waters. Families Calanidae, Paracalanidae, Pontellidae and Acartiidae were generally abundant in the sea outside both the atolls (Fig.2). Among these, Paracalanidae and Acartiidae were fairly common in both lagoons albeit in smaller numbers. Most of the other calanoid families, except Calanidae at Agatti, were either poorly represented or absent in the lagoons.

Table 1—Percentage composition of various taxonomical groups of holo- and meroplankton to total zooplankton in the atolls

	Kalpeni		Agatti	
	Sea	Lagoon	Sea	Lagoon
Total zooplankton [no. (100 m ³) ⁻¹]	1363	305	3828	5776
<i>Holoplankton</i> (%)				
Copepoda	75.5	12.8	74.6	25.0
Cladocera	2.5	0.12	0.62	0.12
Amphipoda	0.24	5.8	0.13	0.02
Ostracoda	0.02	0.23	0.0	0.03
Isopoda	0.01	0.18	0.0	0.0
Cumacea	0.0	4.9	0.0	0.03
Mysidacea	0.0	0.01	0.8	0.0
Euphausiacea	0.13	0.0	0.9	0.0
Chaetognatha	2.0	0.25	13.2	0.04
Tunicata	3.1	0.0	0.86	0.02
Hydromedusae	3.6	0.34	0.9	0.02
Siphonophora	8.3	1.3	1.7	0.0
Pteropoda	1.5	0.15	0.0	0.02
<i>Meroplankton</i> (%)				
Decapod larvae	1.05	71.1	1.2	68.2
Stomatopod larvae	0.03	0.16	0.08	0.68
Cirripede larvae	0.01	0.1	0.0	0.02
Fish eggs & larvae	1.3	1.5	4.6	0.6
Mollusca (veligers)	0.15	0.8	0.01	5.0
Echinoderm larvae	0.01	0.12	0.02	0.0
Polychaete larvae	0.28	0.01	0.24	0.1

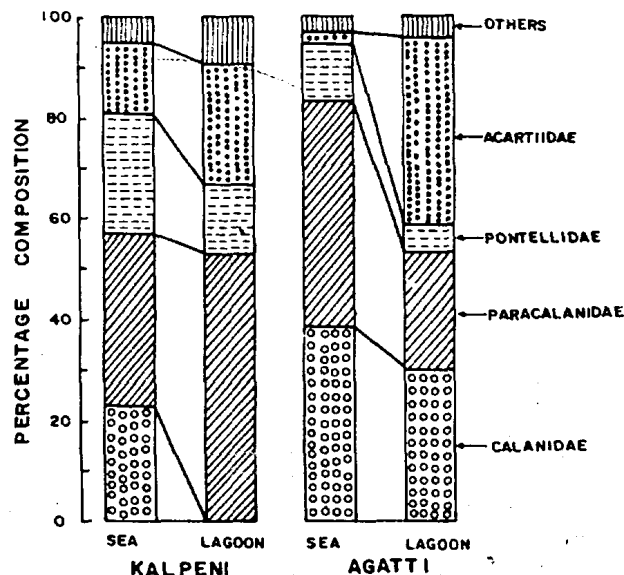


Fig. 2—Percentage composition of different families of calanoid copepods inside and outside the Kalpeni and Agatti atolls

Species composition of copepods is presented in Table 2. The calanids *Canthocalanus pauper* and *Undinula vulgaris* although absent in the Kalpeni lagoon, were abundant in the sea and Agatti lagoon. Species of Eucalanidae were not common in the present study. Paracalanids in general, were more abundant in the sea particularly outside the Agatti atoll. Among the two species belonging to the family Temoridae, *Temora discaudata* was more abundant in the sea and Agatti lagoon, but did not occur in the Kalpeni lagoon. Pontellidae were generally not very abundant in the lagoons and the surrounding sea. However, 11 out of the total 12 species recorded were from the sea and many of them were common. Their diversity and abundance however, dwindled in the lagoons. Acartiidae was represented by 6 species in the collections of which *Acartia amboinensis*, *A. danae* and *A. negligens* were more common in the open waters of the Kalpeni atoll. *A. dweepi* was collected in fairly large numbers, but only from the Agatti lagoon. Species belonging to the families Centropagidae, Candaciidae, Calocalanidae and Euchaetidae were either poorly represented or absent in the collections from the lagoons as compared to the surrounding sea.

Cyclopoid copepods were virtually absent in the sea. However, *Oithona nana* registered a density of 1107 (100 m³)⁻¹ in the Agatti lagoon which was the highest for any species in this study. All three species of poecilostomatoids were abundant in the sea of which *Corycaeus* sp. had the highest density. Of the total of 5 species of harpacticoids recorded, 3 species viz. *Euterpina acutifrons*, *Longipedia* sp. and *Metis jousseaumei* were common in the Kalpeni lagoon.

In general, species diversity¹² was high in the sea (indices were 4 at Kalpeni and 3.4 at Agatti) compared to the lagoons (2 at Kalpeni and 1.6 at Agatti). Equitability component¹³ was low in the lagoons (0.2 at Kalpeni and 0.1 at Agatti) since a few species dominated the zooplankton composition.

Discussion

The present results confirm earlier findings^{8,10,11} that zooplankton standing stock and their population density in the lagoons of the Lakshadweep archipelago are lower compared to those of the surrounding waters. This appears to be the characteristic feature of shallow coral lagoons. On the contrary, deeper lagoons such as the Moorea Island in the Pacific facilitates the establishment of higher zooplankton population densities¹⁴. Poor

Table 2 — Distribution of copepod species [no. (100 m³)⁻¹] in the atolls

Copepod species	Kalpeni		Agatti	
	Sea	Lagoon	Sea	Lagoon
Total Copepoda	1029	39	2855	1443
Order: Calanoidea				
<i>Canthocalanus pauper</i>	97.7*	0.0	309.5*	23.7*
<i>Undinula vulgaris</i>	96.0*	0.0	720.2*	59.7*
<i>Subeucalanus crassus</i>	3.0*	0.3*	1.2*	0.0
<i>Pareucalanus attenuatus</i>	1.2*	0.0	2.8*	1.0*
<i>Acrocalanus gibber</i>	7.7*	2.3*	126.2*	0.0
<i>A. monachus</i>	0.0	0.3*	4.5*	3.3*
<i>Acrocalanus</i> sp.	110.3*	0.0	404.5*	31.0*
<i>Bestiola similis</i>	72.5*	0.3*	453.3*	0.0
<i>Paracalanus</i> sp.	87.2*	0.7*	194.7*	27.7*
<i>Euchaeta rimana</i>	0.2*	0.0	9.0*	4.0*
<i>Temora discaudata</i>	25.3*	0.0	40.5*	5.7*
<i>T. turbinata</i>	0.3*	0.1*	0.0	0.3*
<i>Centropages gracilis</i>	0.2*	0.0	3.8*	0.0
<i>C. calaninus</i>	0.3*	0.1*	8.5*	0.0
<i>C. furcatus</i>	0.0	0.3*	19.2*	1.0*
<i>Candacia truncata</i>	8.1*	0.0	0.0	0.0
<i>C. pachyducylla</i>	0.2*	0.0	0.0	0.0
<i>C. catula</i>	0.0	0.0	14.0*	0.0
<i>Pontella diagonalis</i>	33.5*	0.0	5.3*	0.0
<i>P. danae</i>	0.8*	0.0	0.0	0.0
<i>P. spinipes</i>	61.2*	0.0	17.0*	0.0
<i>P. princeps</i>	21.8*	0.0	3.5*	0.0
<i>Pontella</i> sp.	22.2*	0.5*	13.3*	0.0
<i>Pontellina plumata</i>	26.2*	0.3*	226.5*	5.3*
<i>Pontellopsis villosa</i>	0.2*	0.0	6.8*	0.0
<i>Labidocera pavo</i>	0.0	0.1*	0.0	7.3*
<i>L. minuta</i>	2.7*	0.0	0.0	1.7*
<i>L. acuta</i>	6.2*	0.0	0.0	0.0
<i>L. detruncata</i>	19.8*	0.0	20.3*	1.3*
<i>Labidocera</i> sp.	3.0*	0.0	11.7*	0.0
<i>Calanopia minor</i>	3.0*	0.0	3.0*	0.0
<i>Calocalanus pavo</i>	7.0*	0.0	13.5*	0.0
<i>Acartia amboinensis</i>	99.7*	1.5*	21.2*	3.3*
<i>A. spinicauda</i>	0.0	0.0	0.0	1.0*
<i>A. danae</i>	7.5*	0.1*	4.8*	8.7*
<i>A. negligens</i>	7.2*	0.0	2.3*	24.0*
<i>A. erythraea</i>	0.8*	0.0	0.0	0.0
<i>A. dweepi</i>	0.0	0.0	0.0	66.7*
Order: Cyclopoida				
<i>Oithona brevicornis</i>	4.7*	0.3*	0.0	0.0
<i>O. nana</i>	0.0	0.3*	0.0	1107.0*
<i>Oithona</i> sp.	0.0	0.0	0.0	19.0*
Order: Poecilostomatoida				
<i>Oncaea</i> sp.	21.2*	0.3*	50.5*	4.7*
<i>Corycaeus</i> sp.	157.0*	2.1*	139.0*	25.0*
<i>Copilia</i> spp.	12.0*	0.0	2.3*	0.0
Order: Harpacticoida				
<i>Macrosetella gracilis</i>	1.2*	0.0	1.2*	0.0
<i>Euterpina acutifrons</i>	0.0	1.3*	0.0	0.0
<i>Longipedia</i> sp.	0.2*	2.2*	0.0	10.0*
<i>Metis jousseaumei</i>	0.0	25.8*	0.0	0.0
<i>Clytemnestra scutellata</i>	0.0	0.0	1.3*	0.0

* = Present at > 50% of the stations

+ = Present at < 50% of the stations

abundance of oceanic zooplankton in these lagoons could be due to them being consumed by the reef community while on transport from sea to lagoon. However, it is known that, although important, zooplankton by themselves - be it oceanic or lagoonal - is insufficient to meet the entire metabolic requirements of the reef community^{2,5,7} and supplemental energy is derived from other sources such as detritus or through zooxanthellae¹⁵⁻¹⁷.

There are quite a few differences in the faunal composition between the lagoons and the sea. The most noticeable feature was the dominance of meroplankton inside the lagoons which is characteristic of the coral reef ecosystem^{18,19}. This is strikingly in contrast with the open waters where copepods were dominant.

Among copepods, the higher abundance of harpacticoids and cyclopoids inside the lagoons is also noteworthy. Similar observations have also been made from the Kavaratti lagoon⁷ in this archipelago and the Heron reef²⁰ and One Tree lagoon²¹ in the Great Barrier Reef. The species composition is particularly interesting. The calanoid *Acartia spinicauda* and the harpacticoids *E. acutifrons*, *Longipedia* sp. and *M. jousseaumei* plus the cyclopoid *O. nana* which were present in these lagoons (Table 2) are generally more common and abundant in coastal waters and coastal lagoons^{22,23} and are virtually absent in open ocean²⁴. On the other hand, harpacticoids such as *Macrosetella gracilis* and *Clytemnestra scutellata* which are common in open ocean²⁴ were absent inside the lagoons. Abundance of decapod larvae (Table 1) predominated by brachyuran zoeae as observed in the lagoons has also been reported from the tropical estuaries²³. Low species diversity and equitability in distribution, which are characteristic of tropical estuaries²⁵ are also observed in these shallow lagoons. Another parallel feature is the poor representation of carnivorous calanoid copepods inside the lagoons which is typical of the tropical estuaries²⁶. Thus there are quite a few similarities between the coral and coastal lagoons.

A number of species belonging to calanoid families Pontellidae, Acartiidae and Pseudodiaptomidae have their distribution restricted to limited distance in the open waters around oceanic islands in smaller numbers and the mechanisms

which restrict them to such narrow areas are not clear²⁶⁻²⁸. However, all these species seem to be associated with coral lagoons or reefs. It is quite possible that the individuals of these species observed in open waters are spill overs from the reef environment and that the core of their populations lie in association with the reefs.

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