

## Comparative Studies on the Abundance of Zooplankton in the Surrounding Sea & Lagoons in the Lakshadweep

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Composition and distribution of various groups and species of zooplankton at Kavaratti, Agatti and Suhelipar atolls of the Lakshadweep group of islands are reported. Higher biomass and diversity occur in the sea surrounding atolls compared to lagoons. Copepoda forms the dominant component of zooplankton. Zooplankton washed across the reef into the lagoon may be serving as food to the reef community. No fauna endemic to lagoons are encountered.

**C**ORAL reefs, lagoons and the sea surrounding the atolls of the Lakshadweep form unique habitats having special ecological interest. Since Wolfenden's<sup>1</sup> work on copepods, based on Gardiner's<sup>2</sup> collections from the Maldive and Laccadive Archipelago early this century, zooplankton of Laccadive has received little attention until recently. Zooplankton abundance at Kavaratti and Kalpeni atolls has been reported by Tranter and George<sup>3</sup>, composition of some groups at Kavaratti has been given by Goswami<sup>4</sup> and chaetognaths of the Laccadives have been studied by Nair and Rao<sup>5</sup>. Primary production at Kavaratti has been studied by Qasim and Bhattathiri<sup>6</sup> and Qasim *et al.*<sup>7</sup>, production of particulate organic matter of the reef by Qasim and Sankaranarayanan<sup>8</sup> and chemical characters of water around Kavaratti by Sankaranarayanan<sup>9</sup>. A bloom of the blue green alga *Trichodesmium* from the Laccadives has been reported by Qasim<sup>10</sup>.

A group of 20 islands constitute the Laccadive Archipelago and in the present study composition of zooplankton at Kavaratti (10°35'N; 72°36'E), Agatti (10°51'N; 72°11'E) and Suhelipar (10°04'N; 72°15'E) atolls are reported. Kavaratti lagoon is shallow, the depth being about 2 m. The lagoons at Agatti and Suhelipar are comparatively larger and deeper, the depth at some places exceed 12 m.

### Materials and Methods

Zooplankton samples were taken with a square net (area, 0.0625 m<sup>2</sup>; mesh, 300 μ) at stations located in the sea and lagoons (Fig. 1) in December 1976. Plankton samples were filtered, drained of excess water on absorbent paper and added to a known volume of water to find the displacement volume (biomass). Organisms in each sample were counted to species level wherever possible. Biomass and number of organisms given are averages of 10 min surface hauls taken during day time at the stations in sea or lagoon at each location.

Species diversity and richness for all organisms collectively; and copepods separately were calculated

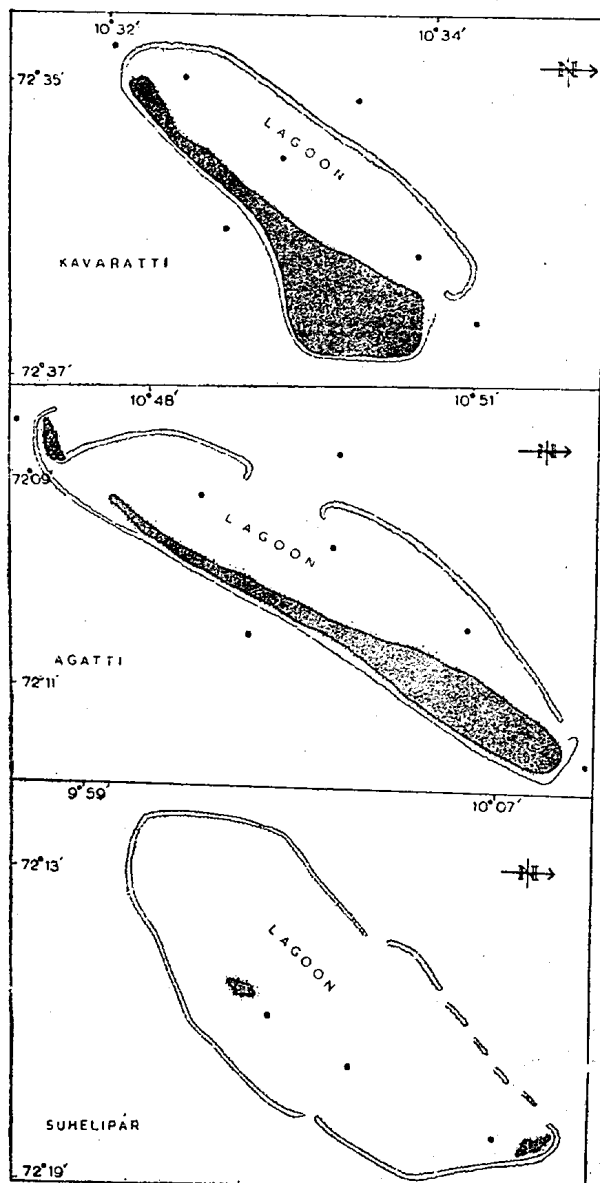


Fig. 1 — Location of stations (closed circles) at Kavaratti, Agatti and Suhelipar atolls

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using three indices for each of the different locations. Diversity index calculated according to the formula given by Fisher *et al.*<sup>11</sup>

$$S = \alpha \log_e (1 + N/\alpha)$$

where  $S$  is the number of species present in a sample and  $N$  the number of individuals of all species taken together in the sample, is similar to the Margalef index<sup>12</sup>

$$D = \frac{S-1}{\log_e N}$$

( $S$  = number of species,  $N$  = number of individuals) which expresses species richness and are density dependent formulations. Sutcliffe<sup>13</sup> has attributed greater stability to the index of Fisher *et al.*<sup>11</sup>. Shannon Weaver Index<sup>14</sup>

$$H' = - \sum_i p_i \log_e p_i$$

where  $p_i$  is the proportion of individuals in the  $i$ th species, seeks to express the distribution of individuals among various species. This index has also been found to be affected by dominance without being dependent on sample size<sup>15</sup>.

## Results

Biomass and total numbers of zooplankton were comparable and higher in the sea around Kavaratti and Agatti than in the lagoons (Table 1). Kavaratti lagoon showed very low values, higher abundance was noticed at other 2 lagoons with Suhelipar showing the maximum. Highest values were encountered (biomass, 6.2 ml; total numbers, 148459) in the collection taken in the sea east of Kavaratti.

From the relative percentages of occurrence of major groups at various areas (Table 2) it could be seen that copepods constituted the dominant component except in Kavaratti lagoon where molluscs dominated. But the ascendancy of copepods was comparatively lesser in the lagoons.

Siphonophores *Sulculeolaria chuni*, *Diphyes chamissonis*, *D. bojani*, *Lensia subteloides*, *L. subtilis*, *Abylopsis tetragona*, *A. eschscholtzi* and *Bassia bassensis* occurred in the collections from sea stations. They were absent in Kavaratti and Agatti lagoons but most of them occurred in Suhelipar lagoon albeit scantily.

Chaetognaths were represented by *Sagitta enflata*, *S. bedoti*, *S. pacifica*, *S. neglecta* and *S. regularis*. *S. neglecta* was the dominant form. Chaetognath population in the surrounding sea was about 250 times higher than Kavaratti lagoon and 45 times higher than Agatti lagoon.

Composition and abundance of the copepods that occurred in the lagoons and sea are given in Table 3. Species belonging to the genera *Paracalanus*, *Acrocalanus*, *Macrosetella*, *Microsetella*, *Oithona* and *Corycaeus* were the most common and abundant forms.

Copepods were poorly represented in Kavaratti lagoon. General reduction in abundance in the lagoons compared to the sea was noticeable for copepods also.

Decapod larvae occurred both in the lagoon and sea and consisted of crab zoea, pagurid larvae, sergestid larvae and caridean larvae. The sergestid, *Lucifer hanseni* and cladoceran *Evadne tergestina* were present except at Kavaratti lagoon. The mysids *Siriella gracilis* and *Anisomysis hanseni* were also recorded. Molluscs often consisted of large numbers of gastropods and lamellibranchs. Pteropod *Cresis* sp. and heteropods belonging to family Atlantidae were observed in some collections from the sea. Fish eggs occurred both in the sea and lagoons and were mostly of engraulids.

The euphausiid *Stylocheiron summii*, invertebrate eggs, cirripede larvae, polychaete larvae and appendicularians also occurred in the collections (Table 2). Few numbers of amphipods, ostracods, salps, doliolids, echinoderm larvae, brachiopod larvae,

TABLE 1 — BIOMASS, TOTAL NUMBER OF ZOOPLANKTON, TOTAL COPEPOD NUMBERS AND DIVERSITY INDICES  $\alpha$ ,  $H'$  AND  $D$  FOR TOTAL ZOOPLANKTON AND TOTAL COPEPODS

	Biomass* (ml)	Total numbers*	$\alpha$	$H'$	$D$	Total Copepoda*	$\alpha$	$H'$	$D$
Kavaratti Sea	4.1	58080	5.90	2.63	4.92	51250	2.41	2.1	2.12
Agatti Sea	3	44934	5.94	2.65	4.88	35287	2.45	1.82	2.1
Kavaratti lagoon	0.3	1168	3.11	2.01	2.01	278	0.85	0.46	0.71
Agatti lagoon	1.4	11790	4.96	2.35	2.88	6340	1.55	1.34	1.37
Suhelipar lagoon	1.8	19480	4.51	1.58	3.74	8890	1.77	0.54	1.53

\*Av. of 10 min hauls made at stations in each area.

TABLE 2 — RELATIVE PERCENTAGES OF MAJOR GROUPS OF ZOOPLANKTON

Location	Chaetog- natha	Poly- chaete larvae	Cirri- pede larvae	Eupha- sids	Cope- poda	Inverte- brate eggs	Decapod larvae	Mollusca	Fish eggs	Appendi- cularia
Kavaratti Sea	1.98	0.34	0.39	0.35	88.24	3.76	0.98	1.3	0.39	0.61
Agatti Sea	6.73	0.4	1.73	—	78.53	2.96	0.45	6.26	1.32	0.95
Kavaratti lagoon	0.01	0.25	—	—	23.8	8.56	13.86	45.29	—	—
Agatti lagoon	0.59	0.08	—	—	53.77	2.54	2.96	33.58	4.91	1.35
Suhelipar lagoon	1.28	0.56	—	—	44.63	30.8	0.79	18.32	0.77	0.3

stomatopod larvae and cyphonautes larvae were present in some samples taken from the sea.

Diversity indices ( $\alpha$ ,  $H'$  and  $D$ ) for both total zooplankton and total copepoda were higher and comparable in the sea surrounding Kavaratti and Agatti than the lagoons (Table 1). Among the lagoons  $\alpha$  and  $D$  showed higher values at Agatti and Suhelipar compared to Kavaratti showing greater richness.  $H'$  values were slightly higher in Kavaratti and Agatti lagoons showing more evenness in distribution than at Suhelipar lagoon.

**Discussion**

The most striking feature in the distribution of zooplankton in Lakshadweep waters was the higher abundance of zooplankton in the sea compared to the lagoons. Zooplankton population was indigent by 81.2% in Kavaratti lagoon and 72.5% in Agatti lagoon compared to the surrounding sea (14 times and twice as high respectively in the sea considering the biomass). It was reduced by 55 to 66% in Suhelipar lagoon assuming their population in the surrounding sea to be similar to that at Kavaratti and Agatti. Similar depletion in abundance at Kavaratti and Kalpeni lagoons have been reported for zooplankton by Tranter and George<sup>3</sup> and for chaetognaths by Nair and Rao<sup>5</sup>. Zooplankton is believed to be vital in coral nutrition<sup>16</sup> and it has been suggested<sup>3</sup> that the biomass lost in transit across the reef is being utilized by

the reef community. Variations in zooplankton abundance in the lagoons and surrounding sea in the present study also support this view.

A high diversity characteristic of the tropical high seas occurred in the sea surrounding the atolls. No endemicity of any group or species of zooplankton in the lagoons as suggested earlier<sup>3,4</sup> was noticed from the distribution.

Greater abundance of zooplankton in Agatti and Suhelipar lagoons compared to Kavaratti lagoon may be because they are larger and deeper and have more carrying capacity. Qasim and Sankaranarayanan<sup>8</sup> have found the production of particulate organic matter in the vicinity of Kavaratti atoll to be high and concluded that it is largely produced by the coral reefs, which they feel may be serving as a source of food for zooplankton. The coral reefs at Kavaratti are less active compared to Agatti and Suhelipar where their growth is prolific and it is possible that the production of organic matter in these reefs is higher to sustain a higher zooplankton biomass in the lagoon.

Qasim *et al.*<sup>7</sup> have observed higher primary production in the Kavaratti lagoon compared to the surrounding sea. However, details of production from other atolls are wanting to draw definite conclusions on the reasons for differences in standing crop of zooplankton. A detailed study of the different pathways of production in the various atolls of Lakshadweep will be very informative in understanding the recycling and

TABLE 3 — COMPOSITION AND DISTRIBUTION OF COPEPODS AT DIFFERENT STATIONS

[Numbers given are average of 10 min hauls made from stations in each area]

Species	Kavaratti Sea	Agatti Sea	Kavaratti lagoon	Agatti lagoon	Suhelipar lagoon
<i>Canthocalanus pauper</i> (Giesbrecht)	125	1658	—	—	15
<i>Undinula vulgaris</i> (Dana)	1327	1708	—	40	35
<i>Calocalanus pavo</i> (Dana)	1524	5	—	120	20
<i>Eucalanus attenuatus</i> (Dana)	126	30	—	—	—
<i>E. monachus</i> Giesbrecht	126	122	—	—	40
<i>Paracalanus</i> spp	15904	5783	16	680	385
<i>Acrocalanus</i> spp	2628	1381	—	280	65
<i>Euchaeta marina</i> Prestandrea	595	63	—	—	—
<i>Scolecithrix danae</i> (Lubbock)	13	—	—	—	—
<i>Centropages gracilis</i> (Dana)	—	3	—	—	—
<i>C. calaninus</i> (Dana)	150	—	—	—	—
<i>Temora stylifera</i> (Dana)	8	—	—	40	—
<i>T. discaudata</i> Giesbrecht	—	—	—	40	—
<i>Candacia bradyi</i> A. Scott	89	306	—	60	5
<i>Labidocera pavo</i> Giesbrecht	—	283	—	—	15
<i>Pontellina plumata</i> (Dana)	153	—	—	—	—
<i>Acartia erythraea</i> Giesbrecht	17	—	—	—	—
<i>A. negligens</i> (Dana)	866	731	5	80	200
<i>A. dweepei</i> n. sp.	—	52	—	—	—
<i>Macrosetella gracilis</i> (Dana)	6786	1299	—	280	40
<i>Miracia efferata</i> (Dana)	5	—	—	—	—
<i>Microsetella norvegica</i> (Boeck)	3427	1678	2	880	120
<i>Clytemnestra scutellata</i> (Dana)	125	—	—	—	—
<i>Oithona brevicornis</i> Giesbrecht	—	4	—	180	—
<i>O. plumifera</i> Baird	966	1031	—	—	—
<i>Oithona</i> spp.	2013	8527	251	1280	1630
<i>Oncea</i> sp.	1864	1743	—	86	15
<i>Corycaeus</i> spp.	13877	10553	5	2380	6240
<i>Copilia</i> sp.	375	35	—	—	—
<i>Sapphirina</i> sp.	20	33	—	—	—

utilization of energy, the much debated problem of coral nutrition and the potentiality of these waters.

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